BRITISH JOURNAL OF HOSPITAL MEDICINE

ARTICLE

Evaluating the Effectiveness of Nurse-Led Early Comfort Using Analgesia, Minimal Sedatives, and Maximal Humane Care Sedation in Mechanically Ventilated Patients

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Abstract

Aims/Background Early Comfort using Analgesia, minimal Sedatives, and maximal Human care (eCASH) is a patient-centered sedation strategy aimed at reducing the use of sedative drugs and improving patient comfort. Therefore, this study evaluated the effectiveness of a nurse-led eCASH sedation strategy in mechanically ventilated patients.

Methods This retrospective cohort study included 149 patients who received mechanical ventilation in the intensive care unit (ICU) of the Second Affiliated Hospital of Harbin Medical University between May 2020 and May 2024. Patients were divided into two groups: the observation group (eCASH sedation group, n = 70), which received nurse-led eCASH sedation, and the control group (traditional sedation group, n = 79), which underwent physician-led traditional sedation strategies. Baseline characteristics, analgesic and sedative use, analgesia and sedation outcomes, duration of mechanical ventilation, ICU stay, length of hospital stay, and incidence of delirium were compared between the two groups.

Results The observation group received a significantly higher dose of fentanyl within the first 24 hours of mechanical ventilation compared to the control group ($p = 0.001$). However, there was no significant difference in fentanyl use at 48 and 72 hours between the two groups ($p > 0.05$). Dexmedetomidine use in the observation group was significantly lower than in the control group at 24, 48, and 72 hours ($p < 0.05$). Moreover, no significant difference was observed in the use of propofol between the two groups ($p > 0.05$). The observation group had a significantly higher analgesia success rate within 72 hours ($p = 0.027$), although the sedation success rate was not significantly different ($p > 0.05$). Both groups showed significant improvement over time in Richmond Agitation-Sedation Scale (RASS) and Critical-Care Pain Observation Tool (CPOT) scores ($p < 0.001$), with the observation group demonstrating a significantly faster improvement in analgesia effectiveness compared to the control group ($p = 0.015$). The duration of mechanical ventilation was significantly shorter in the observation group ($p = 0.011$), while the incidence of delirium was lower but not statistically significant ($p = 0.519$). Additionally, there were no statistically significant differences in ICU stay duration and length of hospital stay between the two groups ($p > 0.05$).

Conclusion The nurse-led eCASH sedation strategy significantly reduces analgesic use, shortens mechanical ventilation duration, and improves analgesia outcomes in mechanically ventilated patients. The effectiveness of sedation and incidence of delirium within the eCASH were comparable to those of traditional sedation.

Key words: sedation; ventilation; analgesia; delirium; intensive care unit

Submitted: 5 December 2024 Revised: 9 January 2025 Accepted: 22 January 2025

How to cite this article:
Hui H, Fang X, Ju L, Tang L, Zhang H, Wang M, Jiang J. Evaluating the Effectiveness of Nurse-Led Early Comfort Using Analgesia, Minimal Sedatives, and Maximal Humane Care Sedation in Mechanically Ventilated Patients. Br J Hosp Med. 2025. https://doi.org/10.12968/hmed.2024.0987

Introduction

Mechanical ventilation (MV) is a commonly used approach in intensive care units (ICUs), with a global study indicating that approximately 30–40% of ICU patients require this life support during hospitalization (Vali et al, 2023). While critical for maintaining respiratory function, MV is associated with several complications. For instance, prolonged mechanical ventilation significantly increases the risk of ventilator-associated pneumonia (VAP), with incidence rates ranging from 5% to 40% (Papazian et al, 2020). Furthermore, MV can result in tracheal injury, pneumothorax, and prolonged ICU and hospital stay (Haribhai and Mahboobi, 2022).

Sedation is a crucial component of MV, aiding in managing patient status. In ICU settings, commonly used sedative protocols include drugs such as propofol, midazolam, and dexmedetomidine (Hughes et al, 2021). Although these medicines provide effective sedation, excessive use can result in adverse effects, such as sedation-related delirium, long-term cognitive dysfunction, and extended hospital stay (Liu et al, 2024). For example, a study by Hyun et al (2023) reported that early and profound sedation is associated with increased long-term mortality rates. In contrast, insufficient sedation, as shown by Grap et al (2012), may lead to patient distress, anxiety, and an increased risk of self-extubating. These challenges highlight the limitations of current sedation methods and the urgent need for improvement in clinical practice.

To address these concerns, Vincent et al (2016) proposed the Early Comfort using Analgesia, minimal Sedatives, and maximal Human care (eCASH) sedation strategy. Emphasizing the use of early analgesia and minimal sedative drugs, and prioritizing human-centered care, thereby enhancing patient comfort and clinical outcomes. In recent years, eCASH has obtained global recognition and has been widely used in ICU settings. Furthermore, its effectiveness and safety have been reported in multiple studies, including a study by Acevedo-Nuevo et al (2018), which revealed enhanced sedation management and decreased delirium in ICU patients adapting eCASH.

Hence, this study aims to evaluate the effectiveness of nurse-led eCASH sedation in mechanically ventilated ICU patients. Applying a retrospective cohort study design, it provides further evidence regarding the specific impacts and potential benefits of eCASH in clinical settings. The findings of this study would contribute to a more evidence-based and patient-centered approach to sedation management in ICU settings.

Methods

Recruitment to Study Subjects

This retrospective study analyzed data obtained from 149 patients who underwent mechanical ventilation between May 2020 and May 2024 at the intensive care unit (ICU) of the Second Affiliated Hospital of Harbin Medical University.

The inclusion criteria were as follows: Patients aged 18 or above, first-time recipients of invasive mechanical ventilation in the ICU, with mechanical ventilation

duration of at least 48 hours, and with an Acute Physiology and Chronic Health Evaluation (APACHE) II score of 24 or lower (Knaus et al, 1985). However, the exclusion criteria included (1) a history of psychiatric disorders or substance abuse, (2) patients with presence of central nervous system or brain diseases, coma, or dementia, (3) patients with history of sleep disorders, (4) patients with inability to communicate, (5) patients with requirements for deep sedation due to medical conditions (Richmond Agitation-Sedation Scale (RASS) <–3) (Sessler et al, 2002), (6) patients who were transferred to other departments or deceased, (7) those with severe intracranial hypertension and acute coronary syndrome within 24 hours, multiple rib fractures, severe acute respiratory distress syndrome, or ischemic-hypoxic encephalopathy with seizures, and (8) those with incomplete clinical data.

Study Groups

Patients undergoing mechanical ventilation were divided into two groups based on their sedation strategies: the control group (traditional sedation group, n = 79) and the observation group (eCASH sedation group, n = 70).

Control Group

Patients in the control group received analgesic followed by sedative drugs and were monitored through standard care. Fentanyl (H20030199, Yichang Humanwell Pharmaceutical Co., Ltd., Yichang, China) was administered at a dose of 0.7–10 μg/kg/h based on patient needs, without strict early usage standards. The goal for pain relief was a Critical-Care Pain Observation Tool (CPOT) score of 0–2. Pain levels were continuously monitored, with CPOT scores recorded every 4 hours, and dosages adjusted per medical advice. Dexmedetomidine (H20213533, Sichuan Meidakang Huakang Pharmaceutical Co., Ltd., Mianyang, China) was routinely used for sedation to achieve mild to moderate sedation (RASS score –1 to 0) within 12 hours of ICU admission. Initially, dexmedetomidine was infused intravenously at a rate of 1 μg/kg for more than 10 minutes, followed by a maintenance dose of 0.2–0.7 μg/kg/h. If sedation targets were not achieved, propofol (12403143 II, Xi'an Libang Pharmaceutical Co., Ltd., Xi'an, China) (10–20 mg) was intermittently administered as an adjunct. Sedation levels were continuously monitored, with RASS scores recorded every 4 hours, and dosages were adjusted based on medical advice.

They were closely monitored, primarily focusing on physiological indicators and mechanical ventilation management, including respiratory rate, blood oxygen saturation, blood pressure, and heart rate. Furthermore, sedation and pain levels were regularly assessed, and the outcomes were timely communicated to physicians.

Observation Group

Initially, fentanyl was administered at a dose of 0.7–10 μg/kg/h, with dosage adjustments made as required to ensure patient comfort during rest and treatment, aiming for effective pain relief (CPOT score 0–2). The use of sedative drugs was minimized, with dexmedetomidine infused at low doses of 0.2–0.7 μg/kg/h. If se-

dation targets were not met, propofol (10–20 mg) was intermittently administered as an adjunct. The target was maintaining mild sedation (RASS score –1 to 0), allowing patients to respond appropriately and cooperate with treatment.

Furthermore, music therapy was introduced as a non-pharmacological intervention to support sedation and analgesia. The implementation protocol for the observation group is detailed in Fig. 1 (Vincent et al, 2016). Patient's condition was closely monitored, focusing on physiological indicators and mechanical ventilation management, including respiratory rate, oxygen saturation, blood pressure, and heart rate. Sedation and pain levels were regularly assessed, and the outcomes were promptly communicated to the doctor.

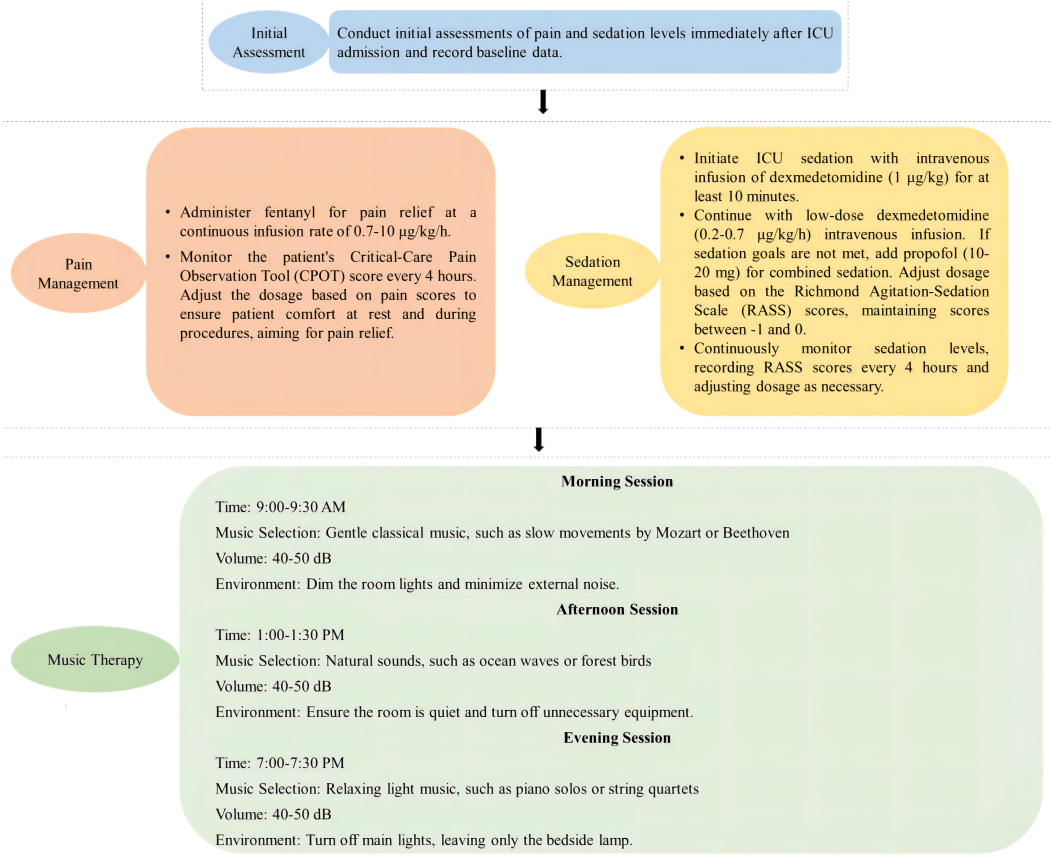

Fig. 1. A flow chart of eCASH sedation protocol used in this study. The figure was created using Microsoft PowerPoint 2016 software (Microsoft Corporation, Redmond, WA, USA). eCASH, Early Comfort using Analgesia, minimal Sedatives, and maximal Human care; ICU, intensive care unit.

Outcome Measures

The primary outcome of this study is the effectiveness of analgesia and sedation in each group, determined by the daily number of patients meeting sedation targets and the corresponding achievement rate. The secondary outcome measures included the usage rates and dosages of analgesic and sedative drugs, the incidence and rate of delirium, and the duration of mechanical ventilation, ICU stay and total hospitalization time.

Data Collection

Data were collected from the electronic medical records of the Second Affiliated Hospital of Harbin Medical University, China, including patient age, gender, weight, height, primary diagnosis (e.g., infectious diseases, cardiovascular diseases, respiratory diseases, post-surgical conditions), comorbidities (e.g., diabetes, hypertension), and APACHE II score upon ICU admission. The data also included usage rates and dosages of analgesics and sedatives, sedation and pain scores at ICU admission as well as at 24, 48, and 72 hours, RASS score (Sessler et al, 2002), and CPOT score (Gélinas et al, 2006), duration of mechanical ventilation, ICU stay, total hospitalization time, and incidence of delirium.

The RASS score is used to assess the depth of sedation and mental status of patients. The assessment consists of three steps: observing the patient, verbal, and physical stimulation to determine sedation depth. The RASS score ranges from –5 to +4. It is divided into the following levels: –5 (no response), –4 (deep sedation), –3 (moderate sedation), –2 (light sedation), –1 (alert), 0 (calm), +1 (mild agitation), +2 (moderate agitation), +3 (severe agitation), +4 (extreme agitation).

This CPOT scale includes four pain behaviors, such as facial expression, movements, muscle tone, and compliance with mechanical ventilation. Each component was scored from 0 to 2, with a total score ranging from 0 to 8. A score of 0 indicates no pain, while 8 shows severe pain.

Both CPOT and RASS scores were assessed by specially trained nursing staff. These nursing staff regularly undergo standardized training and assessment on the scoring tools as part of their routine work.

Data Quality Control

The data were reviewed by two independent researchers to ensure accuracy and consistency in data entry. In cases of any inconsistencies, re-verification was conducted. Both researchers have biostatistics background and expertise in clinical research, with focusing on data review and quality control. Standardized data entry forms were used to ensure a uniform format for all relevant data. Before analysis, data was cleaned to identify and rectify any errors or missing values.

Data Analysis

Statistical analysis was conducted using SPSS 26.0 software (IBM Corporation, Armonk, NY, USA). The Shapiro-Wilk test was used to determine normality within the continuous variable. Normally distributed continuous variables were expressed as mean ± standard deviation, with group comparisons conducted using independent samples *t*-tests. However, non-normally distributed variables were represented as median [P25, P75], with comparison performed using the rank-sum test. Moreover, categorical variables were expressed as frequencies and percentages, with group comparisons performed using chi-square tests. Generalized estimating equations (GEE) were used to analyze the repeated measures data, with Bonferroni correction applied for multiple comparisons. All statistical tests were two-tailed, and a significance level was set at a p-value of <0.05.

Table 1. Comparison of baseline characteristics between the two groups.

Characteristic	Observation group (n = 70)	Control group (n = 79)	t/χ^2	*p*-value
Age (years)	65.3 ± 9.8	64.7 ± 10.2	0.311	0.757
Gender (male/female)	57.14% (40/70)/42.86% (30/70)	56.96% (45/79)/43.04% (34/79)	0.000	0.982
Weight (kg)	70.2 ± 12.5	68.9 ± 11.8	0.640	0.517
Height (cm)	168.5 ± 8.2	169.1 ± 7.9	0.448	0.652
Infectious diseases	40.00% (28/70)	39.24% (31/79)	0.009	0.925
Cardiovascular diseases	25.71% (18/70)	27.85% (22/79)	0.086	0.769
Respiratory diseases	17.14% (12/70)	17.72% (14/79)	0.009	0.926
Post-surgical	11.43% (8/70)	11.39% (9/79)	0.000	0.994
Others	5.71% (4/70)	3.80% (3/79)	0.027	0.870*
Diabetes	25.71% (18/70)	25.32% (20/79)	0.003	0.956
Hypertension	31.43% (22/70)	29.11% (23/79)	0.094	0.759
APACHE II score	13.2 ± 3.6	13.8 ± 4.2	0.936	0.351

Note: *Continuity correction for the chi-square test. APACHE, Acute Physiology and Chronic Health Evaluation.

Results

Comparison of Baseline Characteristics Between the Two Groups

Out of the 149 recruited patients, 70 were categorized in the observation group (eCASH sedation group) and 79 in the control group (traditional sedation group). Baseline characteristics for all patients were collected and compared between the two groups, revealing no statistically significant differences ($p > 0.05$, Table 1). The results indicate that there were no significant differences in demographic characteristics, primary diagnoses, or comorbidities between the two groups.

Comparison of Analgesics and Sedative Dosages Between the Two Groups

The fentanyl analgesic dosage, in the observation group during the first 24 hours of mechanical ventilation was higher than that in the control group ($p = 0.001$). However, the fentanyl dosage between the two groups at 48 and 72 hours post-mechanical ventilation exhibited no significant differences ($p > 0.05$). Moreover, the dosage of dexmedetomidine was significantly lower in the observation group at 24, 48, and 72 hours compared to the control group ($p < 0.05$). Additionally, propofol dosage demonstrated no significant difference between the two groups ($p > 0.05$) (Table 2).

Comparison of Pain Control and Sedation Scores Between the Two Groups

In terms of pain control achievement, the observation group demonstrated a significantly higher achievement rate within 72 hours (95.71%) than the control group (84.81%, $p = 0.027$). However, at 24 and 48 hours, the pain control rates in the observation group (61.43% and 85.71%) were not significantly different from those of the control group (55.70% and 74.68%) ($p > 0.05$).

Regarding sedation achievement rates, the observation group had a slightly higher rate within 72 hours (60.00%) than the control group (49.37%), but the differ-

Table 2. Comparison of drug dosages between the two groups.

Drug	Time point	Observation group (n = 70)	Control group (n = 79)	z	*p*-value
Fentanyl (μg/kg)	24 h	42.00 (16.80, 120.00)	18.00 (12.00, 72.00)	3.396	0.001
	48 h	0.00 (0.00, 8.40)	0.00 (0.00, 18.00)	0.976	0.329
	72 h	0.00 (0.00, 0.00)	0.00 (0.00, 6.00)	1.521	0.128
Dexmedetomidine (μg/kg)	24 h	4.80 (4.80, 12.00)	16.80 (14.40, 16.80)	8.544	<0.001
	48 h	4.80 (4.80, 4.80)	4.80 (4.80, 12.00)	4.311	<0.001
	72 h	4.80 (4.80, 4.80)	4.80 (4.80, 4.80)	2.727	0.006
Propofol (mg/kg)	24 h	0.00 (0.00, 20.00)	0.00 (0.00, 10.00)	1.394	0.163
	48 h	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)	0.000	1.000
	72 h	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)	0.492	0.623

Table 3. Comparison of pain relief and sedation achievement rates between the two groups at 24, 48, and 72 hours.

Indicator	Time point	Observation group (n = 70)	Control group (n = 79)	χ^2	*p*-value
Pain achievement rate	24 h	61.43% (43/70)	55.70% (44/79)	0.502	0.479
	48 h	85.71% (60/70)	74.68% (59/79)	2.808	0.094
	72 h	95.71% (67/70)	84.81% (67/79)	4.874	0.027
Sedation achievement rate	24 h	25.71% (18/70)	21.52% (17/79)	0.363	0.547
	48 h	42.86% (30/70)	30.38% (24/79)	2.501	0.114
	72 h	60.00% (42/70)	49.37% (39/79)	1.691	0.193

ence was not statistically significant ($p = 0.193$). Similarly, at 24 and 48 hours, the sedation achievement rates were also comparable between the observation group (25.71% and 42.86%) and the control group (21.52% and 30.38%) with no significant differences ($p > 0.05$, Table 3).

Furthermore, there was a significant difference in the RASS scores between the two groups, indicating a substantial group effect ($p = 0.031$). Both groups showed a gradual decrease in the RASS scores at 24, 48, and 72 hours, indicating a significant time effect ($p < 0.001$) and progressive enhancement in sedation levels over time. However, the interaction effect between group and time was insignificant ($p = 0.794$), indicating a similar trend in sedation level improvement across both groups (Table 4).

Similarly, the CPOT score of the control group and the observation group decreased gradually over time, and the observation group showed a more obvious time effect ($p < 0.001$), which shows substantial pain relief in both the groups. The interaction effect between group and time was significant ($p = 0.015$), indicating that the observation group experienced a significantly faster improvement in pain relief than the control group. Additionally, the inter-group effect of CPOT scores was significant ($p = 0.032$), with overall lower scores in the observation group than in the control group (Table 4).

Table 4. Generalized estimating equations for RASS and CPOT scores between the two groups.

Indicator	Time point	Observation group (n = 70)	Control group (n = 79)	Group effect		Time effect		Interaction effect	
				Waldχ^2	*p*-value	Waldχ^2	*p*-value	Waldχ^2	*p*-value
RASS score	Baseline	2.00 (2.00, 3.00)	2.00 (1.00, 3.00)	4.634	0.031	449.436	<0.001	1.028	0.794
	24 h	1.00 (0.00, 2.00)	1.00 (0.00, 1.00)						
	48 h	0.50 (0.00, 1.00)	1.00 (–1.00, 1.00)						
	72 h	0.00 (–1.00, 1.00)	0.00 (–1.00, 1.00)						
CPOT score	Baseline	3.00 (3.00, 4.00)	3.00 (3.00, 4.00)	4.573	0.032	638.648	<0.001	10.507	0.015
	24 h	2.00 (1.00, 3.00)	2.00 (1.00, 3.00)						
	48 h	1.00 (1.00, 2.00)	2.00 (0.00, 3.00)						
	72 h	1.00 (0.00, 1.00)	1.00 (0.00, 2.00)						

RASS, Richmond Agitation-Sedation Scale; CPOT, Critical-Care Pain Observation Tool.

Table 5. Comparison of the duration of mechanical ventilation, hospital stay and ICU, and incidence of delirium between the two groups.

Indicator	Observation group (n = 70)	Control group (n = 79)	t/χ^2	p-value
Duration of mechanical ventilation (h)	91.5 ± 12.2	97.3 ± 15.4	2.564	0.011
ICU stay duration (h)	125.5 ± 21.2	131.2 ± 24.6	1.482	0.141
Length of hospital stay (d)	14.5 ± 4.3	15.1 ± 4.8	0.915	0.362
Incidence of delirium	7.14% (5/70)	10.13% (8/79)	0.415	0.519

Comparison of the Duration of Mechanical Ventilation, Hospital Stay and ICU Stay, and Incidence of Delirium

The duration of mechanical ventilation was shorter in the observation group than in the control group ($p = 0.011$). However, there were no significant differences between the two groups regarding ICU stay duration or total length of hospital stay ($p > 0.05$). Regarding the incidence of delirium, the observation group demonstrated a rate of 7.14% (5/70). In comparison, the control group had a rate of 10.13% (8/79), though the difference was not statistically significant ($p = 0.519$, Table 5).

Discussion

This study evaluated the effectiveness of nurse-led eCASH sedation in mechanically ventilated ICU patients, comparing it to traditional sedation methods. The results indicate that eCASH exhibits significant advantages in pain relief and medication usage. However, no significant differences were observed in sedation achievement rates and incidence of delirium.

Our findings suggest that eCASH performs better than traditional sedation protocols in pain and sedation management. Notably, the dosage of dexmedetomidine in the observation group during the first 72 hours post-mechanical ventilation was significantly lower than in the control group while demonstrating a significantly higher pain achievement rate. This indicates that eCASH allows for effective pain relief with reduced medication usage without compromising sedation effectiveness. Our results align with the study by Bian et al (2021), which also found that eCASH significantly improved pain relief and reduced the need for analgesic and sedative medications in ICU patients. This finding underscores the significance of early pain relief management and optimized analgesic usage in eCASH, which can effectively enhance patient comfort while minimizing drug-related side effects. Furthermore, a systematic review and evidence-based guideline by Temesgen et al (2021) reported that unnecessary deep sedation prolongs ICU stay, increasing hospital and personnel costs. Since analgesia is the foundation of sedation, optimizing pain management can effectively reduce sedative usage.

A study by Jain et al (2023) highlights the crucial role of adequate analgesia in improving patient comfort and alleviating suffering. Our study further supports this perspective, particularly in pain management. Despite administering lower doses of fentanyl at 72 hours after mechanical ventilation, patients in the obser-

vation group experienced significantly better pain relief compared to the control group. These observations demonstrate that the optimized pain management strategies within eCASH can effectively control pain while reducing overall medication use. Similarly, Pi (2022) also emphasized the importance of optimizing pain management in ICU patients. Regarding sedation, while the total dexmedetomidine dosage differed between groups, the sedation achievement rate in the observation group was comparable to that of the control group. This suggests that eCASH allows effective sedation with a lower medication dosage, and the sedation levels of patients significantly improve over time.

By minimizing the use of sedative medications and incorporating human-centered care elements such as music therapy, eCASH provides more personalized and comprehensive sedation management. Research by Dallı et al (2023) revealed that music intervention can effectively help manage delirium, pain, sedation needs, and anxiety in ICU patients. Similarly, Giordano et al (2023) reported that music therapy could serve as an alternative to intravenous midazolam to promote preoperative and postoperative anxiolysis and sedation in oral surgery patients.

However, fentanyl consumption in the observation group was higher within the 24 hours compared to the control group. This higher consumption may be due to the reduced use of sedatives, especially the lower dexmedetomidine dosage, requiring additional fentanyl for adequate analgesia. Additionally, music therapy and enhanced nursing interaction in the observation group may have gradually reduced the need for analgesics over time. However, these effects might not be observed in the initial 24 hours, resulting in higher fentanyl consumption at that stage.

Our results showed that the observation group had a significantly shorter duration of mechanical ventilation than the control group, underscoring the advantage of the eCASH strategy in reducing mechanical ventilation time. The reduction in mechanical ventilation time may be due to the optimized pain and sedation management in the observation group, aligning with previous research. For instance, Wang et al (2021) reported that optimized pain management could reduce mechanical ventilation time and improve overall patient outcomes.

However, our study did not demonstrate significant changes in ICU stay duration or total hospital stay, which may be attributed to limitations in sample size and study design. While the reduction in mechanical ventilation time is clinically significant, ICU duration and total hospital stay can be influenced by various factors, such as patients' underlying conditions and treatment regimens. Additionally, the difference in delirium incidence between the observation and control groups was insignificant, possibly attributed to the small sample size. Previous studies have shown that optimized pain and sedation strategies can reduce the incidence of delirium, which was not validated by our study (Casault et al, 2021; Moraes et al, 2022; Yang et al, 2024). Nonetheless, our results provide substantial evidence supporting the application of eCASH in the ICU, particularly regarding its advantages in pain management.

Although this study provides valuable preliminary evidence supporting using the nurse-led eCASH sedation strategy in mechanically ventilated patients, several limitations may affect the generalizability and reliability of the results. The limited

cohort of 149 patients, while providing some statistical power, may be considered relatively small, potentially leading to a lack of statistical significance for certain results. For example, the reason why the differences in the length of ICU stay, total hospital stay, and delirium incidence did not reach statistical significance may be due to the small sample size. To further validate the effectiveness and applicability of the eCASH strategy, future studies should expand the sample size, particularly in multi-center research, to enhance the external validity and reliability of the findings. This study is a single-center retrospective analysis, which may be subject to selection and data biases. Furthermore, retrospective studies cannot control all potential confounding factors. Therefore, future studies should adopt a prospective randomized controlled design to better control for confounding variables and provide higher-quality evidence.

This study did not consider individual patient factors, such as age, gender, and underlying medical conditions, which could influence analgesic and sedative outcomes. Future research should focus more on personalized treatment, exploring the response to the eCASH strategy in different subgroups, such as elderly patients or those with chronic diseases, to optimize individualized treatment plans. Although this study primarily assessed short-term outcomes, such as analgesia, sedation effects, and mechanical ventilation duration, it did not evaluate the long-term impact of eCASH. Long-term effects, including chronic pain control, cognitive recovery, and mental health outcomes, are crucial in determining the comprehensive benefits of eCASH. Thomas et al (2024) highlighted the lasting cognitive and psychological impacts of ICU stays, and future research should address these aspects. Long-term evaluations would provide insights into whether early optimization of pain and sedation management in eCASH leads to sustained benefits during recovery and rehabilitation.

Furthermore, prolonged ICU stays and intensive sedation may lead to post-intensive care syndrome (PICS), which includes physical, cognitive, and psychological symptoms that can persist long after discharge (Ekong et al, 2024; Inoue et al, 2024). Future studies should address these concerns to determine if the eCASH strategy can mitigate these risks. For example, pain management strategies that emphasize minimizing sedative use may reduce the risk of PICS by promoting earlier cognitive recovery and facilitating a smoother transition to normal functioning.

Additionally, assessing the impact of eCASH on patients' long-term quality of life, especially regarding mental health, should be a key area of investigation. Researches have shown that optimal sedation and analgesia can significantly affect post-traumatic stress disorder (PTSD) (Long et al, 2014) and long-term cognitive impairment (Fernandez-Gonzalo et al, 2018), which are commonly found in ICU survivors. By exploring the potential of eCASH to prevent or reduce these long-term psychological outcomes, we can better understand its broader impact. Additionally, another key limitation of this study is the lack of systematic collection of alcohol abuse history. Although the medical and nursing records did not indicate any history of alcohol abuse, this factor may still influence analgesia and sedation outcomes. However, the lack of standardized data on alcohol abuse limits the comprehensive evaluation of its potential impact.

Conclusion

The findings of this study underscore the effectiveness of eCASH sedation in mechanically ventilated patients, particularly in reducing the use of analgesic medications and improving pain relief. These findings have significant clinical implications for sedation management of ICU patients and suggest the potential for further optimization and broader adoption of the eCASH strategy.

Key Points

- The nurse-led eCASH sedation protocol significantly reduces the use of analgesics in mechanically ventilated patients, while improving pain relief within 72 hours compared to traditional sedation approaches.
- Patients in the eCASH sedation group experienced shorter mechanical ventilation times, indicating enhanced recovery and comfort levels.
- While eCASH effectively minimizes drug use, its sedation outcomes and incidence rates of delirium were comparable to those achieved with traditional sedation strategies.
- The eCASH sedation strategy, by incorporating minimal sedatives and humane care approaches, offers a personalized and holistic method of sedation, contributing to improved patient comfort and reduced sedative medication use.

Availability of Data and Materials

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Author Contributions

HH, JJ and LJ designed the study; all authors conducted the study. XF, HH, LT and HZ collected and analyzed the data. HH, MW and JJ participated in drafting the manuscript, and all authors contributed to the critical revision of the manuscript for important intellectual content. All authors gave final approval of the version to be published. All authors participated fully in the work, took public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or completeness of any part of the work were appropriately investigated and resolved.

Ethics Approval and Consent to Participate

This study received ethical review and approval from the Ethics Committee of the Second Affiliated Hospital of Harbin Medical University (Approval No.: KY2024-212). The study adheres to the principles of the Declaration of Helsinki. As this is a retrospective study, all data used were sourced from the hospital's electronic medical record system and paper records, and were de-identified prior to use.

The study does not involve direct interventions with patients. However, all patients had provided informed consent for the use of their medical records for research purposes during their routine clinical visits.

Acknowledgement

Not applicable.

Funding

This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

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