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Pain Behaviors and Physiological Parameters During Painful Procedures in Surgical Intensive Care Patients

Cerrahi Yoğun Bakım Hastalarının Ağrılı İşlemler Sırasında Ağrı Davranışları ve Fizyolojik Parametreleri

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ABSTRACT *Objective:* This study evaluated the pain behavior and physiological parameters in patients followed up on mechanical ventilation support in the surgical intensive care unit.
Materials and Methods: This study was conducted descriptively and observationally with 176 patients. The introductory information form, physiological parameters follow-up form, Behavioral Pain Scale (BPS), and Ramsey sedation scale were used to collect data. Descriptive statistics, two-way variance in repeated measures, Friedman analysis, Post hoc Bonferroni analysis, One-way variance analysis, Kruskal–Wallis analysis, and Spearman correlation analysis were used.
Results: The mean arterial pressure (MAP), heart rate and mean BPS scores increased ($p < 0.001$), and oxygen saturation decreased during aspiration, wound care, and position change ($p < 0.001$). Additionally, while a significant positive correlation was found between BPS and MAP and heart rate during wound care ($r = 0.447$; $p = 0.001$, $r = 0.306$; $p = 0.033$), a significant negative correlation was found between oxygen saturation and BPS during aspiration ($r = -0.389$; $p = 0.000$).
Conclusion: It was determined that patients followed up on mechanical ventilation support experienced pain during aspiration, position change, and wound care procedures. Vital signs and behavioral symptoms related to pain should be evaluated together to relieve pain with non-pharmacological and pharmacological methods.
Keywords: Intensive care, pain, painful procedure, pain assessment, physiological parameters

ÖZ *Amaç:* Bu çalışmada cerrahi yoğun bakım ünitesinde mekanik ventilatörde takip edilen hastaların ağrı davranışları ve fizyolojik parametrelerinin değerlendirilmesi amaçlanmıştır.
Gereç ve Yöntem: Bu çalışma 176 hasta ile tanımlayıcı ve gözlemsel olarak yapılmıştır. Veri toplamak için tanıtıcı bilgi formu, fizyolojik parametreler takip formu, Davranışsal Ağrı Ölçeği ve Ramsey sedasyon skalası kullanıldı. Tanımlayıcı istatistikler, tekrarlı ölçümlerde iki yönlü varyans, Friedman analizi, Posthoc Bonferroni analizi, Tek yönlü varyans analizi, Kruskal Wallis analizi ve Spearman korelasyon analizi kullanılmıştır.
Bulgular: Aspirasyon, yara bakımı ve pozisyon değişikliği sırasında ortalama arter basıncı, nabız ve Davranışsal Ağrı Ölçeği skorlarının arttığı ($p < 0.001$) ve oksijen satürasyonunun azaldığı saptanmıştır ($p < 0.001$). Ayrıca yara bakımı sırasında Davranışsal Ağrı Ölçeği puan ortalaması ile ortalama arter basıncı ve nabız arasında pozitif yönlü anlamlı bir ilişki bulunmuşken (sırasıyla $r=0.447$; $p=0.001$, $r=0.306$; $p=0.033$), aspirasyon sırasında sadece oksijen saturasyonu ile Davranışsal Ağrı Ölçeği puan ortalaması arasında negatif yönlü anlamlı bir ilişki bulunmuştur ($r=-0.389$; $p=0.000$).
Sonuç: Mekanik ventilatördeki hastaların aspirasyon, pozisyon değişikliği ve yara bakımı işlemleri sırasında ağrı yaşadıkları belirlendi. Ağrıya verilen yaşamsal belirtiler ve davranışsal belirtiler birlikte değerlendirilmeli, nonfarmakolojik ve farmakolojik yöntemlerle ağrı giderilmelidir.
Anahtar Kelimeler: Yoğun bakım, ağrı, ağrılı işlem, ağrı değerlendirmesi, fizyolojik parametreler

Introduction

Surgery, invasive diagnosis and follow-up methods, mechanical ventilation, physiotherapy, tracheal aspiration, daily dressings, position changes, and patient transport can cause pain in surgical intensive care patients (1,2). Uncontrolled pain is an important physiological and psychological stressor for intensive care unit (ICU) patients and can negatively affect the healing processes. It is stated that inadequate pain management causes physiological and psychological complications, such as pulmonary complications, severe vasoconstriction, increased oxygen consumption, tissue ischemia, depression, and anxiety. In addition, inadequate pain management negatively affects mortality and morbidity, increases the cost of care, and decreases the quality of life (1-3). Therefore, pain assessment and pain management in ICU patients are of great importance.

The most accurate and valid diagnosis of pain is the verbal expression of the pain. Therefore, verbal or visual comparison scales are used in the diagnosis of pain in communicative patients. However, ICU patients on mechanical ventilators cannot express their pain verbally. When verbal communication cannot be established with ICU patients, health professionals should observe behavioral responses while evaluating pain (4,5). Behavioral responses due to pain include symptoms such as contraction, pulling the damaged organ or area away from the stimulus, supporting the incision site, immobility, pulling the legs towards the abdomen, grimacing, chewing the intubation tube (5,6). In addition, physiological parameters such as blood pressure, heart rate, and oxygen saturation can be used in pain assessment (7). However, pain assessment may not be reliable because ICU patients often experience many hemodynamic problems that cause changes in their vital signs. For example, tachycardia may be due to pain, as well as fever or hypovolemia. For this reason, it is recommended to use validated pain assessment scales in patients who cannot express their pain and to use physiological parameters as supportive data (8).

Studies have reported that endotracheal aspiration, oral care, vascular catheterization, and position changing are the procedures that frequently cause pain (9-11). There was only one study investigated the assessment of pain during wound care in ICU patients who could not express their pain verbally. In that study, pain assessment during wound care in both conscious and unconscious patients after neurosurgery was performed on different scales, and this was reported as a limitation of the study (12). This study was conducted to determine the pain behavior and the effect of pain on physiological parameters during aspiration, wound care, and position change in surgical ICU patients followed up on mechanical ventilation support and sedated, and to contribute to the literature.

Materials and Methods

Study Design and Sample

This study was carried out descriptively and observationally. The data were collected between 2017-2018 in a university hospitals' general surgery intensive care, neurosurgery intensive care and anesthesia intensive care services in the Central Anatolia region of Turkey. There is no routine analgesic and sedation protocol in clinics. Analgesic and sedative drugs are administered according to the patient and clinical situation.

All patients who were hospitalized in neurosurgery intensive care, general surgery intensive care and anesthesia intensive care units, underwent surgery and were on mechanical ventilation support constituted the universe of the study. The study sample consisted of patients who met the inclusion criteria: Followed on mechanical ventilation support, undergone surgery and 24 hours have passed, Ramsey sedation scale 4 and 5 points, and patients with consent from their families. Patients with traumatic brain injury, quadriplegia, excessive postoperative bleeding, continuous analgesic infusion, and aneurysm patients whose blood pressure should be kept high against the risk of vasospasm after surgery were excluded from the study.

The study was completed with 176 patients. Sampling adequacy was decided according to post-hoc power analysis. Based on the mean Behavioral Pain Scale (BPS) score in a study (12), the effect size was found to be 1.430, and when the Type I error was 5% and the sample size was 176, the power of the study was calculated as 99%.

Data Collection Tool

The data were collected using descriptive information form, physiological parameters follow-up form, Behavioral Pain Scale (BPS), and Ramsey Sedation Scale.

The descriptive information form was created by scanning the literature (9, 11, 12). This form includes introductory data such as age, gender, occupation, diagnosis and the drugs used, the duration of stay in the ventilator.

Behavioral Pain Scale (BPS): It was developed in 2001 by Payen et al. (13). In this scale, there are three items: facial expression, upper extremities, and compliance with the ventilator, and four variables for each item, including behavioral responses to pain. Each variable is scored from 1 (no answer) to 4 (complete answer). The scale is scored between 3 and 12, and a score of 6 and above indicates unacceptable pain (9, 10). The scale was adapted to Turkish in 2003 and the Cronbach alpha's value was found between 0.71-0.93 (9). In our study, Cronbach's alpha was determined as 0.84.

Ramsey Sedation Scale (RSS): This scale was developed by Ramsay in the mid-1970's. This scale consists of a total of six items, three in each section including the level of wakefulness and sleep level. These are, respectively, "The patient is restless and/or agitated, patient-oriented, calm and cooperative, the patient only follows orders, obvious response, decreased response and no response "The first three responses are assessed in the awake patient, and the other three responses in the sleeping patient by hitting the glabella or by high verbal stimulation (9). The validity and reliability of the scale were made in 2015 and it was stated that it can be used safely (14). This scale is recommended to be used together with the BPS in sedated ICU patients (15).

Data Collection

It has been shown that physiological parameters such as mean arterial pressure immediately return to their baseline values 5 minutes after aspiration (16). Therefore, in our study, data collection forms were filled 3 times: 10 minutes before aspiration, wound care and position change (T1), during aspiration, wound care and position change (T2), and 10 minutes after the aspiration, wound care and position change (T3). The respiratory rate was not evaluated because the patients were followed up on a mechanical ventilator. Physiological parameters were recorded on the monitor, and BPS was filled in by observation.

Data were collected by researchers and observers who responsible for patient care. For the observers to follow up with the same protocol, joint meetings were held and data were collected by exchanging information.

Ethical Considerations

Before starting the study, ethics committee approval (Decision number: 2017/355) and institutional permission from the institution where the study was conducted was obtained. Because of intubation and sedation, which is one of the sampling criteria, the aim of the study and the method was explained to the first-degree relatives of the patients, and permission was obtained. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Statistical Analysis

Data were analyzed using SPSS 24.0 (IBM Corp., Armonk, NY, USA). Shapiro-Wilk test and Q-Q charts were used to determine whether the numerical data was suitable for normal distribution. Descriptive statistics were given as number, percentage, and mean ± standard deviation. Two-way variance in repeated measures, Friedman analysis, one-way analysis of variance, Kruskal Wallis analysis, and Spearman correlation analysis were used. A value of $p < 0.05$ was considered statistically significant in all results.

Results

In the study, it was found that 64.2% of the patients were male, 57.4% were 51 years and older, and 60.8% had cranial surgery. The mean duration of the patients on followed up on mechanical ventilation support was 9.81 ± 15.11 days. As a painful procedure, aspiration was performed for 46 % of the patients, wound care for 27.8%, and position change for 26.1 %. In addition, 83.0 % of the patients use analgesics, 48.3 % of the patients use sedative drugs (Table 1).

Table 2 shows the vital signs and mean BPS of the patients before, during, and after the painful procedure. It was determined that during aspiration, wound care, and position change, MAP, heart rate and mean BPS scores increased ($p < 0.001$), and oxygen saturation decreased ($p < 0.001$).

When aspiration, position change and wound care applications were compared, it was determined that there was no significant difference between the groups in terms of mean BPS scores and heart rate ($p > 0.05$).However; it was found that MAP increased during wound care and oxygen saturation decreased during aspiration ($p < 0.05$) (Table 3).

A significant negative correlation was found between the oxygen saturation during aspiration and BPS ($r = -0.389$; $p = 0.000$). As the BPS mean score increases, the oxygen saturation decreases. In addition, a significant positive correlation was found between BPS and MAP and pulse rates during wound care ($r = 0.447$; $p = 0.001$, $r = 0.306$; $p = 0.033$, respectively). As the mean BPS mean score increases, the MAP and heart rate increase (Table 4).

Table 1. Descriptive characteristics of the patients		
Descriptive Characteristics	**N**	**%**
Gender		
Female	63	35.8
Male	113	64.2
Age (years)		
≤30	28	15.9
31-40	25	14.2
41-50	22	12.5
≥51	101	57.4
Mean Age± SD (min-max)	53.67±19.78(18-95)	
Operation type		
Cranial surgery	107	60.8
GIS surgery	28	15.9
Cancer surgery	13	7.4
Trauma and orthopedic surgery	28	15.9
Painful procedures		
Aspiration	81	46.0
Wound care	49	27.8
Position change	46	26.1
Occupation		
House wife	48	27.3
Retired	57	32.4
Worker	46	26.1
Self-employed	25	14.2
Duration on mechanical ventilation (days)		
1-5	90	51.1
6-10	43	24.4
11-15	15	8.5
≥16	28	15.9
Mean duration on mechanical ventilation± SD	9.81± 15.11	
Use of analgesic medication *		
Yes	146	83.0
No	30	17.0
Use of sedative medication **		
Yes	85	48.3
No	91	51.7
*Paracetamol, Diclofenac Sodium, Dexketoprofen Trometamol, **Dormicum, Fentanly+Propofol, Rocuronium bromide		

Discussion

Monitoring the pain with observable indicators in non-communicative patients followed up on mechanical ventilators is very important in terms of continuity of care and patient comfort (17). In this study, the relationship between behavioral symptoms of pain and physiological parameters was evaluated of patients who are non-communicative and underwent surgery. In the study, it was found that the heart rate, MAP and BPS mean score increased and oxygen saturation decreased during aspiration, wound care, and position change in patients who were unconscious and followed up on a mechanical ventilator. Our study results are in line with some studies investigating the vital signs and pain levels of intensive care patients during the painful procedure (11,12,18). In the studies, Erden et al. (12), reported that both conscious and unconscious patients had an increase in heart rate during the painful procedure, Al Sutari et al. (11), reported that the mean BPS score increased, Arbor and Gélinas (18), reported that MAP and heart rate increased and oxygen saturation decreased. These results can be considered as a reason for tachycardia and an increase in blood pressure as a result of the release of catecholamines by the pain experienced during painful procedures stimulating the sympathetic nervous system.

In ICU patients, pain may develop at rest, depending on surgical procedures, or during procedures such as endotracheal aspiration, wound care, change of position, and withdrawal of drain tubes and catheters (19,20). In our study, when the pain behavior and physiological parameters of the patients were compared during aspiration, position change, and wound care procedures; It was determined that there was no significant difference in terms of mean BPS scores and heart rate according to the procedures, but the MAP increased significantly during wound care. The reason for this situation may be the tissue damage caused by the recent surgical procedure and the skin integrity has not yet reached its former strength and the pain experienced is more. In addition, it was found that oxygen saturation decreased significantly during aspiration. Complications such as tracheal tissue injury, hypoxia, and decreased oxygen saturation may develop during endotracheal aspiration (21). In our study, we thought that the decrease in oxygen saturation during aspiration could be caused by pain as well as by the procedure itself.

In the study, while there was a moderately negative correlation between BPS score and oxygen saturation during aspiration, a moderate positive correlation was found between BPS and heart rate and MAP during wound care. There are conflicting results on this subject in the literature.

Table 2. Distribution of physiological parameters and mean BPSscore before, during and after the procedure according to painful procedures

Painful procedures	Variables	Time			Test
		T1	T2	T3	
Aspiration (n=81)	Vital signs	Mean ±SD Median (min-max)	Mean ±SD Median (min-max)	Mean ±SD Median (min-max)	
	MAP	84.49±17.11[a]	103.06±20.53[b]	90.65±16.37[c]	***p:* 0.000***
	Heart rate	94.61±18.48[a]	110.96±20.73[b]	97.88±16.70[c]	***p:* 0.000***
	Oxygen saturation	94.92±6.69[a]	87.18±10.46[b]	96.17±4.00[a]	***p:* 0.000***
	BPS mean score	3.97±1.27[a] 3 (4-5)	6.40±2.03[b] 5 (6-8)	4.19±1.20[c] 3 (4-5)	***p:* 0.000****
Wound care (n=49)	Vital signs				
	MAP	87.38±10.85[a]	105.72±17.43[b]	94.17±15.28[c]	***p:* 0.000***
	Heart rate	94.73±19.14[a]	111.32±26.14[b]	97.26±18.70[c]	***p:* 0.000***
	Oxygen saturation	96.93±3.53[a]	93.08±5.88[b]	97.20±2.97[a]	
	BPS mean score	3.85±1.00[a] 3 (4-4)	6.32±1.95[b] 5 (6-8)	4.16±1.14[c] 3 (4-5)	***p:* 0.000****
Position change (n=46)	Vital signs				
	MAP	83.56±16.99[a]	94.10±19.19[b]	87.49±18.44[c]	***p:* 0.000***
	Heart rate	89.54±17.68[a]	105.69±22.54[b]	93.26±17.92[c]	***p:* 0.000***
	Oxygen saturation	95.63±3.73[a]	91.10±5.70[b]	96.32±3.75[a]	***p:* 0.000***
	BPS mean score	4.15±0.98[a] 3 (4-5)	6.56±1.79[b] 5 (7-8)	4.34±1.03[a] 4 (4-5)	***p:* 0.000****

*Two-way variance in repeated measures was used. **Friedman analysis has been done. Superscript (a, b, c): Different letters show statistically difference between the groups. Posthoc Bonferroni analysis was performed.

Table 3. Distribution of physiological parameters and mean BPS score during the procedure (T2) according to the painful procedures

Physiological Parameters	Painful procedures			p
	Aspiration(T2) Mean ±SD Median (min-max)	Wound care (T2) Mean ±SD Median (min max)	Position change (T2) Mean ±SD Median (min max)	
MAP	103.06 ±20.53[a]	105.72±17.43[a]	94.10±19.19[b]	**0.009***
Heart rate	110.96±20.73	111.32±26.14	105.69±22.54	0.386*
Oxygen saturation	87.18±10.46[a]	93.08±5.88[b]	91.10±5.70[b]	**0.000***
BPS mean score	6.40±2.03 6 (5-8)	6.32±1.95 7 (5-8)	6.56±1.79 6 (5-8)	0.716**

*One-way analysis of variance was used. Posthoc Tukey analysis was performed. **Kruskal wallis analysis was used. Superscript (a, b, c): Different letters show statistically difference between the groups

Table 4. Relationship between vital signs and BPS mean scores of patients during painful procedures

Vital Signs	BPS scores in painful procedures (T2)					
	Aspiration		Wound care		Position change	
	r*	p	r*	p	r*	p
MAP	0.113	0.314	0.447	**0.001**	0.078	0.604
Heart rate	0.193	0.084	0.306	**0.033**	0.096	0.526
Oxygen saturation	-0,389	**0.000**	-0.247	0.086	-0.191	0.205

*Spearman correlation analysis were used.

Erden et al (12), found a moderate relationship between pain score and heart rate during wound care. Similarly, in another study, it was reported that there was a relationship between pain score and heart rate and MAP during painful procedures (11). On the contrary, in the Chen & Chen (22) study, no relationship was found between heart rate and blood pressure and pain level. As intensive care patients may experience many hemodynamic problems that cause changes in their vital signs, pain assessment using physiological parameters alone may not be reliable (12). Therefore, physiological parameters such as heart rate, MAP, respiratory rate, and oxygen saturation should be used in combination with behavioral pain scales.

Study Limitations

The dose of sedative drugs administered to the patients during the study and the related change in the patient's consciousness were applied according to their clinical routines and the decision was made beyond our control. In addition, the presence of more than one researcher and observer in the study is one of the limitations of the study.

Conclusion

When considered ethically, every individual has the right to have his/her pain evaluated and relieved (3). It is not possible to manage pain without defining it. Therefore, it is important to evaluate the pain levels of patients on mechanical ventilators who cannot express their pain verbally (23). As a result of this study, BPS scores, MAP, and heart rate increased and oxygen saturation decreased in ICU patients who underwent surgery during aspiration, wound care, and position change.

In this patient group, it may be suggested that intensive care nurses should understand the importance of identifying pain with behavioral pain scales as well as vital signs to maintain the critical role they play in the assessment and management of pain. In addition, case discussions and training sessions on the physiological effects of pain may be recommended to intensive care nurses.

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Ethics

Ethics Committee Approval: Before starting the study, ethics committee approval (Decision number: 2017/355) and institutional permission from the institution where the study was conducted was obtained.

Informed Consent: Consent was obtained from their families.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: Y.S., Ö.C., Design: Y.S., Ö.C., Data Collection and Process: Y.S., Analysis or Interpretation: Y.S., H.Y.K., Literature Search: Y.S., H.Y.K., Writing: Y.S., H.Y.K., Ö.C., İ.Y.

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