Supplementary materials

Suppl. Table S1. Sensitivity analysis using interpretable CAM-ICU records

A. Agreement between EHR-documented delirium and CAM-ICU-positive delirium

EHR-documented delirium status	CAM-ICU positive	CAM-ICU negative
EHR-documented delirium	573 (69.1% row; 61.5% column)	256 (30.9% row; 30.4% column)
No EHR-documented delirium	358 (38.0% row; 38.5% column)	585 (62.0% row; 69.6% column)
Agreement statistics	**Value**	
Overall agreement	0.653	
Positive agreement	0.651	
Negative agreement	0.656	
Cohen's kappa	0.309	
Kappa 95% CI	0.265–0.353	
McNemar test *P* value	<0.001	

B. Multivariable logistic regression for CAM-ICU-positive delirium

Variable	Adjusted OR	95% CI	*P* value	Direction compared with Table 2
Age, per 10-year increase	1.17	1.09–1.24	<0.001	Same direction
Male sex	0.90	0.73–1.10	0.296	Same direction
APACHE II score, per 5-point increase	1.16	1.07–1.26	<0.001	Same direction
Department (reference: Department of Critical Care Medicine)				
Taoxi Department of Critical Care Medicine	0.91	0.68–1.22	0.526	Opposite direction
Diagnosis group (reference: Other)				
Shock/cardiovascular	0.84	0.54–1.29	0.414	Same direction
Neurological	1.30	0.78–2.14	0.310	Same direction
Respiratory infection	1.22	0.84–1.78	0.298	Same direction
Gastrointestinal/hepatic/metabolic	0.64	0.47–0.86	0.003	Opposite direction
Renal/metabolic	0.75	0.50–1.13	0.169	Opposite direction
Trauma	1.53	1.08–2.16	0.016	Same direction
Postoperative/surgical	1.37	0.82–2.29	0.234	Opposite direction
Deep sedation	2.02	1.51–2.69	<0.001	Opposite direction
Mechanical ventilation	1.60	1.25–2.04	<0.001	Same direction
Propofol use	1.74	1.40–2.18	<0.001	Same direction
Dexmedetomidine use	1.31	1.05–1.63	0.017	Same direction
Opioid analgesic use	1.88	1.50–2.36	<0.001	Same direction

The sensitivity analysis was restricted to ICU stays with interpretable CAM-ICU records. CAM-ICU-positive delirium was used as the outcome in the multivariable logistic regression model. The model included the same covariates as the primary EHR-documented delirium model whenever estimable. Age was modeled per 10-year increase and APACHE II score per 5-point increase. Direction compared with Table 2 indicates whether the adjusted odds ratio was in the same direction as the primary EHR-documented delirium model. CAM-ICU and EHR-documented delirium should not be interpreted as interchangeable measures. Differences in the direction of association, particularly for deep sedation, may reflect differences in assessment feasibility, documentation, and outcome definition. Abbreviations: CAM-ICU, Confusion Assessment Method for the Intensive Care Unit; APACHE II, Acute Physiology and Chronic Health Evaluation II; OR, odds ratio; CI, confidence interval.

Suppl. Table S2. Univariable logistic regression for EHR-documented delirium occurrence

Variable	Category or unit	EHR-documented delirium / total, *n/N*	Crude OR	95% CI	*P* value	Included in multivariable model
Age, per 10-year increase	per 10-year increase	843/1843	1.28	1.21–1.36	<0.001	Yes
Male sex	Female	354/801	Reference			Yes
	Male	489/1042	1.12	0.93–1.34	0.243	Yes
APACHE II score, per 5-point increase	per 5-point increase	843/1843	1.20	1.13–1.28	<0.001	Yes
Department	Department of Critical Care Medicine	708/1558	Reference			Yes
	Taoxi Department of Critical Care Medicine	135/285	1.08	0.84–1.39	0.549	Yes
Diagnosis group	Other	273/649	Reference			Yes
	Shock/cardiovascular	46/130	0.75	0.51–1.12	0.158	Yes
	Neurological	54/105	1.46	0.96–2.20	0.074	Yes
	Respiratory infection	97/183	1.55	1.12–2.16	0.009	Yes
	Gastrointestinal/hepatic/metabolic	152/317	1.27	0.97–1.66	0.084	Yes
	Renal/metabolic	72/145	1.36	0.95–1.95	0.096	Yes
	Trauma	106/225	1.23	0.90–1.66	0.188	Yes
	Postoperative/surgical	43/89	1.29	0.83–2.01	0.265	Yes
Deep sedation	No deep sedation	719/1443	Reference			Yes
	Deep sedation	124/400	0.45	0.36–0.57	<0.001	Yes
Mechanical ventilation	No mechanical ventilation	190/525	Reference			Yes
	Mechanical ventilation	653/1318	1.73	1.41–2.13	<0.001	Yes
Propofol use	No propofol use	291/920	Reference			Yes
	Propofol use	552/923	3.22	2.66–3.89	<0.001	Yes
Dexmedetomidine use	No dexmedetomidine use	454/1241	Reference			Yes
	Dexmedetomidine use	389/602	3.17	2.58–3.88	<0.001	Yes
Opioid analgesic use	No opioid analgesic use	287/676	Reference			Yes
	Opioid analgesic use	556/1167	1.23	1.02–1.49	0.031	Yes

Univariable logistic regression models were fitted separately for each candidate variable, with EHR-documented delirium as the outcome. Age was modeled per 10-year increase and APACHE II score per 5-point increase. Reference categories were female sex, Department of Critical Care Medicine, Other diagnosis group, no deep sedation, no mechanical ventilation, no propofol use, no dexmedetomidine use, and no opioid analgesic use. Variables listed in this table were prespecified candidate

covariates for the multivariable EHR-documented delirium model; APACHE II, Acute Physiology and Chronic Health Evaluation II; OR, odds ratio; CI, confidence interval.

Suppl. Table S3. Multicollinearity diagnostics and model performance of multivariable models

A. Model-level diagnostics

A1. Model sample size and performance

Model	*n*	Events or outcome	Number of parameters	Events per parameter or R^2	AUC / C-statistic	Brier score or RMSE	Hosmer–Lemeshow *P* value
EHR-documented delirium occurrence model	1843	843 events; 1,000 non-events	16	52.7	0.775	0.192	0.322
Persistent EHR-documented delirium model	828	512 persistent events; 316 non-events	16	32.0	0.737	0.197	0.410
Delirium duration model	828	Log-transformed delirium duration	16	0.172	not applicable	1.069	not applicable

A2. Model stability diagnostics

Model	Maximum VIF	Complete or quasi-complete separation	Variables not estimable	Diagnostic interpretation
EHR-documented delirium occurrence model	1.26	no	none	Acceptable discrimination and no concerning multicollinearity
Persistent EHR-documented delirium model	1.32	no	none	Acceptable discrimination and no concerning multicollinearity
Delirium duration model	1.32	not applicable	none	No concerning multicollinearity in the duration model

B. Variable-level VIF diagnostics

Model	Variable	Design-matrix term	VIF	Multicollinearity flag
EHR-documented delirium occurrence model	diagnosis_Trauma	diagnosis_Trauma	1.26	No concerning multicollinearity
EHR-documented delirium occurrence model	diagnosis Gastrointestinal/ hepatic/metabolic	diagnosis_Gastrointestinal/ hepatic/metabolic	1.26	No concerning multicollinearity
EHR-documented delirium occurrence model	mechanical_ventilation_ any	mechanical_ventilation_any	1.24	No concerning multicollinearity
EHR-documented delirium occurrence model	opioid	opioid	1.24	No concerning multicollinearity
EHR-documented delirium occurrence model	propofol	propofol	1.24	No concerning multicollinearity
EHR-documented delirium occurrence model	diagnosis_Respiratory infection	diagnosis_Respiratory infection	1.23	No concerning multicollinearity
EHR-documented delirium occurrence model	apache_ii_per5	apache_ii_per5	1.20	No concerning multicollinearity
EHR-documented delirium occurrence model	deep_sedation	deep_sedation	1.20	No concerning multicollinearity
EHR-documented delirium occurrence model	diagnosis Renal/metabolic	diagnosis_Renal/metabolic	1.19	No concerning multicollinearity
EHR-documented delirium occurrence	diagnosis_Shock/ cardiovascular	diagnosis_Shock/cardiovascular	1.17	No concerning multicollinearity

Model	Variable	Design-matrix term	VIF	Multicollinearity flag
model				
Persistent EHR-documented delirium model	opioid	opioid	1.32	No concerning multicollinearity
Persistent EHR-documented delirium model	mechanical_ventilation_any	mechanical_ventilation_any	1.30	No concerning multicollinearity
Persistent EHR-documented delirium model	diagnosis_Gastrointestinal/hepatic/metabolic	diagnosis_Gastrointestinal/hepatic/metabolic	1.30	No concerning multicollinearity
Persistent EHR-documented delirium model	diagnosis_Trauma	diagnosis_Trauma	1.29	No concerning multicollinearity
Persistent EHR-documented delirium model	diagnosis_Respiratory infection	diagnosis_Respiratory infection	1.28	No concerning multicollinearity
Persistent EHR-documented delirium model	propofol	propofol	1.25	No concerning multicollinearity
Persistent EHR-documented delirium model	diagnosis_Renal/metabolic	Diagnosis Renal/metabolic	1.25	No concerning multicollinearity
Persistent EHR-documented delirium model	apache_ii_per5	apache_ii_per5	1.20	No concerning multicollinearity
Persistent EHR-documented delirium model	department_taoxi	department_taoxi	1.17	No concerning multicollinearity
Persistent EHR-documented delirium model	age_per10	age_per10	1.16	No concerning multicollinearity
Delirium duration model	opioid	opioid	1.32	No concerning multicollinearity
Delirium duration model	mechanical_ventilation_any	mechanical_ventilation_any	1.30	No concerning multicollinearity
Delirium duration model	diagnosis_Gastrointestinal/hepatic/metabolic	diagnosis_Gastrointestinal/hepatic/metabolic	1.30	No concerning multicollinearity
Delirium duration model	diagnosis_Trauma	diagnosis_Trauma	1.29	No concerning multicollinearity
Delirium duration model	diagnosis_Respiratory infection	diagnosis_Respiratory infection	1.28	No concerning multicollinearity
Delirium duration model	propofol	propofol	1.25	No concerning multicollinearity
Delirium duration model	diagnosis_Renal/metabolic	diagnosis_Renal/metabolic	1.25	No concerning multicollinearity
Delirium duration model	apache_ii_per5	apache_ii_per5	1.20	No concerning multicollinearity
Delirium duration model	department_taoxi	department_taoxi	1.17	No concerning multicollinearity
Delirium duration model	age_per10	age_per10	1.16	No concerning multicollinearity

C. Consistency check against finalized main-table estimates

Model	Main table	Variable	Finalized estimate	Estimate used for diagnostics	Direction consistency	Comment
EHR-documented delirium occurrence mode	Tables 2	Finalized EHR-documented delirium occurrence-model estimates	not applicable	not applicable	consistent	Estimates used for the EHR-documented delirium occurrence-model diagnostics were directionally consistent with Table 2.

Model diagnostics are shown for the EHR-documented delirium occurrence model reported in Table 2 and for the persistent EHR-documented delirium and delirium duration models included in Suppl. Table S3. Variance inflation factors were calculated from the final design matrices, excluding intercept terms. For logistic regression models, discrimination was assessed using the area under the receiver operating characteristic curve, and calibration was assessed using the Hosmer–

Lemeshow test. The delirium duration model used log-transformed delirium duration consistent with the finalized duration analysis. These diagnostics were intended to assess model stability and should not be interpreted as validation of a prediction model or causal model; AUC, area under the curve; VIF, variance inflation factor; RMSE, root mean squared error.

Suppl. Table S4. Variable definitions, coding rules, and outcome definitions

A. Analysis populations and outcome definitions

Variable or analysis set	Definition	Coding or unit	Included population	Used in analyses	Notes
Primary retrospective ICU cohort	Adult ICU stays with complete key records required for EHR-documented delirium analysis	analysis set primary = 1	*n* = 1843	Tables 1–2; Diagram 1	Do not report raw exported base counts in the table.
EHR-documented delirium	Delirium documented in the retrospective ICU record during the ICU stay; the available data did not reliably distinguish delirium present at ICU admission from delirium first documented after ICU admission.	1 = EHR-documented delirium; 0 = no EHR-documented delirium	Primary retrospective ICU cohort	Tables 1–2; Suppl. Tables S2–S3	Primary retrospective documentation-derived outcome.
CAM-ICU interpretable record	CAM-ICU record with interpretable positive or negative result	1 = interpretable; 0 = not interpretable or unavailable	*n* = 1772	Table S1	Used only for sensitivity and concordance analyses.
CAM-ICU-positive delirium	Positive CAM-ICU result among interpretable CAM-ICU records	1 = CAM-ICU positive; 0 = CAM-ICU negative	CAM-ICU interpretable records	Table S1	Sensitivity-analysis outcome, not the primary outcome.
Positive delirium duration	EHR-documented delirium with delirium duration hours > 0	hours	*n* = 828	Suppl. Table S3	Non-positive duration records were excluded from persistence and duration analyses.
Persistent EHR-documented delirium	Delirium duration ≥ 48 h among EHR-documented delirium patients with positive delirium duration	1 = duration ≥ 48 h; 0 = 0 < duration <48 h	*n* = 828	Suppl. Table S3	48-h threshold was prespecified for persistence analysis; Persistent EHR-documented delirium *n* = 512 and non-Persistent EHR-documented delirium *n* = 316.
Delirium duration	Duration of EHR-documented delirium among ICU stays with positive recorded duration	hours; log-transformed in the duration model	*n* = 828	Suppl. Table S3	Right-skewed distribution

B. Retrospective ICU cohort predictors

B1. Retrospective ICU cohort predictors: definitions and coding

Variable	Source or cleaned field	Definition	Coding or unit
Age	age	Age at ICU admission	per 10-year increase in regression models
Sex	sex	Biological sex recorded in ICU data	male vs female
APACHE II score	apache_ii	Acute Physiology and Chronic Health Evaluation II score	per 5-point increase in regression models

Variable	Source or cleaned field	Definition	Coding or unit
Department	department	ICU department where the stay occurred	categorical variable
Diagnosis group	diagnosis_group	Primary diagnosis group classified for ICU admission	categorical variable
Deep sedation	deep_sedation	Deep sedation status based on RASS or cleaned sedation-depth indicator	1 = deep sedation; 0 = no deep sedation
Mechanical ventilation	mechanical_ ventilation_any	Any recorded mechanical ventilation exposure during ICU stay	1 = yes; 0 = no
Propofol use	propofol	Recorded propofol exposure during ICU stay	1 = yes; 0 = no
Dexmedetomidine use	dexmedetomidine	Recorded dexmedetomidine exposure during ICU stay	1 = yes; 0 = no
Opioid analgesic use	opioid	Recorded opioid analgesic exposure during ICU stay	1 = yes; 0 = no

B2. Retrospective ICU cohort predictors: reference categories and interpretation

Variable	Reference category	Used in models	Notes
Age	not applicable	Tables 2, Tables S2–S3	
Sex	female sex	Tables 2, Tables S2–S3	
APACHE II score	not applicable	Tables 2, Tables S2–S3	
Department	Department of Critical Care Medicine	Tables 2, Tables S2–S3	
Diagnosis group	Other	Tables 2, Tables S2–S3	Poisoning was merged into Other for consistency with the multivariable models.
Deep sedation	no deep sedation	Tables 2, Tables S2–S3	Interpret as sedation-depth / assessment feasibility variable, not as protective effect.
Mechanical ventilation	no mechanical ventilation	Tables 1–2, Tables S2–S3	
Propofol use	no propofol use	Tables 1–2, Tables S2–S3	
Dexmedetomidine use	no dexmedetomidine use	Tables 1–2, Tables S2–S3	
Opioid analgesic use	no opioid analgesic use	Tables 1–2, Tables S2–S3	

C. Nurse survey variables and barrier-score definitions

C1. Nurse survey variables: definitions and scale

Variable	Definition	Coding or scale
Nurse survey respondents	Valid nurse questionnaire responses included in the primary survey analysis	*n* = 183
Likert barrier items	Eighteen nurse-perceived Delirium prevention in the ICU implementation-barrier items	18-item 5-point Likert scale; higher score indicates greater perceived barrier
Total barrier score	Mean score across all 18 barrier items	continuous score
Domain scores	Mean scores of theoretical barrier domains	Individual/knowledge; Staffing/ workload; Organizational and multidisciplinary support; Environment/sleep; Patient-related
Corrected item-total correlation	Correlation between each item and the total scale excluding that item	continuous coefficient
Cronbach's alpha if item deleted	Total scale Cronbach's alpha recalculated after deleting each item	coefficient
EFA factor loading	Rotated exploratory factor loading for each barrier item	factor loading coefficient

Variable	Definition	Coding or scale
Low-quality questionnaire flag	Questionnaire with both short completion time and straight-lining across all 18 Likert items	1 = obvious low-quality response; 0 = otherwise

C2. Nurse survey variables: analytic use and notes

Variable	Used in analyses	Notes
Nurse survey respondents	Table 3; Suppl. Tables S5–S8	All valid questionnaires retained in primary analysis.
Likert barrier items	Table 3; Suppl. Tables S5–S8	
Total barrier score	Table 3; Suppl. Tables S5–S8	
Domain scores	Table 3; Suppl. Tables S6–S7	Theoretical domains retained for interpretation and not redefined by EFA.
Corrected item-total correlation	Table S5	
Cronbach's alpha if item deleted	Table S5	
EFA factor loading	Table S6	Exploratory only; not a confirmatory factor structure.
Low-quality questionnaire flag	Table S8	Excluded only in sensitivity analysis; retained in primary analysis.

D. Statistical coding and interpretation rules

Rule	Definition or implementation	Applied to	Notes
Reference category rule	Reference categories were female sex, Department of Critical Care Medicine, Other diagnosis group, and no exposure for binary treatment variables	Regression models	
Continuous-variable scaling	Age modeled per 10-year increase; APACHE II modeled per 5-point increase	Table 2; Suppl. Tables S2–S3	
Diagnosis grouping rule	Poisoning was merged into Other for consistency with multivariable diagnosis grouping	Table 2; Suppl. Tables S2–S3	
Persistence threshold	Persistent EHR-documented delirium defined as delirium duration > = 48 h	Suppl. Table S3	
Duration transformation	Duration model used log-transformed delirium duration	Suppl. Table S3	
Causal-language restriction	Associations and implementation targets should not be interpreted as causal effects or validated interventions	All analyses	
Deep sedation interpretation	Deep sedation findings should be interpreted in relation to documentation, sedation depth, and assessment feasibility, not as protective effect	Table 2; Suppl. Tables S2–S3	

This table summarizes variable definitions, coding rules, reference categories, and analysis-set definitions used in the retrospective ICU cohort and nurse survey analyses. The table is intended to clarify analytic definitions and does not report additional statistical modeling. Deep sedation variables should be interpreted in relation to sedation depth, documentation, and assessment feasibility rather than as protective effects. Abbreviations: APACHE II, Acute Physiology and Chronic Health Evaluation II; CAM-ICU, Confusion Assessment Method for the Intensive Care Unit; RASS, Richmond Agitation-Sedation Scale; EFA, exploratory factor analysis.

Suppl. Table S5. Full ranking and item-level analysis of nurse-perceived barriers to delirium prevention in the ICU

Rank	Item code	Barrier item	Theoretical domain	Mean ± SD	Median (IQR)	Corrected item–total correlation	Cronbach's alpha if item deleted
1	D1	Noise in the ICU environment, including device sounds and alarms, seriously interferes with patients' sleep and emotional stability	Environment/sleep barriers	3.63 ± 1.16	4.00 (3.00–5.00)	0.616	0.937
2	B3	Frequent night shifts disrupt nurses' circadian rhythms and reduce their ability to manage patients' sleep–wake cycles	Staffing/workload barriers	3.45 ± 1.21	4.00 (3.00–4.00)	0.653	0.936
3	C3	Insufficient multidisciplinary support from physicians, pharmacists, and rehabilitation therapists for delirium prevention	Organizational and multidisciplinary support barriers	3.42 ± 1.15	3.00 (3.00–4.00)	0.736	0.934
4	D2	Excessive nighttime light exposure (>20 lux) interferes with patients' circadian rhythm regulation	Environment/sleep barriers	3.41 ± 1.10	3.00 (3.00–4.00)	0.591	0.937
5	E3	Resource or workflow barriers limit non-pharmacological interventions such as early mobilization and acupuncture analgesia	Patient-related barriers	3.41 ± 0.98	3.00 (3.00–4.00)	0.702	0.935
6	E1	Lack of tailored delirium prevention protocols for older or mechanically ventilated patients, such as sensory stimulation and sleep regulation	Patient-related barriers	3.40 ± 1.03	3.00 (3.00–4.00)	0.734	0.934
7	E2	Insufficient recognition of delirium risk among patients receiving multiple medications, such as anticholinergic agents	Patient-related barriers	3.36 ± 0.98	3.00 (3.00–4.00)	0.772	0.934
8	B1	Insufficient staffing leads nurses to prioritize urgent tasks such as vital-sign monitoring, delaying delirium assessment	Staffing/workload barriers	3.34 ± 1.12	4.00 (3.00–4.00)	0.69	0.935
9	D3	Staffing constraints prevent timely responses to patients' psychological needs, such as explaining treatment and relieving anxiety	Environment/sleep barriers	3.31 ± 1.11	3.00 (3.00–4.00)	0.719	0.934
10	B2	High workload makes it difficult for nurses to complete dynamic delirium assessment every shift	Staffing/workload barriers	3.20 ± 1.14	3.00 (2.00–4.00)	0.671	0.935
11	B4	Non-clinical duties, including teaching, research, assessment, and competitions, reduce time available for preventive care	Staffing/workload barriers	3.19 ± 1.17	3.00 (2.00–4.00)	0.62	0.937
12	A2	Limited proficiency in standardized delirium assessment tools such as CAM-ICU and ICDSC, requiring repeated consultation of guidelines	Individual/knowledge barriers	3.08 ± 1.07	3.00 (2.00–4.00)	0.647	0.936
13	C2	Delirium training is insufficiently tailored to nurses' years of experience and professional title	Organizational and multidisciplinary support barriers	3.07 ± 1.13	3.00 (2.00–4.00)	0.606	0.937
14	C4	Insufficient delirium management resources, including assessment tools, sedation protocols, and early mobilization equipment	Organizational and multidisciplinary support barriers	3.03 ± 1.12	3.00 (2.00–4.00)	0.685	0.935
15	A3	Incomplete understanding of the ABCDEF bundle, including coordinated pain control and early mobilization	Individual/knowledge barriers	3.02 ± 0.99	3.00 (3.00–4.00)	0.643	0.936
16	A1	Insufficient knowledge of delirium mechanisms, risk factors, and early recognition	Individual/knowledge barriers	3.01 ± 0.95	3.00 (3.00–3.00)	0.647	0.936
17	C1	Lack of dedicated training in delirium assessment	Organizational and multidisciplinary support barriers	2.98 ± 1.24	3.00 (2.00–4.00)	0.584	0.937
18	A4	Difficulty implementing individualized sedation management, such as daily awakening and light-sedation strategies	Individual/knowledge barriers	2.78 ± 1.08	3.00 (2.00–3.00)	0.571	0.937

Barrier items were scored on a 5-point Likert scale, with higher scores indicating greater perceived implementation barriers. Items were ranked by mean score in descending order. Corrected item–total correlations and Cronbach's alpha if items deleted were calculated using the 18-item total barrier scale.

Suppl. Table S6. Exploratory structural assessment of the nurse-perceived barrier scale

A. Sampling adequacy and reliability

Measure	Value
Sample size	183
Number of Likert items	18
Total scale Cronbach's alpha	0.939
KMO statistic	0.914
Bartlett's test of sphericity, chi-square	2253.66
Bartlett's test df	153
Bartlett's test *P* value	<0.001
Number of extracted factors	3
Extraction method	exploratory principal component analysis
Rotation method	Varimax rotation

B. Eigenvalues and explained variance

Factor	Eigenvalue	Variance explained, %	Cumulative variance explained, %
Factor 1	8.9698	49.83	49.83
Factor 2	1.8687	10.38	60.21
Factor 3	1.2075	6.71	66.92

C. Rotated factor loading matrix

Item code	Barrier item, short label	Theoretical domain	Factor 1	Factor 2	Factor 3	Primary loading	Cross-loading flag
A1	Insufficient knowledge of delirium mechanisms	Individual/knowledge barriers	0.241	–0.765	0.156	–0.765	no
A2	Limited proficiency in CAM-ICU/ICDSC tools	Individual/knowledge barriers	0.100	–0.772	0.320	–0.772	no
A3	Incomplete understanding of ABCDEF bundle	Individual/knowledge barriers	0.128	–0.785	0.271	–0.785	no
A4	Difficulty with individualized sedation management	Individual/knowledge barriers	0.172	–0.699	0.186	–0.699	no
B1	Insufficient staffing	Staffing/workload barriers	0.305	–0.266	0.744	0.744	no
B2	High workload limiting dynamic delirium assessment	Staffing/workload barriers	0.292	–0.201	0.804	0.804	no
B3	Frequent night shifts	Staffing/workload barriers	0.196	–0.257	0.818	0.818	no
B4	Non-clinical duties reducing preventive care time	Staffing/workload barriers	0.325	–0.196	0.676	0.676	no
C1	Lack of dedicated delirium assessment training	Organizational and multidisciplinary support barriers	0.195	–0.637	0.250	–0.637	no
C2	Training not tailored by experience/title	Organizational and multidisciplinary support barriers	0.270	–0.635	0.201	–0.635	no
C3	Insufficient multidisciplinary support	Organizational and multidisciplinary support barriers	0.527	–0.487	0.302	0.527	yes
C4	Insufficient delirium management resources	Organizational and multidisciplinary support barriers	0.430	–0.642	0.149	–0.642	no
D1	ICU environmental noise	Environment/sleep barriers	0.817	–0.125	0.176	0.817	no
D2	Excessive nighttime light exposure	Environment/sleep barriers	0.888	–0.032	0.157	0.888	no
D3	Delayed response to patients'	Environment/sleep barriers	0.631	–0.295	0.388	0.631	no

Item code	Barrier item, short label	Theoretical domain	Factor 1	Factor 2	Factor 3	Primary loading	Cross-loading flag
	psychological needs						
E1	Lack of tailored protocols for older or mechanically ventilated patients	Patient-related barriers	0.710	–0.335	0.270	0.710	no
E2	Insufficient recognition of medication-related delirium risk	Patient-related barriers	0.705	–0.372	0.305	0.705	no
E3	Barriers to non-pharmacological interventions	Patient-related barriers	0.763	–0.201	0.310	0.763	no

Exploratory factor analysis was conducted for the 18-item nurse-perceived barrier scale. Factor loadings are presented after rotation, and values are shown to three decimal places. The theoretical domains were retained for interpretation and were not redefined based on the exploratory factor solution. Primary loading was defined as the largest absolute loading for each item. Cross-loading was flagged when at least two factor loadings were ≥0.40 in absolute value and the difference between the two largest absolute loadings was <0.20. EFA, exploratory factor analysis; KMO, Kaiser–Meyer–Olkin.

Suppl. Table S7. Comparison of nurse-perceived barrier scores across respondent characteristics

A. Total barrier score across respondent characteristics

Characteristic	Category	*n*	Total barrier score, median (IQR)	*P* value	Statistical test
Sex	Male	41	3.11 (2.67–3.44)	0.056	Mann–Whitney *U* test
	Female	142	3.33 (3.00–3.72)		
Age group, years	<25	28	3.06 (2.76–3.40)	0.004	Kruskal–Wallis test
	26–35	102	3.22 (2.94–3.65)		
	36–45	49	3.56 (3.11–4.00)		
	>45	4	2.78 (2.61–3.01)		
Education level	Diploma/associate degree	21	3.00 (2.44–3.22)	0.021	Kruskal–Wallis test
	Bachelor's degree	160	3.33 (3.00–3.72)		
	Master's degree or above	2	3.58 (3.51–3.65)		
Years of ICU experience	<2	46	3.06 (2.54–3.43)	0.004	Kruskal–Wallis test
	2–5	25	3.17 (3.00–3.44)		
	6–10	45	3.39 (3.00–3.72)		
	>10	67	3.50 (3.06–3.97)		
Professional title	Nurse/junior nurse	99	3.11 (2.81–3.53)	0.008	Kruskal–Wallis test
	Nurse-in-charge	79	3.44 (3.00–3.94)		
	Senior nurse or above	5	3.11 (3.11–3.39)		
ICU bed capacity	<10	38	3.39 (3.00–3.71)	0.413	Kruskal–Wallis test
	10–20	64	3.31 (2.99–3.56)		
	>20	81	3.11 (2.89–3.72)		

B. Domain-level *P* values across respondent characteristics

Characteristic	Individual/ knowledge barriers	Staffing/workload barriers	Organizational and multidisciplinary support barriers	Environment/ sleep barriers	Patient-related barriers
Sex	0.121	0.578	0.004	0.194	0.340
Age group, years	0.263	0.120	0.009	0.006	0.014
Education level	0.665	0.017	0.002	0.141	0.436
Years of ICU experience	0.241	0.122	0.013	0.011	0.002
Professional title	0.127	0.107	0.041	0.015	<0.001

Characteristic	Individual/ knowledge barriers	Staffing/workload barriers	Organizational and multidisciplinary support barriers	Environment/ sleep barriers	Patient-related barriers
ICU bed capacity	0.322	0.385	0.121	0.947	0.281

Values are presented as median (interquartile range) unless otherwise indicated. Barrier scores were derived from 5-point Likert items, with higher scores indicating greater perceived implementation barriers. Two-group comparisons were performed using the Mann–Whitney *U* test, and multi-group comparisons were performed using the Kruskal–Wallis test. These analyses were exploratory and should not be interpreted as causal. IQR, interquartile range. No *post hoc* pairwise comparisons were performed.

Suppl. Table S8. Questionnaire quality control and sensitivity analysis of nurse-perceived barriers

A. Questionnaire quality-control summary

Quality-control indicator	Definition	n	Percentage, %
Total questionnaires included in the primary analysis	All valid questionnaires retained for the primary nurse survey analysis	183	100.0
Likert item missing	Any missing response among the 18 Likert items	0	0.0
Short completion time	Completion time <60 seconds	13	7.1
Straight-lining across all 18 Likert items	Identical responses across all 18 Likert items	27	14.8
Both short completion time and straight-lining	Completion time <60 seconds and identical responses across all 18 Likert items	7	3.8
Total score mismatch, if total score was available	Raw total score did not match the sum of the 18 Likert items	0	0.0
Questionnaires retained in the primary analysis	Questionnaires retained for the primary analysis	183	100.0
Questionnaires excluded only in sensitivity analysis	Obvious low-quality responses excluded only in the sensitivity analysis	7	3.8

B. Sensitivity analysis after excluding obvious low-quality questionnaires

Analysis set	n	Total scale Cronbach's alpha	Top-ranked barrier	Top-ranked barrier mean ± SD	Spearman correlation of item ranking with primary analysis
Primary analysis, all questionnaires	183	0.939	ICU environmental noise	3.63 ± 1.16	reference
Sensitivity analysis excluding obvious low-quality questionnaires	176	0.936	ICU environmental noise	3.64 ± 1.17	1.000

C. Top 10 barrier ranking consistency

Rank in primary analysis	Barrier item, short label	Primary mean ± SD	Rank in sensitivity analysis	Sensitivity mean ± SD	Rank change
1	ICU environmental noise	3.63 ± 1.16	1	3.64 ± 1.17	0
2	Frequent night shifts	3.45 ± 1.21	2	3.46 ± 1.22	0
3	Insufficient multidisciplinary support	3.42 ± 1.15	3	3.42 ± 1.16	0
4	Excessive nighttime light exposure	3.41 ± 1.10	4	3.42 ± 1.11	0
5	Barriers to non-pharmacological interventions	3.41 ± 0.98	5	3.42 ± 0.98	0
6	Lack of tailored protocols for older or mechanically ventilated patients	3.40 ± 1.03	6	3.40 ± 1.03	0
7	Insufficient recognition of medication-related delirium risk	3.36 ± 0.98	7	3.36 ± 0.98	0
8	Insufficient staffing	3.34 ± 1.12	8	3.34 ± 1.13	0
9	Delayed response to patients' psychological needs	3.31 ± 1.11	9	3.31 ± 1.12	0
10	High workload limiting dynamic delirium assessment	3.20 ± 1.14	10	3.20 ± 1.15	0

Quality-control indicators were used to describe response patterns rather than to exclude questionnaires from the primary analysis. The primary nurse survey analysis retained all 183 questionnaires. Obvious low-quality responses were defined as questionnaires with both short completion time and straight-lining across all 18 Likert items, and were excluded only in the sensitivity analysis. Barrier items were scored on a 5-point Likert scale, with higher scores indicating greater perceived implementation barriers. Ranking consistency was assessed by comparing item ranks between the primary and sensitivity analyses.