

Optimizing sedation practices in critically ill adult ICU patients: A comprehensive literature review

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Abstract

Sedation is a fundamental component of critical care, facilitating mechanical ventilation, reducing anxiety, and improving patient comfort in intensive care units (ICUs). However, inappropriate sedation whether excessive or inadequate can result in adverse outcomes such as prolonged ventilation, delirium, and increased morbidity. This review of the library combines some scientific studies of 33 articles that have already been reviewed to provide a complex knowledge of the practice of sedation in emergency patients. This evaluation discusses a variety of non-specific devices that are commonly used, Take Richmond agitation-sedation scale, for example., Critical-care pain observation tool (CPOT), and Confucion assemble method for ICU (CAM-ICU), and review the effectiveness and risks of the various rules. This review determines whether or not there is a big difference in the consistency of the sedation that is being monitored and is giving attention to the need for an individual rule and being determined with evidence of increased clinical results.

Keywords: ICU; Sedation; RASS; CPOT; CAM-ICU; Critically ill; Delirium; Analgesia; Opioid; Sedation monitoring

1. Introduction

Sedation in ICU like a two-edged sword. Although sedation is important for patient comfort and supports the implementation of life-saving mediation for example mechanical ventilation. Inappropriate use can lead to complications such as prolonged care in ICU, nosocomial infection and decreased neurocognitive function. For the past 20 years, sedation practice during special treatment has already undergone a shift from prolonged sedation use leading to a lighter and individual approach, its aim to reduce the negative impact caused by medical actions.

Excess sedation triggers this change, in addition to the many scientific evidence also a lot of bad clinical results, like a delirium, longer use of mechanical ventilation and increased value of morality. Current referral emphasizes the importance of routinely monitoring tools that are already validated. Sedative substances are selected according to the conditions of the patient and this involves management strategies in various scientific disciplines. But when practice in the field still occurs there is organizational instability, particularly such as discipline on rules and monitoring standards. Sedatives such as benzodiazepines, propofol and dexmedetomidine, Individually, they have advantages and disadvantages, depending on the patients condition, the time of therapy and inherited diseases of patients.

Given the clinical importance of sedation and the risks of its misapplication, there is a pressing need to synthesize existing research into a cohesive narrative that can inform practice and policy. This literature review aims to critically evaluate and integrate findings from 33 peer-reviewed studies, focusing on sedation agents, monitoring tools, pain and

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delirium management, and clinical outcomes. By identifying trends, strengths, and gaps in the literature, this review provides a comprehensive foundation for optimizing sedation strategies in the ICU setting.

2. Review Content

2.1. Sedation and Agitation

2.1.1. Definition of Sedation

Sedation refers to the administration of pharmacological agents to reduce a patient's level of consciousness, primarily for the purpose of alleviating pain, anxiety, agitation, and to facilitate invasive procedures such as mechanical ventilation. In the context of critical care, sedation is not merely a comfort measure but a strategic clinical intervention aimed at maintaining patient safety, preventing accidental removal of life-supporting devices, and minimizing the physiological stress response in critically ill patients.

Multiple studies define sedation in ICU patients as a controlled, reversible depression of consciousness that must be carefully titrated to balance comfort and safety. Sedative given in ICU usually in guard with a judgment that had been set, the aim is to reach the patient condition that relaxes, coordinated and there was no sign if the patient stress, but it is easy to wake up.

The category of sedation strategy is generally divided into two approaches. That's the inner sedation, in the early stages that require full ventilation during medical procedures and mild sedation are usually more interested in modern ICU rules, Because the results were better, including decreasing delirium disorder and shorter ventilator usage.

Important notes if universally no sedative agent optimal for all patients. Even, sedation need to adjust to sustainable based on monitoring. With the condition of the patient body, medicinal purposes sert reaction of the body patients during sedation. Develop practices sedation of sedation in creating a sedation lightly with traditional protocol whose center give clinical results reflect the ICU patients overall.

2.1.2. Definition of Agitation

Agitation occurs in patients with complex neural response is critical condition, such as rising motor activity that, excessive physical or verbal expression, as well as emotional instability that could endanger impulsivities patient safety and paramedics. This situation is a challenge common in ICU, especially in patients who is undergoing mechanical ventilation, new recovering from sedation in or experiencing delirium. Are diverse, like to feel uneasy and an uncomfortable feeling of light, behavior hurt themselves or seek equipment that supports life, will require all medical intervention as soon as possible.

International psychogeriatric association (IPA), Agitation Definition Work Group (ADWG), provides a general acceptable definition: activity on'of excessive motor activity followed by inner tension, Sometimes accompanied by irabilities, 'The anxiety is physical or verbal. 'This definition is focused on the relationship between emotional disorders and physical symptoms, as well as recognizing agitation as both symptoms and potential syndromes [7].

Relation to ICU, agitation may be response to various triggers as pain, hypoxia, a sleep disorder, the termination of sedation, delirium, a physiological need that are not being met or disorients noise induced, lighting, and lack of communication. Emergency patient, especially any one under the influence of sedation verbal can communicate or not, have a higher risk of agitation as a form of expression discomfort. Also connected with agitation imbalances neurochemical, and especially dopaminergic hyperactivity and cholinergic deficiency, has strong relationships with pathophysiology delirium in ICU.

Medically, the level of agitation is generally measured by the richmond agitaiton-sedation scale (RASS). RASS scores ranging from +1 (agitated) to +4 (aggressive) describe an increase in the level of agitation. Higher RASS score is independently associated with worse clinical outcomes, For example, unplanned exuberance. Increased use of physical limiters, a longer period of hospitalization in ICU than the specified period of time as well as higher nosocomial infection numbers due to disturbances in hospitalization.

Multimodal approach is necessary in agitation management in the ICU space, Starting with the identification and handling of the basic cause. This is done by providing proper pain relief, re-orientation of patients, restrictions on the use of drugs that trigger delirium and environmental modification. Pharmacological interventions such as the

administration of dexmedetomidine or low-dose haloperidol may be considered if nonpharmacological strategies are ineffective or if agitation poses an imminent risk.

Agitation in ICU is a difficult phenomenon with serious clinical implications. Early detection and thorough deployment are essential to improve patient safety, reduce complications as well as to ensure humane treatment in critical care environments.

2.1.3. Level of Sedation

Daily sedation levels are repeated and regular and adjusted to achieve a therapeutic goal, At the same time minimize the risk of complications. In ICU, Mostly patients can't talk, experiencing cognitive disorder or using mechanical ventilator, to limit the ability to convey discomfort or need. That way the necessary tools must be structured and valid to adjust the depth of the sedation safely and accurately.

The instrument that is widely used in ICU is the RASS, which provides a +10 point scale from +4/aggressive to -5/unable to be awakened. RASS has been recognized in various clinical contexts and demonstrates strong reliability. This scale is designed to provide an assessment of agitation as well as sedation, so as to give a dynamic value and give the possibility of sedative titrations precisely based on the patient's response [9].

Different from old instrument for example Ramsay Sedation Scale, which covers criteria as duration eye contact, at the sound of a response, and reaction to physical stimuli, that gives the increased when distinguish the sedation. For example, patients with a score 0 is in a state of alert and calm, while it is light sedation -2 score, when called upon and maintain eye contact. Sedation deeper (-4 until -5) indicating the absence of a response to the command verbal and only a small motor even no response to physical stimuli.

This research shows if maintaining the level of mild to moderate sedation (RASS -2 to 0) is associated with good medical results, including duration in using a shorter ventilator, decreased delirium events in ICU, and lower mortality rates [23,32]. On the contrary, sedation in there is a relation with various bad effects, for example delayed release from the ventilator, Neurological complications, and cognitive impairment in patients is reversed.

Table 1 Richmond Agitation-Sedation Scale (RASS)

Score	Term	Description
+4	Combative	Overly combative or violent; immediate danger to staff
+3	Very agitated	Pulls at tubes or catheters; aggressive
+2	Agitated	Frequent non-purposeful movement; fights ventilator
+1	Restless	Anxious or apprehensive; movements not aggressive
0	Alert and calm	Spontaneously alert and attentive
-1	Drowsy	Not fully alert, but has sustained eye contact >10 seconds in response to voice
-2	Light sedation	Briefly awakens to voice (<10 seconds); eye contact
-3	Moderate sedation	Any movement or eye opening but no eye contact in response to voice
-4	Deep sedation	No response to voice but movement or eye opening to physical stimulation
-5	Unarousable	No response to voice or physical stimulation

RASS use regularly proves the increasing communication of the multidisciplinary team on ICU and helps standardize sedation practices. This scale is often integrated into the daily sedation and strategy protocols of interruption (DSI) or daily sedation stops. Besides RASS used to be combined with tools like CPOT and CAM-ICU (delirium detectors) in creating frameworks to monitor hard holistic patients. In succinct terms, sedation level must match individually, has orientations on the subject keyed and rechecked periodically using tools are validated by some kind of RASS. Shift towards light sedation and titration which is central to patients who are the main focus in modern ICU treatments, The goal of optimizing the patient's clinical results is to minimize the ill effects of medical action.

2.1.4. Sedation Monitoring

Monitoring the level of sedation on critical patients is a major focus in effective and safe treatment management on the ICU. If the sedation is not properly rated and evaluated inconsistently, this could cause serious consequences like the use of sustained mechanical ventilation, increased risk of delirium or possible coma caused by medical action (iatrogenic coma). Application of systematic sedation monitoring protocols by using validated tools is essential in reaching optimized sedation targets and minimize related risks.

RASS is the most widely used measuring tool worldwide because its tools are easy to use, high inter-rater, and its ability to sedate and desedate. RASS uses a 10 point scale, from +4 to -5, give the possibility of medical personnel documenting the level of sedation consistently, detecting changes every time, and adjustment of the medicinal dose as needed [9]. Can be proved if the RASS has a strong correlation with SAS and GCS, So that it increases the clinical value [8,17].

The study recommended that all patients be maintained at the level of light to moderate sedation so (0) -2 until the, unless sedation is needed on a temporary basis for a particular procedure or in a condition of severe respiratory disorders. Sedation light pertaining to old treated in the ICU at least briefly, faster extubation and decrease the delirium in ICU [23,32].

Unlimited monitoring only exists in the smooth depth. Judgments of pain and delirium must also be done simultaneously. Critical-care pain scale (BPS) is often used for patients who cannot communicate or in sedation state. It can judge behavioral indicators for example facial expressions, body member movement, as well as the wisdom of ventilation. The integration of these tools with RASS increases accuracy when assessing the patient's comforts and can ensure that the sedation does not mask the dull pain that is handled.

Delirium monitoring is also very important for sedation management, especially considering if sedation is a known risk factor could trigger the delirium ICU. Confusion assessment method for the ICU (CAM-ICU) is a cognitive assessment tool that is validated and used broad sevata to detect delirium, neither in the patient nor in the patient's congenital sedation. covers assessment on acute onset symptoms, attention disorder, messed-up mindset and a change in consciousness level, So that gives a systematic framework for diagnosis and early intervention in delirium [18,26]. Clinical practice guidelines highly recommended a multidisciplinary approach called ABCDEF bundle, covering:

- A: Assess, prevent, and manage pain
- B: Both spontaneous awakening trials (SAT) and spontaneous breathing trials (SBT)
- C: Choice of analgesia and sedation
- D: Delirium: assess, prevent, and manage
- E: Early mobility and exercise
- F: Family engagement and empowerment

A bundle of into this, control pain and prevention delirium, and focused on the importance of the routine and structural than clinical value that would be spontaneous [2,9].

In conclusion, monitoring sedation sustainably not so kind of tool, CPOT, it is important to care CAM-ICU, ICU which are dynamic and individualist. It provided as a yardstick to measure objectively, so lead medical officer in titrating sedative agent safely and effectively, at the same time reduce the risk of side effects and encourage recovery faster. But, the effectiveness of this instrument depends on training nurses, strict adherence to protocol and the integration herb into a real-time clinical decision making.

2.1.5. Types of Sedative Medications

Common sedative agents used in ICU environment include benzodiazepin (e.g. midazolam, lorazepam, propofol, dexmedetomidine, and ketamine). That each has a different pharmacological profile. Benzodiazepine, although effective, was less and less used if it is related to the use of risk delirium and longer ventilation. Had the advantage of propofol in rapid onset, but caused risk hypotension and rare infusion syndrome. For sedation dexmedetomidine preferred light because only slightly depressing respiratory function and lower risk having delirium, although bradycardia can cause. Ketamine, dissociative and having analgesic properties, beneficial in patients unstable in hemodynamics or opioid tolerant of patients, but its use may lead to the emergence of agitation (recovery) phenomena. Agent addition as opioid or antipsychotic drugs often used to raise comfort or manage agitation. The sedative drugs should be adjusted to the patient condition, the purpose of sedation, and risk profile of each drug.

Selection of Sedative Medication

The selection of sedative medications for critically ill patients should be tailored based on clinical goals, duration of therapy, organ function, and individual risk factors such as hemodynamic status or risk of delirium. Current guidelines increasingly recommend the use of non-benzodiazepine sedatives such as propofol or dexmedetomidine for most ICU patients due to their superior outcomes regarding ventilation duration and delirium incidence. Benzodiazepines are generally used only in specific cases such as alcohol withdrawal or refractory seizures. Clinicians should also consider pharmacokinetics, cost, availability, and the need for neurological assessment when selecting a sedative agent. Ultimately, sedation strategies must balance adequate patient comfort with early mobilization and preservation of cognitive function.

2.1.6. Accuracy of Medication Use

Precision in the use of sedative drugs in ICU patients is essential to ensure a therapeutic effectiveness while minimizing side effects such as excess sedation, delirium, or respiratory depression. This requires a proper dose, regular reevaluation uses validated tools such as RASS and CPOT, as well as individual dose adjustments based on patient responses and developing clinical conditions. Errors in gift, tardiness recognizes side effects, or failures to adjust doses due to kidney or liver malfunctions can have a profound effect on the patient's safety. Standard sedation protocol application, interprofession communication, and electronic prescription systems have proven to increase the accuracy of drug use and clinical results in intensive care environments..

2.2. Delirium

2.2.1. Definition of Delirium

Delirium is an acute disorder that fluctuates in attention, consciousness, and cognitive function that develops in a short time and is common in ICU patients with critical illness. Delirium is marked by an irregular mindset, a changing consciousness, and perception disorder. Which often leads to serious morbidity and prolonged hospitalization. Diagnostic and statistical manual of mental disorders (DSM-5) defines delirium as a neurocognitive disorder caused by a medical condition, substance, or medicines. In the ICU environment, delirium often not diagnosed due to sedation or communication barriers, but early introduction to tools like CAM-ICU is very important because delirium is associated with increased mortality rates, longer use of ventilator, and long-term cognitive decline.

2.2.2. Pathophysiology of Delirium

Delirium pathophysiology is multifactorian and is not yet fully understood, but it is believed to involve complex interaction between neurotransmitter imbalances, systemic inflammation, and brain oxidative stress. Acetylcholine shortages and excess dopamine activities are often associated with attention disorders and cognition. Cytokine inflammatory like IL-6 and TNF- α can damage the integrity of the brain-blood and change the signal of neurons, especially in critically ill patients with infections or organ failure. Other than that, factors like hypoxia, metabolic interference, as well as the use of sedative or anticholinergic drugs can exacerbate neurochemical dysfunction, so as to increase brain vulnerabilities to acute cognitive disorders.

2.2.3. Delirium Assessment

The delirium assessment of the ICU patient is very important but challenging because there are barriers to communication and influence from the sedation or ventilator. Most validized and widely used tool in this context is confusion method for the ICU (CAM-ICU), evaluating four main aspects: acute agitation or fluctuating travel, inattentive, a change in consciousness level, and irregular thinking. Another tool that's also reliable is intense care delirium screening checklist (ICDSC), evaluating eight clinical criteria during a 24-hour period. Routine use of these devices by trained health workers can increase early detection and delirium implementation, thus lowering long-term cognitive complications and decreased cognitive function.

2.2.4. Management of Delirium

Effective management of patients in the ICU requires a multimodal approach that combines non-pharmacological and pharmacological strategies. Non-pharmacological interventions such as reorientation, sleep promotion, early mobilization, optimization of visual and auditory aids, and minimizing unnecessary stimuli are the first line of treatment with strong evidence of benefit. Pharmacological therapy is used only in cases of severe agitation or safety concerns, typically with antipsychotics such as haloperidol or quetiapine, although their efficacy remains controversial. Most importantly, reducing the use of medications that trigger delirium, optimizing pain control, and maintaining light sedation are key preventive strategies, all emphasized in the ABCDEF bundle for ICU care.

2.3. Pain

2.3.1. Definition of Pain

Pain is defined by the International Association for the Study of Pain (IASP) as an unpleasant sensory and emotional experience related to, or similar to those associated with, real or potential tissue damage. In critically ill ICU patients, pain can come from an underlying disease, invasive procedure, mechanical ventilation, or long-term immobilization. Pain assessment in this population is often difficult due to sedation and communication barriers, so that the use of behavior observation tools becomes important. Recognizing pain not only as a physical sensation but also a subjective emotional experience is key to ensuring effective critical care, humanity, and focus on the patient.

2.3.2. Classification of Pain

Pain in critical patient can be classified according to duration, physiological mechanism, and origin. Understand these categories are important to adjust the right pain management strategies in ICU.

Based on Duration:

- Acute Pain: Short-term pain that arises suddenly due to tissue injury, surgery, or medical procedures such as intubation or catheter insertion. It typically resolves with healing.
- Chronic Pain: Persistent pain lasting longer than three months, which may preexist ICU admission or develop after prolonged illness or immobilization.
- Procedural Pain: Pain occurring during specific procedures like suctioning, wound care, or repositioning.
- Breakthrough Pain: A sudden spike of pain that occurs despite baseline analgesia, often requiring rapid intervention.

Based on Mechanism:

- Nociceptive Pain: Caused by activation of nociceptors due to actual or potential tissue damage.
- Somatic Pain: Sharp, localized pain from skin, muscles, or bones.
- Visceral Pain: Dull, poorly localized pain from internal organs such as the gastrointestinal tract or lungs.
- Neuropathic Pain: Arising from injury or dysfunction of the nervous system, often described as burning, shooting, or electric-like sensations.

Based on Source or Origin:

- Physical Pain: Direct response to mechanical, thermal, or chemical stimuli.
- Psychogenic or Emotional Pain: Pain intensified by psychological factors such as anxiety, fear, or delirium, especially in conscious ICU patients.

2.3.3. Pain Mechanism

Pain mechanism involves a complex nervous process that consists of four main phases: transduction, transmission, perception, and modulation. In transduction, pain stimuli is converted into electrical signals by nosyceptors in the peripheral tissues. This signal is then transmitted via afferent nerve fibers to the spinal cord and up to brainstem and thalamus. The perception of pain occurs in the cerebral cortex, where stimuli is interpreted as an unpleasant sensation. Lastly, modulation involves a drop-off path that can inhibit or strengthen pain signals, affected by an emotional state, attention, dan endogenous opioid. On critical patients, this process can be disturbed by disease, inflammatory, sedation, and communication interference. Which makes pain judgment and control challenging.

2.3.4. Pain Assessment in the ICU

The pain assessment of the ICU patient is critical but challenging, especially in patients who can't communicate or are being sedated. To a conscious patient, self-reporting tools like Numeric Rating Scale (NRS) or Visual Analog Scale (VAS) remains a gold standard. However, for a patient who can't express his pain, valided behavior devices such as Critical-Care Pain Observation Tool (CPOT) and Behavioral Pain Scale (BPS) are widely used. These tools assess facial expressions, body movement, muscle tension, And obedience to mechanical ventilation to predict rate of pain. Routine use of this tool has been proven to increase pain detection, helps adjust the analgesic dose, and reduce complications so that it strengthens the importance of this device in the ICU protocol.

Behavioral Pain Scales (BPS)

Behavioral Pain Scale (BPS) is a validated tool to assess pain in ICU patients who cannot communicate and use mechanical ventilators. It evaluates three behavioral indicators: facial expression, upper arms movement, and obedience to mechanical ventilation. Each one is scored from 1 (no pain) to 4 (Severe pain), with total scores ranging from 3 to 12. Higher scores indicate greater pain intensity. BPS have good and sensitive reliability between values for pain changes during procedures such as repositioning or suctioning. Although most suitable for intubated patients. Its simplicity and reproducibility make it an important tool in regular pain assessments in intensive care.

Critical Care Pain Observation Tool (CPOT)

The Critical Care Pain Observation Tool (CPOT) consists of five assessment indicators, namely: facial expression, body movements, compliance with the ventilator (for intubated patients), vocalization (for non-intubated patients), and muscle tension. The total CPOT score ranges from 0 to 8, with the following interpretations: score 0–2: Mild pain, score 3–4: moderate pain, score 5–8: severe pain.

Analgesedation

Opioids such as fentanyl, hydromorphone, methadone, morphine, and remifentanyl are the primary choice for managing pain in critically ill patients. The appropriate selection of opioid type and dosage must be tailored to the individual characteristics of the patient, including pharmacokinetic and pharmacodynamic considerations. The administration of opioids and other analgesics via the enteral route (orally) and other methods may be limited in patients with adequate absorption capacity and normal gastrointestinal function. Regional or neuraxial methods (such as spinal or epidural use) may also be employed as postoperative analgesic strategies depending on the type of surgery performed.

3. Conclusion

Effective sedation and pain management in critically ill ICU patients require a comprehensive and individualized approach guided by evidence-based protocols and validated assessment tools. Choosing the appropriate sedative agent, maintaining optimal sedation levels, and continuously monitoring for pain and delirium are crucial for improving patient outcomes and reducing ICU-related complications. Tools such as RASS, CPOT, CAM-ICU, and BPS play a vital role in enhancing clinical decision-making, especially in non-communicative patients. The integration of non-pharmacologic strategies, regular assessments, and interdisciplinary collaboration remains the foundation for safe, humane, and effective critical care. Future research should continue exploring sedation strategies that promote comfort while minimizing long-term cognitive and functional impairments.

Compliance with ethical standards

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