Incidences, Characteristics, Management and Outcomes of Different Subtypes of Postoperative Delirium in Elderly Patients Admitted to the Surgical Intensive Care Unit: A Secondary Analysis of a Prospective Cohort Study

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ABSTRACT

Objective: Postoperative delirium (POD) has three subtypes: hyperactive, hypoactive, and mixed, with each having distinct features and implications. This study aimed to determine the incidence, management, and clinical outcomes of each POD subtype in elderly patients admitted to the surgical intensive care unit (SICU) after surgery.

Materials and Methods: This was a secondary analysis of a prospective cohort study of POD in the SICU. Patients aged ≥65 years admitted to the SICU and expected to stay in the SICU for >24 h were recruited. POD was screened using the Confusion Assessment Method for the ICU (CAM-ICU). Patients with positive CAM-ICU were defined as having POD and included in the analysis. The POD subtypes were categorized, pharmacological and nonpharmacological treatments were identified, and clinical outcomes were reported.

Results: Of the 300 included patients, 117 developed POD, with 20 (17.1%) having hypoactive, 45 (38.5%) hyperactive, and 52 (44.4%) mixed. Medications were prescribed in 1 (5.0%), 34 (75.6%), and 35 (67.3 %) in patients with hypoactive, hyperactive, and mixed POD, respectively (P <0.001). Patients with hypoactive POD had the longest duration of delirium, longest length of stay in both the SICU and hospital, and highest hospital mortality. Multivariate regression analysis revealed that hypoactive POD was significantly associated with increased hospital mortality (odds ratio, 3.88; 95% confidence interval, 1.15–13.11).

Conclusion: Different POD subtypes resulted in different outcomes. Although hypoactive POD had the lowest incidence, it carried the highest mortality risk.

Keywords: Postoperative delirium; psychomotor subtype; surgical intensive care unit (Siriraj Med J 2024; 76: 406-414)

INTRODUCTION

Incidence of postoperative delirium (POD), defined as an acute mental state disturbance characterized by reduced awareness and attention deficits extending up to 5 days after surgery[1], varies reported in literature, with 15%–50% in major surgeries in the elderly[2] In critically ill surgical patients, delirium is a common occurrence, affecting 45% to 90% of ICU patients.[3-5] Notably, a prospective observational study in the surgical intensive care unit (SICU) in a Thai university hospital reported an

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incidence of 24%.[6] POD is further categorized into three subtypes based on psychomotor behaviors: hyperactive, hypoactive, and mixed delirium. Hyperactive delirium is characterized by restlessness and agitation, whereas hypoactive delirium presents symptoms of drowsiness and inactivity. Mixed delirium is a combination of the aforementioned features, leading to fluctuating states of hyperactivity and hypoactivity.[7] This classification highlights that delirium is not limited to agitation; it can also manifest as lethargy and inattention. Furthermore, each subtype implies different etiological and risk factors, treatment approaches, and clinical outcomes.[8]

However, detailed information about the incidence and outcomes of individual POD subtypes remains limited. A prospective study in a medical ICU at an academic medical center found that the mixed subtype was the most prevalent (54.9%), followed by hypoactive (43.5%) and then hyperactive (1.6%).[9] Notably, advanced age was independently associated with hypoactive delirium.[9] In the case of critically ill surgical patients, a study conducted in surgical and trauma ICUs reported a significantly higher prevalence of hypoactive delirium (64% and 60%, respectively) than mixed delirium (9% and 6%, respectively) and hyperactive delirium (0% and 1%, respectively).[10] Similarly, the research that focused on SICU patients found that hypoactive delirium was the most common subtype (68%), associated with the highest 6-month mortality rate.[11] However, these studies[10,11] assessed delirium only once daily, potentially underestimating the incidence of other subtypes, and management for each subtype was insufficiently reported.

Therefore, this study aimed to determine the incidences as well as management and clinical outcomes of each POD subtype in elderly patients admitted in the SICU after surgery.

MATERIALS AND METHODS

This study was a secondary analysis of the before-and-after cohort study exploring the effectiveness of the multicomponent nonpharmacological intervention protocol designed to reduce POD incidence in elderly patients admitted to the SICU. This before-and-after cohort study was registered in the Thai Clinical Trials Registry (ID TCTR20181201001) and was approved by the Siriraj Institutional Review Board (COA no. Si 211/2018). In summary, the study included 300 patients aged 65 years or older who were admitted to the SICU within 7 days after surgery and expected to stay there for more than 24 h. The original study was conducted between June 2018 and November 2021 at two SICUs at Siriraj Hospital, Thailand. During the preintervention phase (June 2018 to September 2019), the patients received conventional medical treatments, including pain and sedation management as well as hemodynamic and respiratory care, as determined by the attending physicians. During the intervention phase (December 2019 to November 2021), they received the same medical treatments plus a multicomponent nonpharmacological intervention protocol for POD prevention, which consisted of seven components: orientation, cognition, ambulation, clearing eyes and ears, pain control, sleep promotion, and medication review. Throughout both periods, all the included patients were monitored by designated well-trained research nurses for POD using the Thai version of the Confusion Assessment Method for the ICU (CAM-ICU)[12] and the Richmond Agitation-Sedation Scale (RASS) score twice a day. The SICU nurses, with five or more years of nursing experience, were trained by three physicians. To ensure reliability among the assessors, inter-rater reliability scores were calculated. Once the kappa score reached 0.8, the trained nurses were qualified to perform the Thai CAM-ICU assessments. This intervention was started within 24 h of SICU admission and continued for 28 consecutive days or until the patients were discharged from the SICU or deceased, whichever came first. Patients with positive CAM-ICU were defined as having POD.

In this study, patients who developed POD were further categorized based on their psychomotor behaviors into three subtypes: hyperactive, hypoactive, or mixed POD. Patients with a Richmond Agitation-Sedation Scale (RASS) score between −3 and 0 were classified as having hypoactive POD and those with scores between 1 and 4 as having hyperactive POD. Patients exhibiting hyperactive and hypoactive symptoms at different times of each evaluation were considered as having mixed delirium. Data on baseline characteristics, delirium management, and clinical outcomes were analyzed. Baseline characteristics included age, gender, comorbidities, and status of smoking, alcohol consumption, and history of preoperative benzodiazepine use. Acuity of illness factors included diagnosis and surgery details, such as type (elective or emergency), site (abdomen, vascular, urologic, orthopedics, gynecologic, head and neck) of surgery, operative time, intraoperative fluid intake and blood loss, intraoperative hypotension, and intraoperative desaturation. Scores on the Acute Physiology and Chronic Health Evaluation (APACHE) II and Sequential Organ Failure Assessment (SOFA) scales, requirement of inotropes and/or vasopressors, ventilator support, presence of sepsis, laboratory values upon SICU admission and the use of midazolam or fentanyl in the ICU were also considered.

Clinical outcomes included the duration of delirium, delirium-free day, duration of mechanical ventilation, use of restraints, presence of coma (RASS score of −4 or −5), pain scores, adverse events in the SICU (self-removal of tubes, lines, and drains, agitation-related self-injury, and SICU-acquired infections), length of stay in the SICU and the hospital, and SICU and hospital discharge status. Delirium-free days were defined as the number of days without POD within a consecutive 28-day follow-up period. If a patient was discharged from the SICU before the completion of 28 days, it was presumed there was no occurrence of POD after discharge. If a patient deceased before the 28-day period had elapsed, the number of delirium-free days was recorded as zero.[13]

The primary outcome of this study was to determine the incidence of each subtype of POD in elderly patients admitted to the SICU. The secondary outcome was to compare the management and outcomes of each subtype. Based on the study by Peterson et al.[9], the mixed type was the most common, with an incidence of 54.9%. The incidence varied between 5% and 31% in other studies.[10,11,14] Using an incidence of 45%, with a 95% confidence interval of ±10%, a sample size of 96 subjects was required. To cover missing or incomplete data, 20% inflation of sample size was planned.

For descriptive statistics, continuous data were expressed as mean with standard deviation or median with interquartile range (IQR) depending on their distribution and categorical data as number with percentage. To compare the hyperactive, hypoactive, and mixed subtypes among the patients, analysis of variance was employed for continuous data and chi-squared test for categorical data. POD management, including the nonpharmacological intervention protocol, and the medications prescribed were investigated. To explore the association between each POD subtype and hospital mortality, multivariate logistic regression analysis was employed by entering hospital mortality into the model as dependent variable and POD subtypes as well as other variables that had a p-value <0.05 in the univariate analysis. For all analyses, a two-tailed test was conducted and a p-value <0.05 was considered to indicate statistical significance. Data were prepared and analyzed using PASW Statistics 18 (SPSS Inc., Chicago, IL, USA).

RESULTS

Of the 300 patients in the original study, 117 (39%) developed POD, and all were included in this secondary analysis. The distribution of POD subtypes was as follows: hypoactive in 20 (17.1%), hyperactive in 45 (38.5%), and mixed in 52 (44.4%) patients (Table 1). No significant difference in terms of age, gender, and comorbidities as well as intraoperative data was observed among those with each POD subtype, except for preoperative benzodiazepine use, which was notably higher in the hyperactive subtype (22.2% in hyperactive POD vs. 5.8% and 0.0% in mixed and hypoactive POD, respectively; $p = 0.008$) (Table 1). While the APACHE-II scores remained similar, the SOFA score on the day of ICU admission was higher in the hypoactive subtype (median 6 [IQR 4.5–9.5] vs. 4 [3–6] and 5 [3–8] in the hyperactive and mixed subtypes, respectively; $p = 0.039$) (Table 2). The BUN levels significantly increased in the hypoactive subtype (median 41.2 [IQR 14.9–61.6] mg/dL vs. 22.1 [16.0–36.8] mg/dL and 19.2 [14.4–25.7] mg/dL in the hyperactive and mixed subtypes, respectively; $p = 0.047$) (Table 2). Statistically significant, albeit not clinically significant, differences were observed in the bicarbonate levels in the hyperactive subtype (median 19 [IQR 18–23] mmol/L vs. 18 [15.5–21.5] mmol/L and 17 [15–20] mmol/L in the hypoactive and mixed subtypes, respectively; $p = 0.022$) and in the pain scores (median 2 [IQR 1–3] for hyperactive vs. 0 [0–2] for hypoactive and 1 [0–3] for mixed subtypes; $p = 0.026$) (Table 2).

Table 3 presents management of POD. Overall, there were 24 (20.5%) and 7 (6.0%) patients having geriatric and psychiatric consultation, respectively. As regards the medication treatment, quetiapine was prescribed in approximately two-thirds of patients with hyperactive and mixed subtypes. Interestingly, one patient with hypoactive POD also received quetiapine. Other drugs, including haloperidol and risperidone as well as dexmedetomidine, were prescribed in patients with hyperactive and mixed POD less frequently.

Patients with each POD subtype exhibited significant difference in the outcomes. Hyperactive POD had the shortest duration of delirium and subsequently the longest delirium-free day, whereas mixed POD had the longest duration of delirium and the shortest delirium-free day (Table 4). No difference was observed in the number of ICU adverse events among each POD subtype (Table 4). Nevertheless, patients with hypoactive POD had the longest duration of mechanical ventilation, longest ICU and hospital length of stay, and highest hospital mortality compared with those with hyperactive and mixed POD (Hospital mortality: 35.0% vs. 2.2% and 26.9% in the hyperactive and mixed subtypes; overall hospital mortality 18.8%) (Table 4). The results of univariate logistic regression analysis revealed significant associations between increased hospital mortality and various factors, including underlying diseases of cirrhosis, APACHE-II score, SOFA score, presence of shock, coma, and hypoactive

TABLE 1. Demographic and intraoperative data compared among patients with hypoactive, hyperactive, and mixed postoperative delirium.

	Hypoactive (n = 20)	Hyperactive (n = 45)	Mixed (n = 52)	*p* value
Age, years	77.4 ± 9.2	77.6 ± 8.3	76.7 ± 7.7	0.862
Male gender	10 (50%)	25 (55.6%)	27 (51.9%)	0.898
Comorbidities				
Dementia	5 (25.0%)	15 (33.3%)	18 (34.6%)	0.729
Previous stroke	0 (0.0%)	7 (15.6%)	7 (13.5%)	0.185
Hypertension	15 (75.0%)	30 (66.7%)	44 (84.6%)	0.117
Cardiac disease	5 (25.0%)	15 (33.3%)	15 (28.8%)	0.775
Diabetes mellitus	7 (35.0%)	17 (37.0%)	18 (34.6%)	0.945
Chronic kidney disease	3 (15.0%)	14 (31.1%)	13 (25.0%)	0.386
Cirrhosis	1 (5.0%)	1 (2.2%)	2 (3.8%)	0.829
Current smoking	2 (10.0%)	9 (20.0%)	10 (19.2%)	0.593
Current alcohol drinking	0 (0.0%)	4 (8.9%)	2 (3.8%)	0.277
Preoperative benzodiazepine used	0 (0.0%)	10 (22.2%)	3 (5.8%)	0.008
Site of surgery				0.193
Abdomen	12 (60.0%)	21 (46.7%)	23 (44.2%)	
Vascular	4 (20.0%)	11 (24.4%)	22 (42.3%)	
Urologic	1 (5.0%)	3 (6.7%)	1 (1.9%)	
Orthopedics	0 (0.0%)	4 (8.9%)	2 (3.8%)	
Gynecologic	1 (5.0%)	0 (0.0%)	0 (0.0%)	
Head and neck	2 (10.0%)	6 (13.3%)	4 (7.7%)	
Type of surgery				0.092
Elective	10 (50.0%)	16 (35.6%)	30 (57.7%)	
Emergency	10 (50.0%)	29 (64.4%)	22 (42.3%)	
Operative time, min	112.5 (75–240)	170 (110–250)	180 (100–270)	0.620
Intraoperative fluid intake, mL	2,072 (900–4,020)	1,935 (731.5–4,154)	2,550 (1,100–4,690)	0.632
Intraoperative blood loss, mL	325 (20–1,150)	300 (50–700)	450 (50–1,300)	0.865
Intraoperative events				
Hypotension	15 (75.0%)	37 (82.2%)	41 (78.8%)	0.792
Desaturation	2 (10.0%)	1 (2.2%)	3 (5.8%)	0.406

Data are expressed as mean ± standard deviation or median (interquartile range) or number (%).

and mixed delirium. Subsequent multivariate logistic regression analysis further clarified these relationships. Specifically, hypoactive POD demonstrated a significant association with increased hospital mortality, as evidenced by an odds ratio (OR) of 3.88 (95% confidence interval (CI), 1.15–13.11). In contrast, mixed POD exhibited a non-significant association (OR, 2.37; 95% CI, 0.93–6.03). (Table 5).

TABLE 2. ICU data compared among patients with hypoactive, hyperactive, and mixed postoperative delirium.

	Hypoactive (n = 20)	Hyperactive (n = 45)	Mixed (n = 52)	*p* value
APACHE-II score	14.5 (12–20.5)	12 (11–17)	14.5 (12–18)	0.330
SOFA score	6 (4.5–9.5)	4 (3–6)	5 (3–8)	0.039
Active infection	9 (45.0%)	21 (46.7%)	18 (34.6%)	0.448
Presence of shock	9 (45.0%)	23 (51.1%)	28 (53.8%)	0.797
Use of mechanical ventilation	18 (90.0%)	39 (86.7%)	51 (98.1%)	>0.999
Laboratory values				
Hematocrit, %	29.4 (26.5–37.6)	30 (28.6–35.1)	30.1 (25.6–34.8)	0.416
Albumin, g/dL	2.7 (2.3–3.0)	2.7 (2.4–3.3)	2.7 (2.3–3.1)	0.684
BUN, mg/dL	41.2 (14.9–61.6)	22.1 (16.0–36.8)	19.2 (14.4–25.7)	0.047
Cr, mg/dL	1.9 (1.0–3.1)	1.3 (0.8–1.8)	1.0 (0.6–1.6)	0.063
Sodium, mmol/L	138.5 (135–141)	138 (135–141)	137 (135–142)	0.844
Bicarbonate, mmol/L	18 (15.5–21.5)	19 (18–23)	17 (15–20)	0.022
pH < 7.3	5 (25.0%)	13 (28.9%)	20 (38.5%)	0.444
Midazolam used in ICU	4 (20.0%)	13 (28.9%)	20 (38.5%)	0.282
Cumulative dose, mg	4 (2–48)	2 (2–6)	3.5 (2–5.75)	0.913
Coma (RASS score of −4 or −5)	4 (20.0%)	7 (15.6%)	13 (25.0%)	0.516
Fentanyl used in ICU, cumulative dose, mcg	1,465 (580–6,340)	1,565 (550–8,653)	1,790 (710–4,555)	0.974
Pain score	0 (0–2)	2 (1–3)	1 (0–3)	0.026
Physical restrain	13 (65.0%)	36 (80.0%)	42 (80.8%)	0.319

Data are expressed as median (interquartile range) or number (%).
Abbreviations: APACHE-II, Acute Physiology and Chronic Health Evaluation II; BUN, blood urea nitrogen; Cr, Creatinine; ICU, intensive care unit; RASS, Richmond Agitation-Sedation Scale; SOFA, Sequential Organ Failure Assessment

TABLE 3. Management of postoperative delirium compared among patients with hypoactive, hyperactive, and mixed postoperative delirium.

	Hypoactive (n = 20)	Hyperactive (n = 45)	Mixed (n = 52)	*p* value
Consultation				
Geriatrician	3 (15.8%)	13 (30.2%)	8 (18.2%)	0.298
Psychiatrist	2 (10.5%)	3 (7.0%)	2 (4.5%)	0.675
Medication used	1 (5.0%)	34 (75.6%)	35 (67.3 %)	<0.001
Quetiapine	1 (5.0%)	28 (62.2%)	33 (63.5%)	<0.001
Cumulative dose, mg	375*	62.5 (25–172)	75 (31.25–125)	0.406
Haloperidol	0 (0.0%)	15 (33.3%)	9 (17.3%)	0.007
Cumulative dose, mg	–	2.5 (2.25–5)	5 (4–12.5)	0.125
Risperidone	0 (0.0%)	2 (4.4%)	1 (1.9%)	0.536
Cumulative dose, mg	–	2.5 (1–4)	1*	0.480
Dexmedetomidine	0	5 (11.1%)	2 (3.8%)	0.150
Cumulative dose, mcg	–	432 (100–2,422)	679 (668–690)	0.699

Data are expressed as median (interquartile range) or number (%).
*The drug was administered to only one patient.

TABLE 4. Clinical outcomes compared among patients with hypoactive, hyperactive, and mixed postoperative delirium.

	Hypoactive (n = 20)	Hyperactive (n = 45)	Mixed (n = 52)	*p* value
Delirium duration, day	3 (1–8)	1 (1–4)	4 (2–7)	0.001
Delirium-free day, day	25 (21–27)	27 (24–27)	24 (21–26)	0.001
ICU adverse events				
Self-removal of tube	2 (10%)	9 (20.0%)	10 (19.2%)	0.593
Self-removal of line and drain	4 (20.0%)	18 (40.0%)	15 (28.8%)	0.235
Nosocomial infection	11 (55.0%)	12 (26.7%)	19 (36.5%)	0.089
Duration of mechanical ventilation, day	7 (3–18)	5 (1–7.5)	6 (4–15.5)	0.009
ICU LOS, day	14 (5.5–19.5)	6 (4–10)	9.5 (6–17.5)	0.003
ICU mortality	1 (5.0%)	0 (0.0%)	4 (7.7%)	0.172
Hospital LOS, day	36 (19–63.5)	18 (10–32)	21.5 (16–39)	0.004
Hospital mortality	7 (35.0%)	1 (2.2%)	14 (26.9%)	0.001

Data are expressed as median (interquartile range) or number (%).
Abbreviations: ICU, intensive care unit; LOS, length of stay.
Delirium-free days, the number of days without POD within a consecutive 28-day follow-up period. If a patient was discharged from the SICU before the completion of 28 days, it was presumed there was no POD after discharge. If a patient deceased before the 28-day period had elapsed, the number of delirium-free days was recorded as zero.

TABLE 5. Factors associated with hospital mortality in 300 elderly patients with and without postoperative delirium.

	Univariate analysis			Multivariate analysis		
	OR	95% CI	p-value	OR	95% CI	p-value
Cirrhosis	4.80	1.74–13.25	0.002	5.23	1.54–17.82	0.008
APACHE-II score	1.12	1.06–1.17	<0.001	1.12	1.05–1.20	<0.001
SOFA score	1.18	1.08–1.30	<0.001	0.99	0.89–1.11	0.916
Presence of shock	2.85	1.43–5.67	0.003	2.52	1.10–5.76	0.028
Coma (RASS -4 or -5)	4.21	1.90–9.34	<0.001	2.32	0.84–6.35	0.103
Type of postoperative delirium						
No delirium (reference)			<0.001	1		
Hypoactive delirium	4.94	1.75–13.96	0.003	3.88	1.15–13.11	0.029
Hyperactive delirium	0.21	0.03–1.60	0.132	0.12	0.01–1.02	0.052
Mixed delirium	3.38	1.54–7.39	0.002	2.37	0.93–6.03	0.069

Abbreviations: APACHE-II, Acute Physiology and Chronic Health Evaluation II; SOFA, Sequential Organ Failure Assessment; BUN, blood urea nitrogen; CI, confidence interval; ICU, intensive care unit; OR, odds ratio; RASS, Richmond Agitation-Sedation Scale.

DISCUSSION

The main findings of this secondary analysis of POD in elderly patients admitted to the SICU were that mixed POD had the highest incidence among approximately 40% of patients who developed POD, followed by hyperactive and hypoactive POD. Antipsychotics were the mainstay for treating hyperactive and mixed POD. Lastly, hypoactive POD, but not the other two subtypes, was an independent factor for increased hospital mortality in elderly patients admitted to the SICU postoperatively.

The incidence of POD in our study was higher than that reported in a previous study conducted in the same SICU from 2016 to 2017[6] (40% vs. 24.4%). This disparity is likely due to differences in the study populations. The earlier study[6] had included SICU patients over the age of 18, while our study exclusively involved patients aged 65 and older. It is this difference in age that may explain the higher incidence of POD observed in our study.

Our study demonstrated that a significant portion of surgical ICU patients (44.4%) had mixed POD. This finding is consistent with those from a previous study in an ICU conducted by Peterson et al.[9], where delirium screening was also performed twice daily and mixed delirium was the most prevalent (54.9%). This prevalence may reflect the fluctuating nature of delirium, where patients exhibit hypoactive and hyperactive features alternately during their ICU stay.[15] Contrarily, several other studies have reported hypoactive POD as the most common subtype.[10,11,14] The variation in these findings may be attributed to differences in the frequency of delirium assessments. Studies that performed delirium screening only once a day might have missed the transition to hyperactive delirium at other times. Nevertheless, our study identified a significant number of patients with hypoactive delirium (17%). This subtype might be overlooked without active monitoring, highlighting the importance of regular delirium screening. Several studies, both in the ICU and non-ICU settings, have emphasized the significance of validated screening tools, as they reported that without these tools, bedside nurses and physicians often fail to recognize delirium.[16]

The association between predisposing factors and psychomotor subtypes of delirium has received limited extensive review. Observational studies suggest that delirium related to metabolic factors or organ failure tends to manifest as hypoactive, whereas delirium resulting from substance intoxication or withdrawal is typically hyperactive.[17-19] Our study aligns with this pattern, with more patients in the hyperactive group having a history of preoperative benzodiazepine use and the hypoactive group showing higher serum BUN and SOFA scores, despite similar APACHE-II scores. Abrupt discontinuation of benzodiazepine use after surgery can induce rebound insomnia, potentially leading to withdrawal hyperactive delirium in long-term users, as noted in previous research.[19,20] However, some previous studies on medical ICU patients reported a higher prevalence of hypoactive POD in older individuals, possibly due to differences in patient population.[9] Further systematic research is warranted to fully understand the association between predisposing factors and psychomotor profiles of delirium.

Pharmacological management plays a limited role in the care of patients with POD. The use of both typical (haloperidol) and atypical (quetiapine, risperidone, olanzapine) antipsychotics is recommended to address agitation accompanied by perceptual disturbances related to sleep–wake cycle irregularities and uncontrolled behavioral issues, whereas dexmedetomidine is recommended for delirium in adult patients on mechanical ventilator support when agitation impedes weaning or extubation.[16,21] Our study aligns with these recommendations, as the majority of patients who received pharmacological intervention, including the use of haloperidol, quetiapine, risperidone, and dexmedetomidine, belonged to the hyperactive and mixed delirium groups. Notably, quetiapine was the most frequently prescribed medication in this context.

In terms of clinical outcomes, the hypoactive subtype had the poorest prognosis, longest duration of mechanical ventilation, longest ICU and hospital stays, and highest hospital mortality. Even after adjusting for comorbidities, APACHE-II scores upon ICU admission, presence of shock, and coma status, the hypoactive subtype remained a significant predictor of increased hospital mortality. This finding is consistent with that of previous researches that has consistently observed worse prognosis among surgical and medical patients who developed hypoactive delirium.[11,14,22,23] The higher mortality in this subtype may have resulted from the challenges in detecting delirium and subsequent delayed treatment of precipitating factors. Prolonged mechanical ventilation in patients with hypoactive delirium could be attributed to limited consciousness and impaired coordination between the respiratory system and the brain, requiring a longer rehabilitation period.[14] Conversely, the hyperactive subtype did not predict hospital mortality in this study. Patients with this subtype may be physically healthier and exhibit agitation, as opposed to more physically compromised patients who tend to show confusion and lethargy.[22]

Our study provided updated information on the specific management and clinical outcomes of each POD subtype. However, this study has some limitations that

deserve mention. First, it was a single-center study, and half of the study was conducted during the early phase of the 2020 COVID-19 pandemic, which resulted in the postponement of elective surgeries and admission of critically ill patients requiring emergency procedures, potentially limiting the generalizability of the results to all surgical ICUs. Second, the delirium screening frequency of twice a day might be suboptimal. A subset of patients, initially classified with hypoactive delirium, exhibited behaviors such as self-removal of endotracheal tubes, lines, and drains. These actions, which led to the administration of sedation and the application of physical restraints, are inconsistent with the hypoactive classification. Consequently, a reevaluation towards a mixed subtype classification might be justified, particularly if the RASS score was assessed during these incidents. Third, the CAM-ICU was used for POD diagnosis. Despite its validation and practicality in ICU settings, CAM-ICU does not meet the gold standard of diagnostic accuracy, with its sensitivity and specificity ranging from 78-91% and 95-98% respectively[24], compared to the Diagnostic and Statistical Manual of Mental Disorders (DSM) standards. Variations in these metrics can be due to factors like mechanical ventilation use and the assessors' expertise, potentially affecting the identification of delirium subtypes.[25] Nevertheless, we chose CAM-ICU for delirium screening in this study because it is considered a practical screening tool in the ICU.[16] Fourth, the study included a relatively small number of cases with hypoactive delirium. This limited sample size may have led to the observed non-significant results when comparing this group to the other two delirium subtypes, particularly in the percentage comparisons using Chi-Square analysis, despite noticeable differences. Typically, significant P-values were more common in comparisons involving hyperactive and mixed delirium subtypes, which had a larger number of cases, indicating that sample size and distribution across subtypes could impact statistical outcomes. Lastly, delirium screening was performed only until patients were discharged from the SICU, potentially leading to an underestimation of delirium duration. Given the exploratory nature of this research, a new, specifically designed trial is warranted to further address this issue.

CONCLUSION

Mixed POD had the highest incidence among approximately 40% of patients who developed POD, followed by hyperactive and hypoactive POD. The differential impact of delirium subtypes on patient outcomes underscores the critical need for early detection and tailored management strategies. Notably, hypoactive POD emerged as an independent predictor of increased hospital mortality, emphasizing the urgency in recognizing and addressing this less overt but more perilous form of delirium. While most patients in our study experienced mixed delirium, hypoactive delirium still constituted a substantial portion. Hence, additional research on the risk factors, prevention, and treatment of hypoactive delirium is warranted.

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Author Contributions

TS: Investigation, Formal analysis, Writing - Original Draft, Writing - Review & Editing.: SL: Investigation, Data Curation.: AN: Investigation, Data Curation.: NT: Investigation, Data Curation.: CP: Investigation, Data Curation.: CT: Formal analysis, Data Curation.: TY: Investigation, Data Curation.: OC: Conceptualization, Methodology.: AP: Conceptualization, Methodology, Validation, Formal analysis, Supervision, Funding acquisition, Writing - Original Draft, Writing - Review & Editing.

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