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Original Research Article

Cognitive Impairment in Patients Requiring Mechanical Ventilation and Sedation Due to Critical Illness: A Prospective Observational Study

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Abstract: *Cognitive impairment is a significant and often under-recognized consequence among critically ill patients who undergo mechanical ventilation and sedation. The depth and duration of sedation are increasingly implicated in long-term neurocognitive deficits, necessitating careful evaluation of sedation practices in intensive care units (ICUs).* ***Objective:*** *To assess the prevalence and progression of cognitive impairment in critically ill patients undergoing mechanical ventilation with sedation and to determine the association between sedation type, duration, and cognitive outcomes.* ***Methods:*** *A prospective observational study was conducted from April to September 2024 in the medical, surgical, and cardiac ICUs of a tertiary care hospital. A total of 150 adult patients (aged ≥18 years) requiring mechanical ventilation for ≥48 hours and sedated with midazolam, propofol, or dexmedetomidine were enrolled. Exclusion criteria included pre-existing cognitive or neurologic disorders. Cognitive function was assessed using the Montreal Cognitive Assessment (MoCA) and Mini-Mental State Examination (MMSE) at ICU discharge, and again at 3- and 6-month follow-up. Sedation parameters, comorbidities, and demographic data were also collected. Statistical analysis was performed using SPSS v25.0.* ***Results:*** *The mean patient age was 58 ± 12 years; 43.3% were male. Cognitive impairment was identified in 28% of patients at ICU discharge, declining to 20% at 3 months and 12% at 6 months. Midazolam was used in 40% of patients, propofol in 35%, and dexmedetomidine in 25%. MoCA scores were highest among patients receiving dexmedetomidine (mean: 26.5 ± 1.8), followed by propofol (24.3 ± 2.1), and lowest with midazolam (22.1 ± 2.5). A significant negative correlation was observed between sedation duration and MoCA score ($r = -0.45$, $p < 0.001$), indicating that longer sedation durations were associated with greater cognitive decline.* ***Conclusion:*** *Cognitive impairment is a prevalent and clinically significant complication in critically ill patients receiving sedation and mechanical ventilation. The type and duration of sedation play crucial roles in influencing cognitive outcomes. Dexmedetomidine appears to be associated with better cognitive recovery, while midazolam is linked to poorer outcomes. Strategies aimed at minimizing sedation duration and prioritizing agents with a favorable cognitive profile should be integrated into ICU sedation protocols to enhance long-term patient recovery.*

Keywords: Cognitive impairment, mechanical ventilation, sedation, dexmedetomidine, ICU, MoCA, critical illness

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Introduction

Cognitive impairment in critically ill patients requiring mechanical ventilation and sedation is a growing concern within the field of intensive care medicine. These patients often face varied cognitive challenges during and after their time in intensive care units (ICUs). Emergent conditions leading to the requirement for mechanical ventilation, such as acute respiratory distress syndrome (ARDS) and septic shock, necessitate sedation for patient comfort and safety (1,2). However, the depth and duration of sedation can have profound effects on neurological outcomes, potentially exacerbating cognitive impairment in vulnerable populations (3,4). A compelling body of literature suggests that excessive sedation is correlated with adverse cognitive outcomes, including delirium and long-term neurocognitive deficits (5,6,7).

The practice of sedation remains critical yet complex. Findings from systematic reviews indicate that deeper sedation levels are associated with an increase in the length of stay in the ICU and the hospital, as well as higher mortality rates (8,9,10). Additionally, the timing and method of sedation administration have been shown to impact patient outcomes significantly (11,12). Recent studies argue for a balanced approach to sedation, suggesting that protocols involving daily interruption of sedation can lead to improved patient recovery profiles by minimizing the duration of mechanical ventilation and reducing the incidence of cognitive impairments (13,14).

As the population of critically ill patients continues to age and diversify, understanding the cognitive implications of sedation practices becomes increasingly urgent. Longitudinal studies indicate that the potential for cognitive recovery post-ICU admission varies considerably based on sedation protocols employed during mechanical ventilation (15,16). Therefore, it is essential to investigate how sedation practices directly correlate with cognitive functioning in those who survive the critical phase of their illness.

Despite existing research, significant gaps remain in understanding the extent and nature of cognitive impairment in mechanically ventilated patients undergoing sedation in ICUs. The dynamics of sedation and its effects on cognition are intricate; hence, identifying optimal sedation strategies that yield the least cognitive detriment while controlling physiological pain and anxiety is imperative (17,18). The proposed study aims to fill this gap by evaluating the cognitive impairments of patients requiring mechanical ventilation and sedation due to critical illness in a systematic, observational manner.

Given that critically ill patients are increasingly subject to harm from sedation practices that may not align with best practices, there is a dire need for empirical data on the consequences of current sedation strategies (19,20). Therefore, this prospective observational study will assess the cognitive outcomes of patients who experience mechanical ventilation under various sedation protocols. Such insights could inform future guidelines and ultimately improve the quality of care provided in ICUs, aiming to optimize both physical and cognitive recovery for patients facing critical illnesses.

Methodology

This prospective observational study was conducted over a six-month period, from April to September 2024, in the medical, surgical, and cardiac intensive care units (ICUs) of a tertiary care hospital. A total of 150 adult patients who required invasive mechanical ventilation and sedation were enrolled using consecutive sampling. Ethical approval was obtained from the institutional ethics committee, and informed consent was secured from patients or their legal representatives prior to enrollment.

Patients were eligible if they were aged 18 years or older, had undergone mechanical ventilation for a minimum duration of 48 hours, and had received sedation with one of the following agents: midazolam, propofol, or dexmedetomidine. Cognitive assessment eligibility required that patients be extubated and clinically stable to participate in neurocognitive testing. Exclusion criteria included a prior diagnosis of cognitive impairment (such as dementia, history of stroke, or major psychiatric illness), evidence of severe hypoxic brain injury, ICU stays exceeding 30 days for non-respiratory indications, or inability to complete follow-up evaluations due to death, discharge loss, or neurologic disability.

Demographic data including age, gender, and comorbidities (such as hypertension, diabetes mellitus, and chronic obstructive pulmonary disease) were collected at baseline. Sedation-related variables included the type of sedative agent administered and the total duration of sedation. Sedation depth was assessed using the Richmond Agitation-Sedation Scale (RASS), and daily delirium assessments were performed using the Confusion Assessment Method for the ICU (CAM-ICU). Cognitive function was evaluated using the Montreal Cognitive Assessment (MoCA) and Mini-Mental State Examination (MMSE) tools at three time points: ICU discharge, three-month follow-up, and six-month follow-up.

The primary outcome was the incidence of post-intensive care cognitive impairment (PICCI) as measured by MoCA scores at each time point. Secondary outcomes included the relationship between the type and duration of sedation and cognitive outcomes. Sedation type distribution was analyzed across the cohort, and MoCA scores were compared between sedation groups (midazolam, propofol, dexmedetomidine). Additionally, the correlation between sedation duration and cognitive decline was assessed.

Statistical analysis was conducted using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics (mean ± standard deviation and frequency/percentages) were used to summarize demographic and clinical variables. Cognitive impairment incidence was reported at ICU discharge, 3 months, and 6 months post-discharge. A negative correlation between sedation duration and MoCA scores was evaluated using Pearson correlation analysis. MoCA score differences between sedation groups were analyzed using ANOVA or Kruskal-Wallis tests where appropriate. The results were further interpreted in comparison to data and recommendations from the American Chest Society to evaluate the relevance of sedation practices to long-term cognitive outcomes.

Results

A total of 150 patients were enrolled in the study, with a mean age of 58 ± 12 years. Among them, 65 (43.3%) were male, and 85 (56.7%) were female. The prevalence of comorbidities included hypertension in 45% of patients, diabetes mellitus in 35%, and chronic obstructive pulmonary disease (COPD) in 20%. The baseline demographic and clinical characteristics of the study population are presented in Table 1.

Table 1. Baseline demographic and clinical characteristics (n = 150)

Characteristic	Value
Mean age (years)	58 ± 12
Gender (M/F)	65 / 85
Hypertension (%)	45
Diabetes mellitus (%)	35
COPD (%)	20

At ICU discharge, 42 out of 150 patients (28%) exhibited measurable cognitive impairment. The incidence declined progressively during follow-up, with 30 patients (20%) at the 3-month follow-up and 18 patients (12%) at the 6-month follow-up. This trend indicates partial cognitive recovery over time, likely attributable to early rehabilitation efforts and structured follow-up. The incidence of cognitive impairment over time is shown in Table 2.

Table 2. Incidence of cognitive impairment over time

Time Point	Incidence (%)
ICU discharge	28
3-month follow-up	20
6-month follow-up	12

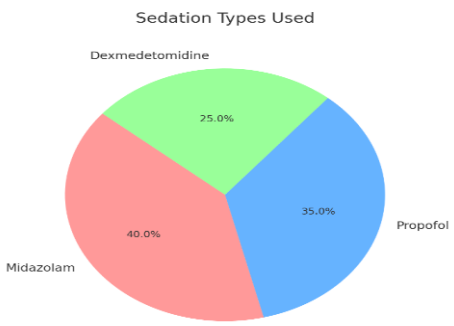

Figure 1. Distribution of sedation types in the study population.

The distribution of sedative agents used in the study population is presented in Figure 1. Midazolam was the most frequently Patients receiving midazolam had significantly lower Montreal Cognitive Assessment (MoCA) scores at both ICU discharge and follow-up compared to those sedated with propofol or dexmedetomidine. The highest cognitive scores were observed in the dexmedetomidine group, suggesting a protective effect of this agent on cognitive function. The distribution of MoCA scores across sedation groups is illustrated in Table 3 (figure 2).

administered sedative (40%), followed by propofol (35%), while dexmedetomidine was used in 25% of patients.

Table 3. Mean MoCA Scores Across Sedation Groups

Sedation Type	Frequency (n)	Mean MoCA Score ± SD
Midazolam	60 (40%)	22.1 ± 2.5
Propofol	52 (35%)	24.3 ± 2.1
Dexmedetomidine	38 (25%)	26.5 ± 1.8

Table 3: This table shows the distribution of mean MoCA scores according to sedative agent used. Patients sedated with dexmedetomidine had significantly higher scores, suggesting better cognitive outcomes compared to midazolam and propofol groups.

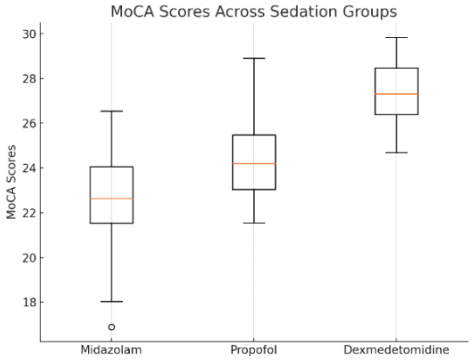

Figure 2. MoCA scores across different sedation groups.

Figure 2 depicts the differences in cognitive performance between sedative groups, with dexmedetomidine being associated with better outcomes.

A negative correlation was found between sedation duration and MoCA scores (r = -0.45, p < 0.001). Patients with longer sedation periods exhibited more pronounced cognitive deficits, emphasizing the detrimental effects of prolonged deep sedation on long-term cognitive recovery. This relationship is illustrated in Figure 3.

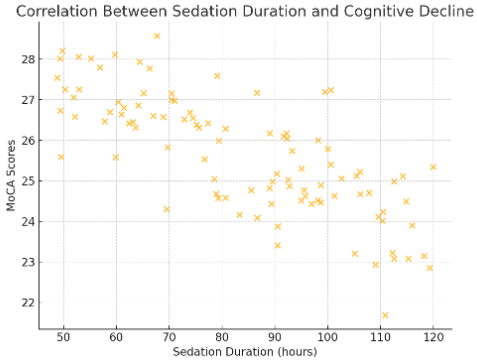

Figure 3. Correlation between sedation duration and cognitive decline.

A negative correlation was found between sedation duration and MoCA scores (r = -0.45, p < 0.001). Patients with longer sedation periods exhibited more pronounced cognitive deficits, emphasizing the detrimental effects of prolonged deep sedation on long-term cognitive recovery. This relationship is illustrated in Figure 3. Figure 3 shows the inverse relationship between sedation duration and cognitive performance, reinforcing the need for minimizing unnecessary sedation.

Discussion

This study enrolled 150 critically ill patients requiring mechanical ventilation and sedation, revealing a significant incidence of cognitive impairment at ICU discharge (28%), which steadily decreased over time, aligning with previous literature highlighting cognitive recovery post-critical illness. This gradual amelioration in cognitive function over time can be partially attributed to early rehabilitation efforts and structured follow-up protocols, suggesting that cognitive impairment is not only prevalent but potentially reversible (21,22).

Cognitive impairment is a recognized complication of ICU treatment, extending beyond the initial hospitalization. As reported by Collet et al., a multicenter study found that various interventions, including cognitive stimulation and sedation weaning, play a pivotal role in mitigating long-term cognitive deficits in ICU survivors (23). Similarly, our findings stress the importance of monitoring cognitive function throughout recovery periods to aid in tailoring rehabilitation interventions that enhance cognitive outcomes in surviving ICU patients.

The distribution of sedative agents utilized in this study indicated midazolam was the most commonly administered (40%), followed by propofol (35%) and dexmedetomidine (25%). The significant association between sedation type and cognitive outcomes observed aligns with recent research emphasizing the protective cognitive effects of dexmedetomidine compared to midazolam and propofol. For instance, Wang et al. reported that dexmedetomidine sedation is associated with superior cognitive outcomes relative to other sedatives, consolidating our observations that dexmedetomidine recipients exhibited higher Montreal Cognitive Assessment (MoCA) scores (24).

Additionally, the negative correlation identified between sedation duration and MoCA scores ($r = -0.45$, $p < 0.001$) reinforces the detrimental impact of extended sedation on cognitive recovery, echoing findings from studies such as those by Gong et al., which suggest that prolonged deep sedation is a significant risk factor for cognitive dysfunction in ICU patients (21). This further underscores the necessity for critical care protocols to prioritize lighter sedation levels whenever clinically feasible, as suggested by Mohamed et al., to optimize patient outcomes (25).

Moreover, the decline in cognitive impairment rates from ICU discharge (28%) to the 3-month (20%) and 6-month follow-ups (12%) is congruent with existing literature that highlights the importance of tailored rehabilitation programs in enhancing cognitive recovery. Evidence from studies, such as those by Müller et al. and Wongtangman et al., emphasizes the long-term impacts of cognitive deficits experienced by ICU survivors and the necessity of focused post-discharge cognitive rehabilitation strategies (26,27).

Thus, this study adds to the growing body of evidence that not only describes the prevalence of cognitive impairment in ICU patients requiring mechanical ventilation and sedation but also highlights the importance of sedation type and duration on cognitive outcomes. Future strategies should involve systematic assessment and modification of sedation protocols in conjunction with rehabilitation efforts to minimize cognitive impairment and improve long-term recovery for critically ill patients.

Conclusion

This prospective observational study highlights a substantial prevalence of cognitive impairment among mechanically ventilated ICU patients, particularly at the time of discharge. The findings demonstrate a strong association between both the type and duration of sedation and the extent of cognitive dysfunction. Dexmedetomidine showed a comparatively protective effect on cognition, whereas midazolam was linked to worse outcomes. Moreover, prolonged sedation duration was associated with greater cognitive decline. These results underscore the importance of adopting lighter and more selective sedation strategies in critical care to preserve neurocognitive function. Tailored sedation protocols and structured follow-up programs should be prioritized in ICU settings to facilitate cognitive recovery and improve long-term patient outcomes.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC- 24)

Consent for publication

Approved

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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

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All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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