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Original Article

Best Evidence Summary for Sedation Monitoring in Neurocritical Care Patients

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Abstract

Background and objectives: Sedation monitoring is crucial in neurosurgical intensive care units to ensure optimal patient comfort and safety. However, sedation practices vary significantly. This study aimed to evaluate and summarize the evidence related to sedation monitoring in neurocritical care patients, with a focus on identifying best practices for improving monitoring accuracy and patient outcomes.

Methods: This study was conducted as an evidence summary, following the evidence summary reporting standards of the Fudan University Evidence-based Nursing Center. The evidence on sedation monitoring management in neurocritical care patients was systematically retrieved using the 6S evidence model, including clinical decisions, best practices, guidelines, expert consensus, evidence summaries, systematic reviews, and more. Searches of domestic and international databases covered all records from the databases' inception to June 2024. Two researchers independently selected literature that met the inclusion criteria and conducted quality assessment, evidence-level evaluation, and evidence synthesis.

Results: Ten high-quality studies were ultimately included. From these, twenty pieces of best evidence were extracted, covering four categories: monitoring personnel, monitoring targets, monitoring tools, and monitoring timing and content. Among these, fifteen pieces of evidence were classified as strong recommendations, while five were classified as weak recommendations.

Conclusions: This study summarized the best evidence on sedation monitoring for neurocritical care patients, providing guidance for clinical staff to improve sedation monitoring accuracy and patient outcomes in neurosurgical intensive care units.

Introduction

The neurosurgical intensive care units (ICUs) mainly treat patients with severe traumatic brain injury, acute cerebrovascular disease, intracranial tumors, status epilepticus, *etc.*[1] Patients are exposed to various stimuli, including the disease itself, surgical trauma, mechanical ventilation, and environmental noise, often accompanied by stress reactions such as pain, agitation, and delirium. These reactions can cause fluctuations in blood pressure and intracranial pressure, increasing the risk of brain edema, rebleeding, accidental injury, and death.[2] Sedation is an important component of neurocritical care treatment. Appropriate sedation not only prevents episodes of intracranial hypertension and reduces the incidence of delirium but also has neuroprotective and brain-protective effects.[3–6] It can improve patient tolerance to invasive tubes and increase overall comfort. Conversely, inappropriate sedation may lead to prolonged mechanical ventilation, increased risk of pulmonary infection, and higher incidence of delirium.[7] Because sedation can affect a patient's neurological status and the evaluation of treatment outcomes, effective monitoring of sedation depth and related complications is essential to provide accurate feedback for sedation management. The depth of sedation directly impacts the assessment of neurological function and the judgment of treatment

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outcomes; therefore, accurate monitoring of sedation and complications is a key aspect of sedation management. This requires balancing the need for dynamic neurological assessment with the goals of patient comfort and long-term prognosis.[8]

Wang *et al*.[9] reported that the overall knowledge, attitudes, and clinical practices regarding sedation among neurosurgical critical care staff in China are suboptimal, highlighting the urgent need for specific monitoring plans to guide clinical sedation practices. Currently, various clinical guidelines and expert consensus statements focus on overall sedation and analgesia management in ICU patients, such as the guidelines issued by the Society of Critical Care Medicine and the Chinese Expert Consensus on the Treatment of Neurological Critical Illness Patients with Analgesia and Sedation (2023).[10–12] Although these documents provide comprehensive guidance, they are often lengthy, lack focus, and are less specific to sedation monitoring in neurocritical care patients.

Evidence summaries, developed by the Joanna Briggs Institute (JBI), provide a systematic method to synthesize evidence for a specific topic or research question and effectively integrate high-quality evidence.[13] It is recommended to prioritize evidence sources that have undergone rigorous quality assessment, such as authoritative guidelines, systematic reviews, and expert consensus. Relevant evidence can also be extracted from existing evidence-based summaries and authoritative resources, such as JBI and the Cochrane Library, according to specific research questions. This approach ensures that the evidence used is both high-quality and closely aligned with the research question, offering targeted and practical guidance for sedation management in neurocritical care patients.[14]

As noted, existing guidelines and expert consensus primarily address overall sedation and analgesia management in ICU patients. Literature specifically addressing sedation management in neurocritical care patients is mostly review-based, with variable evidence quality and, in some cases, conflicting conclusions. There is a lack of unified standards for the content, timing, and tools of sedation monitoring. This study aimed to identify the best evidence for sedation monitoring in neurocritical care patients through evidence-based methods, providing a reference for standardizing sedation monitoring practices in neurosurgical ICUs.

Materials and methods

Question identification

The Fudan University Evidence-based Nursing Center proposed the PIPOST model to standardize the process of establishing evidence summary questions.[15] In this study, the PIPOST model was employed to analyze the evidence-based question: P (population): neurocritical care patients aged ≥18 years; I (intervention): sedation assessment, management, and pharmacological and non-pharmacological interventions; P (professional): clinical medical staff; O (outcome): respiratory depression, incidence of delirium, medical staff knowledge regarding sedation management in neurocritical care patients, and complication incidence (e.g., unplanned extubation, prolonged mechanical ventilation, extended hospital stay); S (setting): units admitting neurocritical care patients; T (type of evidence): clinical decisions, best practices, guidelines, systematic reviews, expert consensus, evidence summaries, and randomized controlled trials. This evidence summary was reported in accordance with the standards of the Fudan University Evidence-Based Nursing Center (registration number ES20244303).

Inclusion and exclusion criteria of evidence

Inclusion criteria for this study were: (1) subjects were neurocritical care patients aged ≥18 years; (2) literature focused on sedation assessment, monitoring, and nursing interventions; (3) literature published in Chinese or English; (4) evidence types included clinical decisions, best practices, guidelines, expert consensus, evidence summaries, systematic reviews, meta-analyses, and randomized controlled trials.

Exclusion criteria were as follows: (1) literature for which the full text was unavailable or that represented duplicate publications; (2) conference proceedings, outdated guidelines, or guideline interpretations; (3) low-quality literature.

Search strategy

Using the 6S evidence pyramid model for top-down retrieval,[16] the following databases were searched: UpToDate, National Guideline Clearinghouse, JBI Evidence-Based Healthcare Center, National Institute for Health and Care Excellence, UK Intensive Care Society, British Neurosurgical Society, American Association of Neurological Surgeons, and the Society for Neuroscience. Additional searches were conducted in MedPulse and the Chinese Nursing Society website using the Chinese terms “sedation” and “management/monitoring”. Searches were also conducted in Embase, CINAHL, Web of Science, PubMed, CNKI, VIP, Wanfang, the Chinese Biomedical Literature Database, and the Chinese Medical Journal Full-Text Database. For example, the PubMed search strategy was: (((((((((guidelines) OR (systematic review)) OR (Meta analysis)) OR (evidence*)) OR (recommendation*)) OR (best practice*)) OR (consensus)) OR (criteria*)) OR (standard*)) AND (((neurological) OR (severe neurosis)) OR (NICU)) OR (NSICU)) OR (traumatic brain injury)) OR (Stroke)) OR (traumatic brain injury)) OR (cerebral hemorrhage))) AND (((monitoring) OR (evaluation)) OR (screening))) AND (sedation) NOT (((Child*) OR (Neonatal) OR (Pediatrics)). For CNKI, the search strategy was: (Subject: Neurosurgical Critical Illness) OR (Subject: NICU) AND (Subject: Sedation). References of included literature were manually retrieved. The search period covered all records up to June 13, 2024.

Literature quality evaluation

Three researchers (Xueqin Guo, Na Huang, and Shuoyi Liu) with professional backgrounds in critical care nursing, neurosurgical nursing, and evidence-based nursing independently evaluated the quality of the guidelines. Other types of evidence were independently evaluated by two researchers (Xueqin Guo and Shuoyi Liu). In cases of disagreement, a third researcher (Na Huang) was consulted to facilitate discussion and achieve consensus. The intraclass correlation coefficient (ICC) was used to assess inter-rater consistency, with an ICC > 0.75 indicating high consistency.[17] Evaluation criteria were as follows: (1) Clinical decisions were traced back to the original literature and evaluated according to the original study type; (2) Guidelines were evaluated using the Appraisal of Guidelines for Research and Evaluation Instrument II (hereinafter referred to as AGREE II)[18]; (3) Expert consensus was evaluated according to the JBI Evidence-Based Healthcare Center criteria for expert opinions and professional consensus articles (2022).[19]

Evidence extraction and summary

Two researchers (Na Huang and Yali Wan) independently read each article and extracted evidence related to sedation monitoring in neurocritical care patients. Extracted information included basic literature attributes (title, type, publication date, source, sub-

ject, and key points). For ICU sedation and analgesia management literature, recommendations relevant to sedation in neurosurgical ICU patients were extracted. For neurocritical care literature, recommendations specifically related to sedation monitoring were extracted. Evidence inconsistent with the clinical context in China or routine neurosurgical nursing practices was excluded. Evidence was integrated based on clinical applicability. Consistent evidence was presented concisely and logically without omission or bias. Complementary evidence was merged according to linguistic logic, while independent evidence was retained in its original form. In cases of conflicting evidence, priority was given to evidence of higher level, higher quality, or more recent publication. Original studies were appraised using the JBI Evidence Pre-grading System (2014 edition).[20] Evidence was classified into five levels according to study design, with Level 1 representing the highest quality and Level 5 the lowest. Subsequently, a panel discussion comprehensively evaluated evidence based on JBI criteria of feasibility, appropriateness, meaningfulness, and effectiveness. Using the JBI recommendation framework, the strength of each recommendation was graded as either a strong recommendation (Grade A) or a weak recommendation (Grade B).

Results

General characteristics of the included literature

Initially, 2,945 articles were retrieved. After importing the records into ENDNOTE 20 for deduplication and screening titles and abstracts, 188 articles remained. Following full-text review, ten articles were included, comprising two clinical decisions, four guidelines, and four expert consensus statements. The literature screening process is shown in Figure 1, and the general characteristics of the included articles are presented in Table 1.[1,10,12,21–27]

Quality evaluation of the included literature

Quality evaluation of guidelines

A total of four guidelines were included. The results of the quality assessment using AGREE II are presented in Table 2.[10,23–25] The ICC among the three investigators was 0.883.

Quality evaluation of consensus statements

Four expert consensus statements were included and evaluated according to JBI evidence-based criteria.[1,12,26,27] In the consensus by Ni *et al*.,[27] the response to item 6, "Is there any inconsistency between the proposed views and previous literature?" was "No", while all other items were rated "Yes". The other three consensus statements received "Yes" for all items.[1,11,26] The quality of these three expert consensus statements is relatively high, and they were approved for inclusion.

Quality evaluation of clinical decision-making literature

Two clinical decision-making articles were identified,[21,22] both sourced directly from UpToDate, and were included.

Evidence aggregation and generation

Through systematic retrieval, evaluation, synthesis, and analysis, the study extracted the best evidence, ultimately forming twenty key evidence items for sedation monitoring in neurocritical care patients. Among these, fifteen pieces of evidence were classified as strong recommendations, while five were classified as weak recommendations. Additionally, seven pieces of evidence were rated as Level 1, and one piece of evidence was rated as Level 2, as shown in Table 3.[1,10,12,21–27]

Discussion

Through literature analysis and evidence extraction, this study identified twenty best evidence items for sedation monitoring, categorized into four aspects: monitoring personnel, monitoring targets, monitoring tools, and timing and content of monitoring (Table 3).

Goal-directed sedation and scientific sedation monitoring

Evidence items 4 to 7 summarize the indications and target values for sedation in neurocritical care patients. Currently, both oversedation and undersedation are common issues in clinical practice.[28] Implementing a goal-directed sedation strategy can effectively prevent these problems, reduce total hospital stay and ICU length of stay[24], and enhance cerebral oxygen metabolism.[29] For neurocritical care patients with stable organ function who are in the recovery phase, a light sedation strategy can be adopted to ensure patient wakefulness and comfort, reduce adverse stress responses, and thereby shorten mechanical ventilation time and hospital stay.[30] For patients with unstable organ function in the acute stress phase, a deep sedation target may be appropriate to control intracranial pressure, maintain cerebral perfusion, inhibit sympathetic excitation, control epileptic seizures, and prevent or mitigate secondary brain injury, contributing to neurological protection.[31] Once organ function stabilizes, gradually transitioning from deep sedation to light sedation or no sedation facilitates neurological assessment and ventilator weaning.[12] However, only 57.2% of nurses reported formulating individualized sedation goals based on patient condition, and insufficient sedation knowledge affects the standardization of sedation nursing practice.[32] Therefore, it is necessary to strengthen nurse training on sedation target setting, help nurses recognize sedation indications, and improve the scientific implementation of sedation strategies.

Selection of appropriate sedation monitoring tools

Evidence items 8 to 11 summarize tools and techniques for monitoring sedation in neurocritical care patients. Among subjective sedation assessment tools, the Richmond Agitation-Sedation Scale and the Sedation-Agitation Scale are most widely used. However, relying solely on the Richmond Agitation-Sedation Scale to adjust sedative medications may be insufficient; these tools cannot provide real-time monitoring and are susceptible to subjective bias.[10,33] Objective assessment tools, such as the Bispectral Index (BIS), can be complementary for patients receiving neuromuscular blocking agents, those in persistent coma, or those with severe consciousness impairment.

The BIS score ranges from 0 to 100, with higher scores indicating closer states to wakefulness. The target BIS range for light sedation is 60–80.[34] BIS monitoring has low variability, more reliably maintains sedation levels, reduces intracranial pressure, and improves the quality of care.[35,36] BIS-guided sedation can also reduce the use of sedatives and antihypertensive drugs, shorten the duration of delirium and coma, and ensure higher cerebral tissue oxygenation.[37,38] However, BIS values become more variable as sedation depth increases.[39]

Multimodal brain function monitoring (MMM) integrates imaging, electroencephalography, and cerebral hemodynamics to provide multidimensional, real-time data. This approach facilitates accurate diagnosis, individualized treatment planning, and early

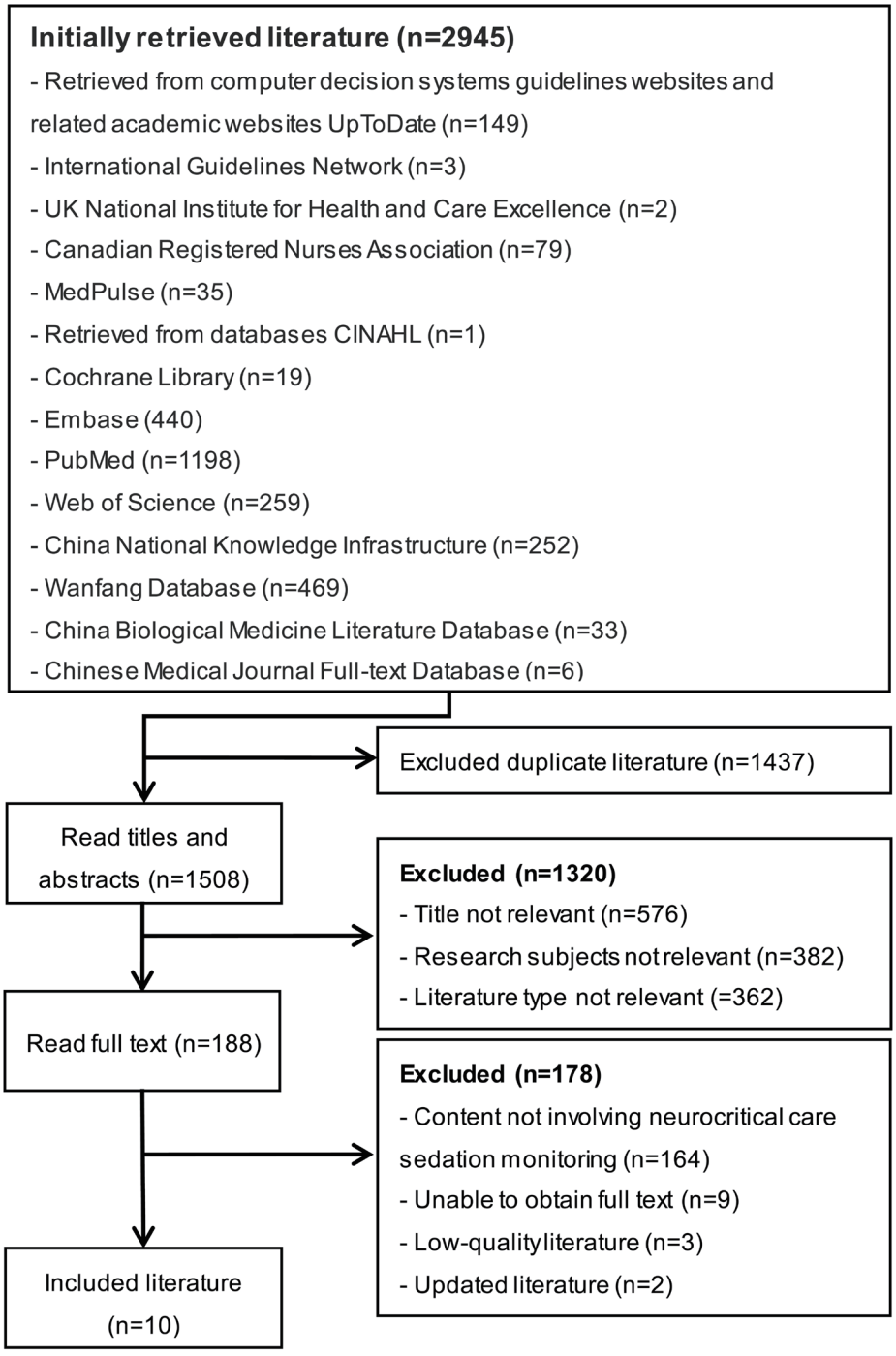

Fig. 1. Flow chart of literature screening.

detection of neurological deterioration.[40] Sedation monitoring in neurocritical care patients can be optimized by combining tools such as BIS, Narcotrend Index, Cerebral State Index, Auditory Evoked Potentials, Muscle Activity Score, and Entropy Index.[41] In France, over 60% of sedated patients undergo cerebral function monitoring, highlighting the importance of MMM.[42] However, advanced monitoring technologies such as BIS and MMM require significant initial investment, and training personnel in core monitoring skills is essential.[43] Furthermore, more clinical practice and multicenter cohort studies are needed to determine whether MMM improves long-term patient prognosis.[44]

Determining the timing of sedation monitoring and clarifying the specific monitoring content

Evidence items 12 to 20 summarize the timing and specific content of sedation monitoring in neurocritical care patients. While seda-

Table 1. General characteristics of the included literature (n = 10)

Included literature	Year of publication (year)	Literature reference	Type of literature	The literature theme
Frank RL[21]	2023	UpToDate	Clinical decision	Procedural sedation in adults in the emergency department: General considerations, preparation, monitoring, and mitigating complications
Fuchs *et al*[22]	2022	UpToDate	Clinical decision	Sedative-analgesia in ventilated adults: Management strategies, agent selection, monitoring, and withdrawal
Arbour R[23]	2022	Critical Care Nurse	Guideline	Nursing Guidelines for Sedation Titration or Pausing to Facilitate Neurological Assessment
Chinese Medical Association Critical Care Medicine Branch[24]	2018	Chinese Medical Journal Database	Guideline	Chinese Guidelines for Analgesia and Sedation in Adult ICU Patients
Devlin *et al*[10]	2018	National Guideline Clearinghouse	Guideline	Clinical Practice Guidelines for the Prevention and Management of Pain, Agitation/Sedation, Delirium, Immobility, and Sleep Disruption in Adult Patients in the ICU
Baron *et al*[25]	2015	PubMed	Guideline	Evidence and consensus based guideline for the management of delirium, analgesia, and sedation in intensive care medicine. Revision 2015
Prabhakar *et al*[26]	2021	PubMed	Expert consensus	Consensus Statement on Analgo-sedation in Neurocritical Care and Review of Literature
National Nervous System Disease Medical Quality Control Center Neurocritical Care Professional Working Group[12]	2023	CNKI	Expert consensus	Chinese expert consensus on analgesia and sedation therapy in neurocritical care patients
Chinese Medical Association Neurosurgery Branch[1]	2020	CNKI	Expert consensus	Chinese expert consensus on neurosurgical critical care
Ni *et al*[27]	2018	Wanfang	Expert consensus	Chinese expert consensus on neurosurgical critical care rehabilitation

CNKI, China National Knowledge Infrastructure databases; ICU, intensive care unit.

tion therapy can reduce stress and protect organ function, it may also suppress important physiological functions in certain organs. Assessing the patient's organ function and reserve capacity is crucial to ensure the safety, effectiveness, and appropriateness of sedation therapy. After initiating sedation, assessment and documentation should be conducted hourly. Compared with pulse oximetry, capnography can detect hypoventilation and apnea more rapidly, particularly when the patient is receiving supplemental oxygen.[45]

Evidence items 18 to 20 address daily sedation interruption (DSI) and the neurological wake-up test (NWT) after sedation, clearly outlining relevant contraindications and precautions. DSI aims to limit excessive sedative use in deeply sedated patients and reduce sedative accumulation in the body.[24] NWT is considered the "gold standard" for assessing neurological function by temporarily interrupting sedation therapy. However, its implementation and timing in neurocritical care patients must be carefully balanced against

Table 2. Quality evaluation results of guidelines (n = 4)

Guideline	Standardized scores in various domains (%)						≥60%	≥30%	Quality evaluation
	Scope and purpose	Stakeholder involvement	Rigour of development	Clarity of presentation	Applicability	Editorial independence			
Arbour R[23]	76.19	50.79	52.38	79.37	63.10	40.48	3	6	B
Chinese Medical Association Critical Care Medicine Branch[24]	85.71	87.30	85.12	84.13	60.71	83.33	6	6	A
Devlin *et al*[10]	90.48	76.19	79.17	71.43	73.81	83.33	6	6	A
Baron *et al*[25]	100	80.95	83.93	77.78	78.57	88.10	6	6	A

Table 3. Summary of best evidence for sedation monitoring in neurocritical care patients

Evidence items	Evidence content	Level of evidence	Recommended level
Monitoring personnel	1. Sedation monitoring requires a multidisciplinary team approach, including physicians, pharmacists, respiratory therapists, neurosurgical intensive care nurses, and charge nurses, all of whom need to receive professional education and training[22,23,26]	1	A
	2. Monitoring goal-setters: physicians, pharmacists, respiratory therapists[23]	1	A
	3. Sedation depth assessment and program implementation: physicians, neurosurgical critical care nurses, and charge nurses[21,23]	1	A
Monitoring targets	4. It is recommended that the depth of sedation be individualized according to the functional status of the organs, that goal-oriented sedation strategies be implemented to avoid over-sedation, and that sedation be gradually reduced to the lowest achievable effective sedative dose[12,22,24]	1	B
	5. Indications for shallow sedation: patients with relatively stable organ function and recovery period, such as patients with mild to moderate craniocerebral injury[24,27]	2	A
	6. Indications for deep sedation: patients with unstable organ function and acute stage of stress: (1) patients with severe human-machine incoordination of mechanical ventilation; (2) severe acute respiratory distress syndrome (ARDS), early and short course of neuromuscular blocking agents, prone ventilation, and pulmonary reanimation as a basis of treatment; (3) patients with severe craniocerebral injury with cranial hypertension; (4) epilepsy in a state of persistence; (5) patients who need to be tightly braked by surgery (6) Anyone who needs to be treated with neuromuscular blocking agents[24,27]	5	A
	7. Suggested target values for sedation depth are: light sedation, Richmond Agitation Sedation Scale (RASS) −2 ~ +1 points, Rike Sedation Agitation Scale (SAS) 3~4 points; deep sedation, RASS −3 ~ −4 points, SAS 2 points; combined with the application of neuromuscular blockers, RASS -5 points, SAS 1 point. The ideal state of sedation is: RASS −1 ~ 0 points[1,12,23,24,26,27]	5	A
Monitoring tools	8. Subjective sedation assessment tools: Richmond Agitation Sedation Scale (RASS), Ramsay Sedation Scale (RSS), Rike Sedation Agitation Scale (SAS), Minnesota Sedation Assessment Tool (MSAT), and Bizek Agitation Scale[1,22–24,26]	3	B
	9. Objective assessment methods: Bispectral Index Score (BIS), Narcotrend Index (NI), Cerebral State Index (CSI), Auditory Evoked Potentials (AEP), Muscle Activity Score (MAAS), and Entropy Index (SE)[10,12,24,26]	3	B
	10. Multimodal monitoring techniques can dynamically assess the safety and efficacy of analgesia and sedation from different perspectives[12,27]	5	B
	11. Objective brain function monitoring is recommended for assessing the level of sedation in patients under deep sedation or combined with neuromuscular blocking agents[10,24]	3	A
Timing and content of monitoring	12. After sedation is administered, the depth of sedation should be assessed and recorded hourly at the bedside, and medication should be adjusted until the sedation goal is achieved[12,22–25]	3	A
	13. Patients' organ functional status and organ reserve capacity should be routinely assessed before and after sedation[24]	1	A
	14. Monitor vital signs: pulse, blood pressure, heart rate, temperature, respiration, oxygen saturation, end-expiratory carbon dioxide[21,27]	5	A
	15. Attend to conditions relevant to the neurosurgical specialty: assessment of consciousness, pupillary changes, intracranial pressure monitoring, neurological physical examination, laboratory tests, and imaging studies[27]	5	A
	16. Monitor the patient's response to medications and maneuvers: the patient's level of alertness, depth of respiration, and response to painful stimuli[21]	5	B
	17. Perform DSI and NWT on deeply sedated patients every morning in the absence of contraindications[12,22,24,25]	5	A
	18. DSI monitoring consists of: compliant eye opening, eye tracking, compliant fist clenching, and compliant toe moving, with at least 3 of these items being met before sedation is reintroduced[24]	1	A
	19. Contraindications to NWT: patients with neurocritical conditions such as refractory status epilepticus, paroxysmal sympathetic activity, refractory intracranial hypertension, implantation of oxygen monitoring devices in brain tissue, hemodynamic instability, patients undergoing targeted temperature management, and end-of-life care during high-intensity therapy[12,23,24,26]	1	A
	20. Patients with refractory intracranial hypertension undergoing intracranial pressure monitoring, DSI or NWT should be attempted only at the beginning of treatment and when intracranial pressure is close to normal[26]	5	A

Evidence levels were assessed using the JBI Evidence Pre-grading System (2014 edition), and the strength of recommendations was determined according to the JBI recommendation framework. DSI, Daily sedation interruption; JBI, Joanna Briggs Institute; NWT,neurologic wake-up test.

potential risks and benefits.[12] Relevant studies indicate that only 76.9% of nurses routinely assess sedation depth, 60.3% dynamically adjust sedation depth, and 28.0% perform hourly sedation assessments.[32] Nurses need to increase the frequency of sedation assessments, selectively implement DSI or NWT based on patient condition and assessment results, and dynamically adjust sedation depth accordingly.

Establishment of a multidisciplinary team for sedation monitoring in neurocritical patients

Evidence items 1 to 3 summarize the composition of the sedation monitoring team for neurocritical care patients and clarify the responsibilities and requirements of team members. Team members should be involved throughout the process of setting sedation goals, assessing sedation depth, and implementing sedation plans to achieve dynamic management of sedation. Guidelines emphasize the importance of multidisciplinary collaboration in sedation monitoring for neurocritical patients.[23] Compliance with bundled sedation strategies is related to the configuration of the multidisciplinary team and members' knowledge levels.[46] Each professional must improve their knowledge of analgesia and sedation and their ability to collaborate effectively to ensure rational sedation. As primary executors of sedation strategies, main observers of patient conditions, and key communicators between the team and patients, nurses play a critical role in implementing sedation plans, dynamically monitoring sedation status, and providing feedback. A systematic review and meta-analysis showed that nurse-led sedation protocols significantly reduced the duration of mechanical ventilation (standardized mean difference = −1.765; 95% confidence interval [CI] = −2.461, −1.068; $P < 0.001$; $I^2 = 97.7\%$), ICU length of stay (standardized mean difference = −1.463; 95% CI = −2.181, −0.745; $P < 0.001$; $I^2 = 97.3\%$), ICU mortality (relative risk = 0.854; 95% CI = 0.747, 0.983; $P = 0.027$; $I^2 = 0\%$), and incidence of adverse events such as ventilator-associated pneumonia (relative risk = 0.438; 95% CI = 0.292, 0.657; $P < 0.001$; $I^2 = 41.4\%$).[47] It is recommended that nurse-led, protocolized sedation strategies be encouraged in clinical practice to fully leverage nurses' professional expertise, ensure rational sedation, and reduce the incidence of adverse events.

Limitations

Although this study provides a comprehensive summary of evidence on sedation monitoring in neurocritical care patients, differences in regional, ethnic, and cultural backgrounds may affect the findings. In addition, the literature search was limited to English and Chinese databases, excluding studies in other languages. Most included studies were guidelines and expert consensus statements, with few randomized controlled trials, which may have affected the comprehensiveness of the evidence. Future studies should continuously update and supplement the available evidence to ensure its accuracy and currency. Additionally, this study did not provide a detailed description of the specific operational mechanisms of nurse-led multidisciplinary sedation teams.

Conclusions

This study systematically summarized the evidence on sedation monitoring in neurocritical care patients and may provide an evidence-based foundation for developing and implementing best practices and standards to improve monitoring accuracy and patient outcomes. It highlights the importance of establishing and operating a dedicated sedation monitoring team in neurosurgical ICUs. However, as the evidence is derived from different countries, it is essential to consider contextual factors, such as the local clinical environment, before applying it. Future research should focus on developing stratified monitoring frameworks for subjective and objective tools tailored to specific neurological states, creating risk prediction models, and designing more targeted sedation monitoring decision-support systems.

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Conflict of interest

We declare that there is no conflict of interest.

Author contributions

Study conception and design, evidence analysis and summary, writing of the manuscript (XG, XW, YX), literature search (XG, NH, YW), literature quality evaluation (XG, YW, SL), manuscript review, funding acquisition, and resource coordination (HJ). All authors discussed the results and contributed to the final manuscript.

Ethical statement

This study is an evidence summary based on already published literature. It did not involve human or animal subjects, nor did it require the collection of new data. Therefore, ethical approval was not required. All methods were conducted in accordance with relevant reporting standards and guidelines.

Data sharing statement

The data used to support the findings of this study are included within the article.

References

[1] Chinese Medical Association Neurosurgery Branch, China Neurosurgical Intensive Care Management Collaboration Group. Expert Consensus on Neurosurgical Intensive Care Management (2020 Edition). Natl Med J China 2020;100(19):1443–1458. doi:10.3760/cma.j.cn112137-20200318-00818.

[2] Meyfroidt G, Bouzat P, Casaer MP, Chesnut R, Hamada SR, Helbok R, *et al*. Management of moderate to severe traumatic brain injury: an update for the intensivist. Intensive Care Med 2022;48(6):649–666. doi:10.1007/s00134-022-06702-4, PMID:35595999.

[3] Payen JF, Schilte C, Bertrand B, Behouche A. Toward individualized sedation in patients with acute brain damage. Anaesth Crit Care Pain Med 2023;42(4):101219. doi:10.1016/j.accpm.2023.101219, PMID:36933799.

[4] Roberson SW, Patel MB, Dabrowski W, Ely EW, Pakulski C, Kotfis K. Challenges of Delirium Management in Patients with Traumatic Brain Injury: From Pathophysiology to Clinical Practice. Curr Neuropharmacol 2021;19(9):1519–1544. doi:10.2174/1570159X19666210119153839, PMID:33463474.
[5] Davis JA, Grau JW. Protecting the injured central nervous system: Do anesthesia or hypothermia ameliorate secondary injury? Exp Neurol 2023;363:114349. doi:10.1016/j.expneurol.2023.114349, PMID:36775099.
[6] Kayambankadzanja RK, Samwel R, Baker T. Pragmatic sedation strategies to prevent secondary brain injury in low-resource settings. Anaesthesia 2022;77(Suppl 1):43–48. doi:10.1111/anae.15621, PMID:35001384.
[7] Shehabi Y, Bellomo R, Kadiman S, Ti LK, Howe B, Reade MC, *et al*. Sedation Intensity in the First 48 Hours of Mechanical Ventilation and 180-Day Mortality: A Multinational Prospective Longitudinal Cohort Study. Crit Care Med 2018;46(6):850–859. doi:10.1097/CCM.0000000000003071, PMID:29498938.
[8] Bauerschmidt A, Al-Bermani T, Ali S, Bass B, Dorilio J, Rosenberg J, *et al*. Modern Sedation and Analgesia Strategies in Neurocritical Care. Curr Neurol Neurosci Rep 2023;23(4):149–158. doi:10.1007/s11910-023-01261-7, PMID:36881257.
[9] Wang X, Zeng FL, Wu HT, Miao XJ, Li Y, Wu F. Current status and influencing factors of knowledge, attitude, and practice of analgesia and sedation among medical staff in neurosurgical intensive care units. China Modern Medicine 2023;30(9):122–127. doi:10.3969/j.issn.1674-4721.2023.09.029.
[10] Devlin JW, Skrobik Y, Gélinas C, Needham DM, Slooter AJC, Pandharipande PP, *et al*. Clinical Practice Guidelines for the Prevention and Management of Pain, Agitation/Sedation, Delirium, Immobility, and Sleep Disruption in Adult Patients in the ICU. Crit Care Med 2018;46(9):e825–e873. doi:10.1097/CCM.0000000000003299, PMID:30113379.
[11] Lewis K, Balas MC, Stollings JL, McNett M, Girard TD, Chanques G, *et al*. A Focused Update to the Clinical Practice Guidelines for the Prevention and Management of Pain, Anxiety, Agitation/Sedation, Delirium, Immobility, and Sleep Disruption in Adult Patients in the ICU. Crit Care Med 2025;53(3):e711–e727. doi:10.1097/CCM.0000000000006574, PMID:39982143.
[12] National Medical Quality Control Center for Neurological Diseases Neurocritical Care Subgroup, Chinese Association of Pathophysiology Critical Care Medicine Professional Committee, Working Group Expert Consensus on Analgesia and Sedation in Neurocritical Care Patients. Expert Consensus on Analgesia and Sedation in Neurocritical Care Patients (2023). Chin Crit Care Med 2023;35(9):897–918. doi:10.3760/cma.j.cn121430-20230731-00568.
[13] Munn Z, Lockwood C, Moola S. The Development and Use of Evidence Summaries for Point of Care Information Systems: A Streamlined Rapid Review Approach. Worldviews Evid Based Nurs 2015;12(3):131–138. doi:10.1111/wvn.12094, PMID:25996621.
[14] Zhang YJ, Li XJ, Wu JY, Deng SS, Guo ZH, Wu YN. Evidence summary development process in Joanna Briggs Institute evidence-based healthcare centre: elaboration and explanation. J Nurs 2024;31(16):39–43.
[15] Zhu Z, Hu Y, Xing WJ, Zhou YF, Gu Y. The composition of different types of evidence-based questions. Nurs J Chin Med 2017;32(21):1991–1994. doi:10.16821/j.cnki.hsjx.2017.21.025.
[16] Dicenso A, Bayley L, Haynes RB. Accessing pre-appraised evidence: fine-tuning the 5S model into a 6S model. Evid Based Nurs 2009;12(4):99–101. doi:10.1136/ebn.12.4.99-b, PMID:19779069.
[17] Qiao J. Theoretical basis and modeling application of the intraclass correlation coefficient. Statistics & Information Forum 2016;31(11):44–48. doi:10.3969/j.issn.1007-3116.2016.11.008.
[18] Brouwers MC, Kho ME, Browman GP, Burgers JS, Cluzeau F, Feder G, *et al*. AGREE II: advancing guideline development, reporting and evaluation in health care. CMAJ 2010;182(18):E839–E842. doi:10.1503/cmaj.090449, PMID:20603348.
[19] Joanna Briggs Institute. CRITICAL APPRAISAL TOOLS. 2023. Available from: https://jbi-global-wiki.refined.site/space/MANUAL/355862165/5.2.6.4.1+JBI+Critical+Appraisal+Checklist+for+Policy+%2F+Consensus+Guidelines+Evidence. Accessed March 3, 2023.
[20] JBI Levels of Evidence and Grades of Recommendation Working Party. Supporting Document for the JBI Levels of Evidence and Grades of Recommendation [EB/OL]. 2014. Available from: https://jbi.global/sites/default/files/2019-05/JBI%20Levels%20of%20Evidence%20Supporting%20Documents-v2.pdf. Accessed June 13, 2024.
[21] Frank RL. In: Wolfson AB (ed). Procedural sedation in adults in the emergency department: General considerations, preparation, monitoring, and mitigating complications. Waltham: UpToDate, Inc; 2023. Available from: https://www.uptodate.com Accessed June 13, 2024.
[22] Fuchs B, Bellamy C. In: O'Connor MF, Burnham EL (eds). Sedative-analgesia in ventilated adults: Management strategies, agent selection, monitoring, and withdrawal. Waltham: UpToDate, Inc; 2024. Available from: https://www.uptodate.com Accessed June 13, 2024.
[23] Arbour R. Nursing Guidelines for Sedation Titration or Pausing to Facilitate Neurological Assessment. Crit Care Nurse 2022;42(1):79–81. doi:10.4037/ccn2022761, PMID:35100625.
[24] Chinese Medical Association Critical Care Medicine Branch. Chinese Guidelines for Analgesia and Sedation in Adult ICU. Chin J Crit Care Intensive Med 2018;4(2):90–113. doi:10.3760/cma.j.issn.2095-4352.2018.06.001.
[25] Baron R, Binder A, Biniek R, Braune S, Buerkle H, Dall P, *et al*. Evidence and consensus based guideline for the management of delirium, analgesia, and sedation in intensive care medicine. Revision 2015 (DAS-Guideline 2015) - short version. Ger Med Sci 2015;13:Doc19. doi:10.3205/000223, PMID:26609286.
[26] Prabhakar H, Tripathy S, Gupta N, Singhal V, Mahajan C, Kapoor I, *et al*. Consensus Statement on Analgo-sedation in Neurocritical Care and Review of Literature. Indian J Crit Care Med 2021;25(2):126–133. doi:10.5005/jp-journals-10071-23712, PMID:33707888.
[27] Ni YY, Wang SH, Song WQ, Li BQ, Chen JL, Feng Z, *et al*. Expert Consensus on Neurocritical Care Rehabilitation in China (Part II). Chin J Rehabil Med 2018;33(2):130–136. doi:10.3969/j.issn.1001-1242.2018.02.002.
[28] Wang T, Zhou D, Zhang Z, Ma P. Tools Are Needed to Promote Sedation Practices for Mechanically Ventilated Patients. Front Med (Lausanne) 2021;8:744297. doi:10.3389/fmed.2021.744297, PMID:34869436.
[29] Lu S, Song H, Lin Y, Song B, Lin S. A randomized controlled trial investigating the impact of early goal-directed sedation dominated by dexmedetomidine on cerebral oxygen metabolism and inflammatory mediators in patients with severe brain injury. Neurol Sci 2025;46(4):1741–1750. doi:10.1007/s10072-024-07916-8, PMID:39673043.
[30] Jaworska N, Hezam A, Poulin T, Kromm JA, Burry LD, Niven DJ, *et al*. Evaluation of Objective Sedation Monitoring Practices in Critically Ill Adult Patients: A Systematic Review and Meta-Analysis. Crit Care Explor 2025;7(8):e1297. doi:10.1097/CCE.0000000000001297, PMID:40788313.
[31] Kandelman S, Allary J, Porcher R, Righy C, Valdez CF, Rasulo F, *et al*. Early abolition of cough reflex predicts mortality in deeply sedated brain-injured patients. PeerJ 2020;8:e10326. doi:10.7717/peerj.10326, PMID:33304651.
[32] Yang Y F, Yu H Y, Yan X J, Yan X, Zhang L. Current status survey of sedation nursing practice among ICU nurses. Chin J Disaster Med 2020;8(6):322–325. doi:10.13919/j.issn.2095-6274.2020.06.008.
[33] Park K, Froese L, Bergmann T, Gomez A, Sainbhi AS, Vakitbilir N, *et al*. Association Between Clinical Measures of Depth of Sedation and Multimodal Cerebral Physiology in Acute Traumatic Neural Injury. Neurotrauma Rep 2024;5(1):916–956. doi:10.1089/neur.2024.0090, PMID:39474098.
[34] Herzog M, Rudzki M, Plößl S, Plontke S, Kellner P. Depth of sedation during drug induced sedation endoscopy monitored by BiSpectral Index® and Cerebral State Index®. Sleep Breath 2021;25(2):1029–1035. doi:10.1007/s11325-020-02180-4, PMID:32857320.
[35] Yan K, Pang L, Gao H, Zhang H, Zhen Y, Ruan S, *et al*. The Influence of Sedation Level Guided by Bispectral Index on Therapeutic Effects for Patients with Severe Traumatic Brain Injury. World Neurosurg 2018;110:e671–e683. doi:10.1016/j.wneu.2017.11.079, PMID:29196250.
[36] He QQ, Zhou R. Qualitative study on experience of nurses using Bispectral Index to monitor the level of sedation in patients with severe brain injury. Chin Nurs Res 2020;34(19):3527–3530. doi:10.12102/j.issn.1009-6493.2020.19.035.

[37] Huespe I, Giunta D, Acosta K, Avila D, Prado E, Sanghavi D, *et al*. Comparing Bispectral Index Monitoring vs Clinical Assessment for Deep Sedation in the ICU: Effects on Delirium Reduction and Sedative Drug Doses-A Randomized Trial. Chest 2024;166(4):733–742. doi:10.1016/j.chest.2024.05.031, PMID:38901489.
[38] Chen QM, Ma B, Dou ZM, Zhu L, Yang H, Chen ZT, *et al*. Application of target oriented analgesia and sedation with bispectral index in early blood pressure management for patients with spontaneous intracerebral hemorrhage. Journal of Lanzhou University (Medical Sciences) 2023;49(9):16–20. doi:10.13885/j.issn.1000-2812.2023.09.003.
[39] Kaye C, Rhodes J, Austin P, Casey M, Gould R, Sira J, *et al*. Assessment of depth of sedation using Bispectral Index™ monitoring in patients with severe traumatic brain injury in UK intensive care units. BJA Open 2024;10:100287. doi:10.1016/j.bjao.2024.100287, PMID:38868457.
[40] Chen Y, Wang S, Xu S, Xu N, Zhang L, Zhou J. Current advances in neurocritical care. J Intensive Med 2025;5(1):23–31. doi:10.1016/j.jointm.2024.04.005, PMID:39872833.
[41] Lindblad C, Raj R, Zeiler FA, Thelin EP. Current state of high-fidelity multimodal monitoring in traumatic brain injury. Acta Neurochir (Wien) 2022;164(12):3091–3100. doi:10.1007/s00701-022-05383-8, PMID:36260235.
[42] Poignant S, Vigué B, Balram P, Biais M, Carillon R, Cottenceau V, *et al*. A One-Day Prospective National Observational Study on Sedation-Analgesia of Patients with Brain Injury in French Intensive Care Units: The SEDA-BIP-ICU (Sedation-Analgesia in Brain Injury Patient in ICU) Study. Neurocrit Care 2022;36(1):266–278. doi:10.1007/s12028-021-01298-x, PMID:34331208.
[43] Yang F, Peng A, Song Y, Wang Q, Lin X, Jing L, *et al*. Knowledge and Attitudes Towards Multimodal Brain Function Monitoring Among Nurses in the Intensive Care Unit. Nurs Crit Care 2025;30(4):e70070. doi:10.1111/nicc.70070, PMID:40509645.
[44] Li YF, Liu B, Li XP. Research Progress in the Application of Brain Multimodal Monitoring in Aneurysmal Subarachnoid Hemorrhage. China Health Standard Management 2025;16(4):194–198. doi:10.3969/j.issn.1674-9316.2025.04.045.
[45] Ravikumar N, Nallasamy K. Nasal End-tidal Carbon Dioxide Monitoring during Procedural Sedation: Is it time for Wider Adoption? Indian J Crit Care Med 2020;24(8):611–612. doi:10.5005/jp-journals-10071-23512, PMID:33024359.
[46] Costa DK, White MR, Ginier E, Manojlovich M, Govindan S, Iwashyna TJ, *et al*. Identifying Barriers to Delivering the Awakening and Breathing Coordination, Delirium, and Early Exercise/Mobility Bundle to Minimize Adverse Outcomes for Mechanically Ventilated Patients: A Systematic Review. Chest 2017;152(2):304–311. doi:10.1016/j.chest.2017.03.054, PMID:28438605.
[47] Qi Z, Yang S, Qu J, Li M, Zheng J, Huang R, *et al*. Effects of nurse-led sedation protocols on mechanically ventilated intensive care adults: A systematic review and meta-analysis. Aust Crit Care 2021;34(3):278–286. doi:10.1016/j.aucc.2020.07.013, PMID:33054987.