



# The effect of nursing-implemented sedation on the duration of mechanical ventilation in the ICU

Yoğun bakım ünitesinde mekanik ventilasyon süresi üzerine hemşire kontrollü sedasyonun etkisi

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## BACKGROUND

We aimed to compare the effects of nursing-implemented sedation protocol and daily interruption of sedative infusion on the duration of mechanical ventilation.

## METHODS

Fifty patients receiving mechanical ventilation and requiring sedation in the intensive care unit (ICU) were randomly selected to receive either daily interruption of sedative infusion (Group P, n=25) or nursing-implemented sedation protocol (Group N, n=25). In Group P, daily interruption of sedative infusions without any sedation protocol was performed by physicians. In Group N, nursing-implemented sedation protocol prepared by physicians was applied. In this group, if the ideal level of sedation was not achieved, information was given by nurses to physicians. Patients in each group were compared according to demographic variables, duration of mechanical ventilation and sedation, length of stay in the ICU, and mortality.

## RESULTS

Demographic variables, length of stay in the ICU and mortality were similar between the two groups. In Group P, duration of sedation and mechanical ventilation were significantly shorter than in Group N. Light sedation was seen more frequently in Group P and deep sedation in Group N.

## CONCLUSION

Daily interruption of sedative infusions provided shorter duration of sedation and mechanical ventilation than nursing-implemented sedation with protocol. Although nurse-implemented sedation protocol has been found acceptable, if the number of nurses is lacking, we believe the nurse-implemented sedation protocol should not be applied.

**Key Words:** Daily interruption of sedation; intensive care unit; mechanical ventilation; nursing-implemented sedation.

## AMAÇ

Doktorlar tarafından hazırlanmış belli bir protokole dayalı hemşire kontrollü sedasyon ile sedasyon uygulamasına gün içi ara verilerek uygulanan doktor kontrollü sedasyonun mekanik ventilasyon süresine etkisini karşılaştırdık.

## GEREÇ VE YÖNTEM

Mekanik ventilasyon tedavisi uygulanan ve sedasyon gereksinimi olan 50 hasta çalışmaya alındı. Grup P'de (n=25) herhangi bir sedasyon protokolü kullanılmadan, sedatif infüzyonuna gün içi ara verilerek, doktor kontrollü sedasyon; Grup N'de (n=25) doktorlar tarafından hazırlanmış belli bir protokole göre, hemşire kontrollü sedasyon uygulandı. Bu grupta istenen sedasyon düzeyine ulaşamaz ise doktora bilgi verildi ve doktor tarafından ek sedatif ilaç başlandı. Hastaların demografik özellikleri, mekanik ventilasyon, sedasyon, yoğun bakım ünitesinde yatış süreleri ve mortalite karşılaştırıldı.

## BULGULAR

Demografik veriler, yoğun bakım yatış süresi ve mortalite iki grupta da benzerdi. Sedasyon ve mekanik ventilasyon süresi, Grup P'de Grup N'ye göre anlamlı olarak kısaydı. Hafif sedasyon Grup P'de, derin sedasyon ise Grup N'de daha sık gözlemlendi.

## SONUÇ

Sedatif infüzyonuna gün içi ara verilerek sağlanan sedasyonun, protokole bağlı hemşire-kontrollü sedasyondan daha kısa sedasyon ve mekanik ventilasyon süresi sağladığı saptandı. Hemşire-kontrollü sedasyon, uygulanabilir bulunmasına rağmen, eğer yeterli sayıda hemşire yoksa hemşire-kontrollü sedasyon protokolünün uygulanmasının uygun olmadığını düşünmekteyiz.

**Anahtar Sözcükler:** Sedasyona günlük ara verilmesi; yoğun bakım ünitesi; mekanik ventilasyon; hemşire kontrollü sedasyon.

The administration of sedatives is necessary for most patients admitted to an intensive care unit (ICU).<sup>[1-3]</sup> Sedative drugs are commonly administered to aid the healing process, facilitate the use of life support technology such as mechanical ventilation, relieve anxiety, and achieve amnesia.<sup>[1,4,5]</sup> Nevertheless, inappropriate use of these agents can carry far-reaching implications for the patient.<sup>[2,5,6]</sup> Inadequate sedation may aggravate the risk of adverse events such as accidental self-extubation with subsequent acute respiratory insufficiency due to upper airway collapse, loss of venous catheters, and self-injury or injury to the clinicians.<sup>[2,5]</sup> On the other hand, excessive sedation can also lead to complications, such as respiratory depression, hypotension and bradycardia. Moreover, over-sedation may prolong the duration of mechanical ventilation, as well as ICU and hospital stay, and thereby increase hospital costs.<sup>[1,2,5,6]</sup>

Traditionally, sedative agents have been prescribed by physicians and administered by nurses, often with a wide margin of discretion in dose and without explicit understanding of the target level of sedation. The strategies about the means of administration of sedative drugs are quite varying. There are different strategies such as daily interruption of sedation, intermittent bolus of sedatives, nursing-implemented sedation according to protocol, and continuous infusion of sedative drugs for sedation for critically ill patients requiring mechanical ventilation.<sup>[5-11]</sup> Several recent studies have highlighted the cost and health-care benefits of drug delivery protocols based upon sedation assessment scales.<sup>[2,12]</sup> Similar results have been achieved by daily interruption of sedative drug infusions.<sup>[6]</sup> Subsequently, a standardized approach to sedation that combines a protocol with a sedation scale is becoming more common in the care of patients receiving mechanical ventilation.<sup>[1,12,13]</sup> Use of sedation protocols has been shown to decrease the duration of mechanical ventilation and the length of stay in the ICU, promote the judicious use of therapeutic agents, reduce variability in prescribing, and decrease sedative costs for critically ill patients.<sup>[2-4,12,14]</sup> Sedation protocols are algorithms by which adjunct sedative and analgesic doses given by the nurses are based upon written guidelines and assessment of the patient's level of sedation. Given that nurses have the responsibility of administering sedation in the ICU, their perspectives regarding the bedside are crucial to the development and implementation of sedation protocols at the local level.<sup>[9]</sup>

Daily interruption of sedative infusions, which is one of the sedation strategies, allows patients to awaken daily. This has recently been shown to have notable advantages such as shorter duration of mechanical ventilation, ICU and hospital length of stay, and bet-

ter one-year survival.<sup>[6,7,11,13]</sup> It is preferred to perform daily interruption of sedative drugs in the clinic where the study is implemented. On the other hand, no standardized criteria are used to determine the situations in which the interruption of sedatives are appropriate.

We aimed in this study to compare the effects of nursing-implemented sedation with protocol and daily interruption of sedative infusions by physicians on the duration of mechanical ventilation.

## MATERIALS AND METHODS

The study was carried out in the general eight-bed adult ICU within Uludag University Faculty of Medicine tertiary referral university teaching hospital. The investigation was a prospective, randomized study. Hospital Ethics Committee approval and informed consent from relatives of the patients were obtained. Then, 50 patients receiving mechanical ventilation and requiring sedation in the ICU were enrolled in the study. Patients were randomly assigned, at the time of initiation of mechanical ventilation, to have their sedation managed by a nursing-implemented sedation protocol (Group N, n=25) or daily interruption of sedative infusion by physicians (Group P, n=25). Exclusion criteria were age under 18 years, pregnancy, a history of allergy to the drugs used for sedation or analgesia, a disease affecting mental status such as head trauma or meningitis, current receipt of a neuromuscular blocking agent, and need of mechanical ventilation less than 24 hours.

Blocked randomization was accomplished using opaque and sealed envelopes, opened at the time each patient was enrolled in the study. Demographic data, Glasgow coma scores (GCS) and Acute Physiology and Chronic Health Evaluation (APACHE) II scores, duration of mechanical ventilation and sedation, length of stay in the ICU, and mortality were recorded.

### Sedation Protocol

A simple sedation protocol was developed for nurses by a group of two physicians and three nurses (Fig. 1). The protocol was copied on colored paper and posted at each bed in the ICU. The nurses in charge of the patient were responsible for monitoring the sedation level using the scoring system in this protocol and were allowed to adjust sedation according to the protocol. Midazolam was the first drug selected for sedation in both groups. In Group P, daily interruption of sedative infusions without any sedation protocol was used; whenever the physicians wanted to interrupt the sedative drugs according to patients' blood gas analyses or hemodynamic variables, they ordered cessation of the sedative drug infusions. In Group N, conversely, a nursing-implemented sedation protocol prepared by physicians was applied. If the targeted level of sedation was not achieved in this group, physicians were informed by nurses and additional sedative agent in-

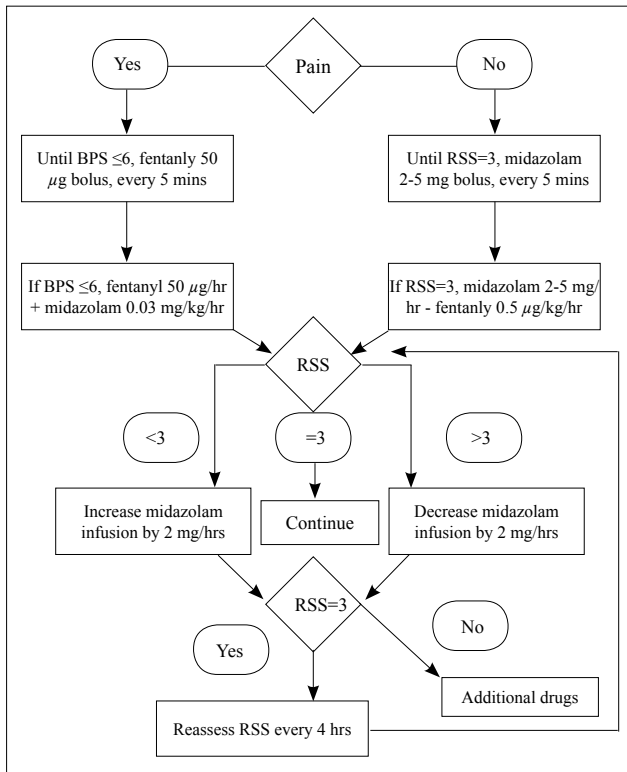


Fig. 1. Nurse-implemented sedation protocol.

fusions were initiated based on their clinical opinion. The additional sedative drugs used in the two groups included diazepam, propofol, and dexmedetomidine. Dosages of these drugs were ordered and adjusted by physicians.

Ramsay sedation score (RSS)<sup>[15]</sup> (Table 1) was used for the evaluation of the sedation level. While the ideal sedation level was accepted as RSS 3-4, RSS <3 and RSS >4 were evaluated as light and deep sedation, respectively.<sup>[6]</sup> In each group, pain was evaluated according to the behavioral pain scale (BPS)<sup>[16]</sup> (Table 2) in patients in whom agitation was caused by pain (i.e. trauma, postoperative period). Fentanyl was given

Table 1. Ramsay Sedation Score

- 1 Patient anxious and agitated or restless or both
- 2 Patient cooperative, oriented, and tranquil
- 3 Patient responds to commands only
- 4 Patient asleep, shows brisk response to light glabellar tap or loud auditory stimulus
- 5 Patient asleep, shows sluggish response to light glabellar tap or loud auditory stimulus
- 6 Patient asleep, shows no response to light glabellar tap or loud auditory stimulus

50 µg intravenously (IV) every 5 minutes as a bolus dose, according to BPS ≤6, in these patients. After BPS ≤6 was achieved, fentanyl 50 µg /h infusion was initiated for maintenance.

**Statistical Analysis**

Values are expressed as either the mean±standard deviation (SD) (continuous variables) or as a percentage of the group from which they were derived (categorical variables) for statistical comparisons. The Spearman’s correlation or Fisher’s exact test was used to compare categorical variables. Continuous variables, however, were compared using the Mann-Whitney U test or Kruskal Wallis test. SSPS for Windows 13.0 software was used for the analyses. A p value <0.05 was considered to be indicate statistical significance.

**RESULTS**

Fifty patients were included in this study. There were no significant differences among the groups with respect to demographic data and GCS; likewise, APACHE II scores were similar (Table 3).

The mean duration of mechanical ventilation was statistically longer among Group N patients compared with Group P (p<0.05). Furthermore, the duration of sedation was statistically shorter in Group P than Group N (p<0.05) (Table 4).

Table 2. Behavioral Pain Scale

Item	Description	Score
Facial expression	Relaxed	1
	Partially tightened (e.g., brow lowering)	2
	Fully tightened (e.g., eyelid closing)	3
	Grimacing	4
Upper limb	No movement	1
	Partially bent	2
	Fully bent with finger flexion	3
	Permanently retracted	4
Compliance with ventilation	Tolerating movement	1
	Coughing but tolerating ventilation most of the time	2
	Fighting ventilator	3
	Unable to control ventilation	4

**Table 3.** Demographic details and diagnosis of patients

	Group P (n=25)	Group N (n=25)	p
Age (years)	44.76±18.04	50.44±18.89	NS
Gender (Female/Male)	10 / 15	9 / 16	NS
Length (cm)	171.72±9.80	171.36±8.66	NS
Weight (kg)	78.00±11.11	74.96±8.99	NS
GCS	6.56 ±2.68	8.32±4.17	NS
APACHE II	18.00±5.33	19.88±7.51	NS
ICU diagnosis (n)			NS
Pulmonary edema	2	0	NS
Trauma	8	6	NS
PORF	4	3	NS
Drug overdose	2	0	NS
Cardiac arrest	2	5	NS
Pneumonia	3	4	NS
Sepsis	4	4	NS
Other	0	3	NS

GCS: Glasgow Coma Scale; APACHE: Acute Physiology and Chronic Health Evaluation, ICU: Intensive care unit; PORF: Postoperative respiratory failure; NS: Not significant. GCS and APACHE II scores were calculated based on variables recorded from the first 24 hours of ICU admission. Values are presented as mean±SD if not n.

It was noted that more light sedation (RSS <3) and heavy sedation occurred in Group P and Group N ( $p<0.001$ ), respectively. The duration of sedation in both study groups was found to be significantly correlated with the duration of mechanical ventilation [Spearman's correlation coefficient ( $r$ ) =0.86,  $p<0.001$ ] and the length of stay in the ICU ( $r=0.886$ ,  $p<0.001$ ). There was also a statistical correlation between the duration of mechanical ventilation and the length of stay in the ICU ( $r=0.76$ ,  $p<0.001$ ).

**Table 4.** Clinical outcome measures

	Group P (n=25)	Group N (n=25)	p
Duration of MV (min-max), day	6.66±5.22 (1.5-22)	9.52±6.07 (2-26)	<0.05
Duration of sedation (min-max), day	4.56±3.09 (0.8-12.5)	7.82±5.60 (1.3-21.70)	<0.05
Length of ICU day (min-max)	11.12±7.15 (3-37)	12.18±6.95 (3-26)	NS
Mortality rate	20%	32%	NS

MV: Mechanical ventilation; ICU: Intensive care unit; NS: Not significant. Values are presented as mean±SD and minimum-maximum, or percentage.

**Table 5.** The doses of additional sedatives drugs, and light and deep sedation episodes during the sedation

	Group P (n=25)	Group N (n=25)
Total dose of diazepam [mg (n)]	70 (3)	30 (2)
Total dose of propofol [mg (n)]	1520 (2)	3040 (3)
Total dose of dexmedetomidine [mcg (n)]	4448 (6)	2328 (3)
Total light sedation episodes during the sedation (mean±SD)	16.56±12.47	8.48±4.23
Total deep sedation episodes during the sedation (mean±SD)	1.18±4.31	7.04±7.76

In Group P, all sedative drugs were used according to physicians' specific order and the requested sedation level was achieved. On the other hand, the requested sedation level was not achieved in 32% of cases in Group N. Physicians were informed by nurses and additional sedative agent infusions were initiated by them (Table 5), and adequate sedation level was achieved.

No statistically significant differences were found between the groups with respect to the lengths of stay in the ICU and the mortality rates (Table 4).

## DISCUSSION

The administration of sedative drugs is common in ICU practice.<sup>[3-5]</sup> There are many drugs to use for sedation in the ICU, and selection of the drugs and adjustment of the dosages are very significant to minimize patient side effects.<sup>[1,2,4]</sup> Furthermore, the sedation method is also very important in the patient's treatment process. Sedative drugs can be used continuously or in a bolus fashion, and with/without protocol. Patients with respiratory failure, who need to be mechanically ventilated, are normally given sedatives, commonly by continuous infusion.<sup>[2,3,5]</sup> Nevertheless, studies have shown that drug accumulation occurring with continuous sedative infusions may result in prolongation of mechanical ventilation and ICU length of stay because patients are too heavily sedated.<sup>[1,17,18]</sup> It has been shown recently that intermittent bolus administration of sedatives, daily interruption of sedative infusion, or sedation according to protocol is more advantageous than the continuous infusion of sedative drugs.<sup>[6,8,11-14]</sup> Kollef et al.<sup>[17]</sup> compared the use of continuous IV sedation with bolus administration of seda-

tives and analgesics, then concluded that the use of continuous IV sedation might be associated with the prolongation of mechanical ventilation, ICU and hospital lengths of stay and a greater incidence of reintubation.

Daily interruption of sedative infusion is one of the sedation strategies in critically ill patients receiving mechanical ventilation; it is shown to decrease the duration of mechanical ventilation and length of stay in the ICU and hospital.<sup>[6-8,11,13]</sup> Kress et al.<sup>[11]</sup> compared daily interruption of sedative infusions and continuous sedative infusion in critically ill patients receiving mechanical ventilation, and found that daily discontinuation of sedative drug infusions decreased the duration of mechanical ventilation and the length of stay in the ICU by 2.5 days and 3.5 days, respectively. Schweickert et al.<sup>[7]</sup> also detected that daily interruption of sedative infusions reduces ICU length of stay, and therefore, decreases the incidence of complications of critical illness associated with prolonged intubation and mechanical ventilation. This treatment also allows more informative evaluation of a patient's neurological status, is helpful to determine whether the current targeted level of sedation is still necessary or less sedative medication is adequate, and reduces the likelihood of over-sedation with delayed recovery.<sup>[6,7,11-13]</sup> In this study, daily interruption of sedative infusion by physician was also used for sedation. It was detected that the duration of mechanical ventilation and sedation were shorter, whereas the sedation level was lighter. On the other hand, no statistically significant differences were found between the groups with respect to the length of stay in the study. A second level ICU is not present in the hospital. Therefore, some patients could not be discharged from third level ICU until they reached first level care. This absence of a second level ICU is thought to have affected the results regarding the length of stay in the ICU in this study.

In clinical practice, it is thought that the use of sedation protocols and scores may be beneficial in achieving more uniform sedation practices and that it protects patients against being under- or over-sedated by sedative adjustment.<sup>[2,9,12,14]</sup> Brattebø et al.<sup>[12]</sup> used a scoring system and protocol for sedation to determine the effect on the duration of patients' need for ventilator support in a surgical ICU, and detected that using a scoring system and protocol led to reductions in the total duration of mechanical ventilation and length of stay in the ICU. Devlin and colleagues<sup>[19]</sup> developed a guideline for the use of IV sedation among ICU patients requiring mechanical ventilation. The authors found that the implementation of their sedation guideline produced a nonsignificant trend toward shorter total ventilation times and a statistically

significant savings in total sedation costs by using a before-after study design. Nevertheless, the main focus of their study was to decrease the costs associated with providing sedation; its lack of power precluded any definitive conclusion regarding the overall effectiveness of sedation guidelines in the ICU setting. In this study, a sedation score in both groups was also used, whereas sedation protocol was only used in the nurse-implemented sedation group. In contrast with Brattebø et al.,<sup>[12]</sup> in this study, durations of mechanical ventilation and sedation were detected to decrease with daily interruption of sedative drug infusion without using protocol. It was thought that even if a protocol was not used in daily interruption of sedative drug infusion, the strategy of daily sedative interruption allowed a focused downward titration of sedative infusion rates over time and minimized the tendency for accumulation. On the other hand, when sedation was managed by nurses according to a sedation protocol in this study, sedative drugs were used continuously. It was shown that continuous IV sedation was associated with prolongation of mechanical ventilation and ICU and hospital lengths of stay when compared with the intermittent bolus or daily interruption sedation strategies.<sup>[6-8,17]</sup> Kollef et al.<sup>[17]</sup> detected that nursing-initiated sedation protocol avoided the unnecessary use of IV sedation among patients requiring ventilatory support. It was thought that the nurses' input is helpful for assessment of the adequacy of sedation because he/she will often notice changes from an optimal level of sedation.<sup>[1,9,10]</sup> Nevertheless, the number of nurses staffing an ICU is likely to be important for successful and appropriate evaluation of sedation. It was suggested that the intensity of sedation varied inversely with the number of nurses on a shift.<sup>[2,20]</sup> Thorens et al.<sup>[20]</sup> detected that the number and quality of nurses has an important influence on the treatment of patients with chronic obstructive lung disease requiring mechanical ventilation. In this study, despite the usage of the protocol, the requested sedation level was not achieved in 32% of cases in the nurse-implemented sedation group. Therefore, the physicians prescribed additional sedative drugs to achieve the requested sedation level in these cases. It has been speculated that units with understaffing tend to under-use sedation scores and over-treat patients with sedative drugs.<sup>[2,20]</sup> It was noted that the number of nurses in the hospital's ICU is lower than that of the other study.<sup>[12]</sup> This lower number of nurses may have caused the lack of ability to achieve the desired sedation.

Brook et al.<sup>[9]</sup> performed a randomized trial comparing a nurse-implemented sedation protocol on the duration of mechanical ventilation, and this comparison demonstrated a reduction in the duration of mechanical ventilation, ICU and hospital stay, and a lower tracheostomy rate in the nurse-implemented

sedation protocol group. On the other hand, in their study, continuous sedative infusion was performed in the control group. In this study, however, duration of mechanical ventilation and sedation were longer in the nurse-implemented sedation with protocol group than the control group. Contrary to Brook's control group, a daily interruption sedative infusion strategy was used in the control group for this study. It is suggested that this strategy was more advantageous than other strategies for sedation in the ICU.<sup>[6-8]</sup>

This study has several limitations. First, the number of the patients was smaller than in other studies. At the same time, the nurses had a new responsibility while performing the sedation according to protocol during the study period. This situation was very unusual for them owing to the hospital's policy; therefore, it resulted in an increase in anxiety. Their anxiety level was not evaluated; anxiety might have affected the evaluation of RSS and their decisions regarding the drug regimen.

In conclusion, sedation is a significant component for critically ill patients requiring mechanical ventilation; therefore, it should be systematic, standardized and supported by interdisciplinary cooperation. The strategy of daily interruption of sedative infusion is a safe and practical approach for sedation. This practice provides a shorter duration of sedation and mechanical ventilation, and may be preferred as the sedation treatment in the ICU. Nurse-implemented sedation protocol was compared with continuous sedation, and nurse-implemented sedation protocol has been found acceptable in the previous studies. Despite the fact that nurse-implemented sedation protocol is considered to be applicable, the study concludes that it may be not appropriate to carry out the nurse-implemented sedation protocol if the number of the nursing staff is inadequate.

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