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Physiological and Behavioral Pain Responses to Endotracheal Suctioning in Unconscious ICU Patients: A Descriptive Observational Study

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ABSTRACT

Objective: To examine the effect of endotracheal suctioning (ETS) on physiological parameters and behavioral indicators of pain in unconscious, mechanically ventilated ICU patients.

Methods and Materials: In this descriptive observational study, 80 unconscious intubated adults were recruited purposively from two ICUs in Kerbala, Iraq. Pain was assessed using the Behavioral Pain Scale (BPS), and physiological variables (systolic and diastolic blood pressure, mean arterial pressure, heart rate, respiratory rate, and oxygen saturation) were recorded immediately before, during, and 5 minutes after ETS. Data were analyzed with SPSS version 26.

Findings: During ETS, systolic blood pressure, heart rate, and respiratory rate increased markedly compared with pre-procedure values, while oxygen saturation decreased; all changes in physiological and behavioral pain scores across the three time points were highly significant ($p < 0.001$). During suctioning, grimacing facial expression reached 55%, permanently retracted or fully bent upper limb movements 40%, and ventilator asynchrony (coughing or fighting the ventilator) 100%. In contrast, most patients were relaxed and ventilator-tolerant before and 5 minutes after the procedure. Associations between pain responses and demographic or clinical variables were limited and generally non-significant.

Conclusion: ETS represents a brief but intense noxious stimulus that elicits significant, transient physiological instability and behavioral signs of pain in unconscious ICU patients. Routine use of validated behavioral pain scales and anticipatory pain management during ETS is recommended to improve comfort and safety.

Keywords: Endotracheal Suctioning, Unconscious patients, Physiological responses, procedural pain.

Introduction

According to the International Society for the Study of Pain (IASP), pain is a prevalent symptom in intensive care units (ICUs). It is characterized as a negative emotional and sensory experience caused by actual or anticipated tissue damage (Gomarverdi et al., 2019). During nursing care, intensive care patients experience pain for various reasons, including endotracheal suctioning. Compared to patients in other units, those in

the intensive care unit suffer more from pain (Gregory, 2017).

During various nursing care procedures, such as endotracheal suctioning, the critically ill patients had mild to severe discomfort, which affected their hemodynamic parameters and perception. For patients in critical care, untreated pain can cause psychological and physical stress and delay their recovery (Azevedo-Santos & DeSantana, 2018).

Various physiological and behavioral characteristics may serve as useful objective indicators of pain. Expressions on the face that may indicate pain include crying, frowning, forehead wrinkles, and grimacing. Pain is also correlated with patient movements, particularly during procedures. Additionally, certain physiological indicators, such as elevated blood pressure and heart rate, may indicate the presence of pain and are therefore useful for assessing it (Gülsoy & Karagözoğlu, 2020).

According to Gomarverdi et al. (2019), critically ill people experienced significant discomfort when their secretions were suctioned. 94% of patients undergoing endotracheal suctioning showed changes in facial expression, 78% in body motion, and 68% in muscle tension. The same study also found that 105 patients experienced significantly greater discomfort during endotracheal suctioning (Özden & Görgülü, 2015).

Patients in the intensive care unit frequently endure several invasive and painful procedures, and because pain is challenging to assess and manage, it is frequently ignored. This harms both the time patients spend in the ICU and the rate of their recovery. Approximately 75% of patients admitted to intensive care units experience excruciating agony. Approximately 30% of them have pain even while they are at rest, and 50% of them experience pain during intrusive nursing treatments (Kemp et al., 2017).

Methods and Materials

Study Design and Participants

A descriptive-observational study design was conducted to investigate the effect of endotracheal suctioning on physiological and behavioral pain responses in unconscious patients. The study was initiated from 26th September 2024 to 12th May 2025.

The study was conducted in the ICUs at Imam Al-Hussein Medical City and Imam Al-Hassan Al-Mujtaba Teaching Hospital in Kerbala, Iraq. A purposive nonprobability sampling method was used in the current study, selected based on population characteristics, eligibility criteria, and the study's aims. The exclusion criteria of this study included patients who were <18 years old, patients with neuropathic disorders such as Myasthenia Gravis, Guillain-Barré Syndrome (GBS), and upper limb neuropathy, because those conditions may hinder behavioral responsiveness when utilizing the Behavioral Pain Scale (BPS), and patients who had fractures in their upper limbs. People on strong anesthetic regimens were also not allowed to participate in the study because they might not be able to exhibit any behavioral responses that could compromise the accuracy of the measurements and the usability of the study tool. The study sample consisted of 80 patients; the sample size was determined a priori using a power analysis for Student's t-tests.

Study instruments

The Behavioral Pain Scale (BPS), developed by Dr. Jean F. Payen, was used in this study. The BPS is both reliable and valid for use in assessing pain for mechanically ventilated-sedated patients who are hospitalized in the ICUs and patients who are unable to communicate and express their distress. Cronbach's alpha coefficient of the scale was highly reliable; the reliability coefficient for the BPS was 0.79 (Payen et al., 2001). The BPS contains three main domains: facial expression, compliance with mechanical ventilation, and upper limb movement. Within each domain, behavioral responses are scored from 1 (no pain) to 4 (worst, indicating pain). The health care professional uses BPS to assess the presence and severity of pain and to determine the best behavioral response within each domain. Patients' responses are scored from 1 to 4 in each domain, with a total score of 12 indicating maximum pain (Pinheiro & Marques, 2019). In addition, physiological pain responses, including systolic and diastolic blood pressure, heart rate, respiratory rate, and oxygen saturation, were measured simultaneously.

Data collection method

The data were collected through observational methods from 6th December 2024 to 10th February 2025. The severity of pain was measured objectively by observing the patient's response using BPS. The study sample includes 80 patients selected purposively among ICU patients with a diminished level of consciousness.

The level of consciousness was measured using the Glasgow Coma Scale. The patients selected for the current study had a consciousness range of 5 to 10, then the presence and severity of pain were determined through three phases: the first was assessing patients' pain immediately before endotracheal suctioning; the second was during endotracheal suctioning; finally, the third phase, which was done to determine patients' pain within 5 minutes post-endotracheal suctioning.

Data analysis

The data were analyzed using IBM Statistical Package for Social Sciences (SPSS) version 26, which included descriptive and inferential statistical measures. Descriptive statistics are used to describe the demographic data and health-related variables. Chi-square and exact Fisher tests were used to determine the association between pain levels and clients' demographic information and health-related variables.

Ethical considerations

With the submission of the study protocol, ethical approval was sought from the Scientific Committee of the Nursing Faculty, University of Kerbala, on 27/8/2024. The researcher submitted a detailed description of the study, including the problem statement, objectives, and questionnaire, as well as an official agreement from the Ministry of Health/Kerbala Health Directorate/Center of Training and Human Development on 3/11/2024, to obtain official permission.

Findings and Results

Table 1

Distribution of the patients according to their socio-demographic characteristics (n-80):

Variables		Mean ± SD	Minimum-Maximum
Age (years)		48.4±14.8	18-77 years
Duration unconsciousness		6.0±4.6	1-26 days
Duration of ICU admission		6.1±4.6	1-26 days
Socio-demographic Characteristics		**f**	**%**
Sex	**Male**	42	52.5
	Female	38	47.5
	Total	80	100
Reasons for ICU admission	**Traumatic**	15	18.8
	Non-traumatic	65	81.3
	Total	80	100.0
Preexisting chronic diseases	**None**	12	15
	DM	17	21.25
	HTN	44	55
	Respiratory Diseases	5	6.25
	Cancers	2	2.5
	Total	80	100.0

The results in Table 1 showed that the mean age of the patients was 48.4 ± 14.8 years, ranging from 18 to 77 years; the mean duration of unconsciousness was 6.0 ± 4.6 days, ranging from 1 to 26 days; and the mean ICU stay was 6.1 ± 4.6 days, ranging from 1 to 26 days. Regarding participants' gender, there was a relatively balanced representation, with 52.5% of patients male and 47.5% female. In terms of the reason for ICU admission, the majority of patients (81.3%) were admitted for non-traumatic causes, such as chronic illnesses or acute medical conditions, whereas 18.8% were admitted due to traumatic causes.

With respect to preexisting chronic diseases, 55% of the patients had a history of hypertension, followed by diabetes mellitus at 21.25%, and 15% without underlying chronic diseases; 6.25% had respiratory disease, and 2.5% had cancer.

Table 2

Comparing the physiological responses of pain before, during, and after endotracheal suctioning (n = 80)

Physiological responses	Before Mean ± SD	During Mean ± SD	After Mean ± SD
SBP	131.0±19.2	148.6±22.9	131.5±24.0
DPB	79.6±13.5	89.3±14.6	81.0±13.5
MAP	91.5±15.5	108.8±15.5	93.8 ±16.4
HR	97.1±18.6	109.9±18.8	97.8±18.7
RR	18.6±5.8	24.5±6.7	19.3 ±6.6
SPO2	96.4±2.8	93.1±3.8	96.2 ±3.4

As shown in Table 2, several physiological variables (blood pressure, MAP, heart rate, respiratory rate, and oxygen saturation) change before, during, and after endotracheal suctioning. Before the procedure the physiological variables were: SBP = 131.0, DBP = 79.6, MAP = 91.5, HR = 97.1, RR = 18.6, SPO2 = 96.4. During the procedure the physiological variables was: SBP = 148.6, DBP = 89.3, MAP = 108.8, HR = 109.9, RR = 24.5, SPO2 = 93.1. And after the procedure the physiological variables was: SBP = 131.5, DBP = 81.0, MAP = 93.8, HR = 97.8, RR = 19.3, SPO2 = 96.2.

Table 3

Comparing the behavioral pain response indicators before, during, and after endotracheal suctioning (N=80)

Indicators	Value	Immediately before the procedure		During the procedure		5 minutes after the procedure	
		f	%	f	%	f	%
Facial expression							
Neutral, relaxed	1	50	62.5	0	0.0	52	65.0
Partially tightened	2	26	32.5	11	13.8	24	30.0
Fully tightened	3	4	5.0	25	31.3	4	5.0
Grimacing	4	0	0.0	44	55.0	0	0.0
Body movements							
No movement	1	60	75.0	4	5.0	62	77.5
Partially bent	2	16	20.0	15	18.8	14	17.5
Fully bent with finger flexion	3	4	5.0	29	36.3	4	5.0
Permanently retracted	4	0	0.0	32	40.0	0	0.0
Compliance with ventilation							
Tolerating movement	1	78	97.5	0	0.0	78	97.5
Coughing with movement	2	2	2.5	61	76.3	2	2.5
Fighting ventilator	3	0	0.0	19	23.8	0	0.0
Unable to control ventilation	4	0	0.0	0	0.0	0	0.0

The results in Table 3 revealed a statistically significant difference between behavioral pain scores during suctioning and pre-suctioning scores. The behavioral pain scores increased during suctioning compared with pre-suctioning time; they returned to pre-procedural values after 5 minutes. It is highlighted that the behavioral pain response indicators change during endotracheal suction. Facial expressions showed more tension and discomfort, with increases in fully tightened (31.3%) and grimacing (55%). Body movements showed a decrease in immobility and a rise in fully bent with finger flexion (36.3%) and retracted movements during suctioning (40%). Compliance with ventilation shifted completely, with patients no longer tolerating ventilation and increased coughing (76.3%) and fighting the ventilator (23.8%) during the procedure. After the procedure, most behaviors returned to baseline, with patients tolerating ventilation and displaying fewer signs of distress.

Table 4

Comparing the effect of endotracheal suctioning on physiological and behavioral pain responses at three time periods

Parameters	df	F	p-value	Level
SBP	1.6	78.47	0.000	HS
DBP	1.8	63.05	0.000	HS

MAP	1.6	454.18	0.000	HS
HR	1.8	179.71	0.000	HS
RR	2	227.44	0.000	HS
SPO2	1.5	132.5	0.000	HS
Behavioral responses	1.0	941.7	0.000	HS

df=Degree of freedom; F=F-statistics; HS: Highly Significant (P value ≤0.01) .

The table (4) represents a statistical comparison of behavioral and physiological pain responses during endotracheal suctioning. The results reveal a highly significant change (p=0.001) across all parameters, indicating that endotracheal suctioning profoundly affects both behavioral pain responses and physiological stability.

Table 5

Association between the effect of endotracheal suctioning on behavioral and physiological pain responses with patients' socio-demographic and clinical data:

Variables	**Age**		**Sex**		**Reason for ICU admission**		**Duration of unconsciousness**	
	P-value	**Level**	**P-value**	**Level**	**P-value**	**Level**	**P-value**	**Level**
SBP	0.22	NS	0.94	NS	0.31	NS	0.25	NS
DBP	0.66	NS	0.46	NS	0.41	NS	0.21	NS
MAP	0.34	NS	0.12	NS	0.62	NS	0.33	NS
HR	0.08	NS	0.48	NS	0.01	HS	0.94	NS
RR	0.98	NS	0.18	NS	0.04	S	0.60	NS
SPO2	0.12	NS	0.009	S	0.40	NS	0.04	S
Behavioral responses	0.51	NS	0.47	NS	0.13	NS	0.82	NS

NS: Non-Significant (P value >0.05); S: Significant (P value ≤0.05- > 0.01).

Table 5 illustrates the association between patients' sociodemographic and clinical information and the effect of endotracheal suctioning on different physiological and behavioral pain responses. The p-values indicate the statistical significance of these associations. Age, sex, the reason for ICU admission, and the length of unconsciousness are among the characteristics examined. Heart rate (HR), respiratory rate (RR), and oxygen saturation (SPO2) were significantly associated with the reason for ICU admission, sex, and length of unconsciousness; SPO2 was also significantly related to length of unconsciousness. SBP, DBP, MAP, and behavioral pain responses did not significantly associate with any of the clinical or sociodemographic factors.

Discussion and Conclusion

Endotracheal suctioning is used in intensive care units (ICUs) to clean the trachea, prevent endotracheal tube obstruction, remove secretions that may lead to atelectasis and pulmonary infections, and thereby enhance airway ventilation in patients on mechanical ventilation. Previous studies demonstrated that the mean pain score increased significantly during the endotracheal suction (Gregory, 2017). The results showed that the patients' ages ranged widely, with a mean of 48.4 ± 14.8 years and a range of 18 to 77 years. A cross-sectional study that evaluated the current assessment and management of pain in severely ill patients confirms this finding (Alikiaie et al., 2019). The researcher justified the findings by stating that the higher prevalence of chronic conditions (e.g., CVA, heart failure, diabetes, and COPD) among older persons accounts for an increasing percentage of ICU admissions (Wunsch et al., 2013).

More than half of the patients enrolled in this study were male (52.5%), and 47.5% were female. These results align with the present literature, which presents that males have greater age-adjusted stroke incidence (Girijala et al., 2017) and account for 73% of overall road traffic deaths globally (Organization, 2019). The gender difference may be recognized as a biological risk factor for stroke events combined with male-dominant risk-having behaviors (Rhodes & Pivik, 2011).

The health-related measures were dedicated because they play an important role in elucidating and delineating the primary health-related measures. Findings revealed that the Patient's Mean ± SD was 6.0 ± 4.6, and the patient's length of stay ranged from 1 to 26 days. This finding is supported by Moitra et al. (2016), who reported that most patients (88.9%) were part of a retrospective cohort study assessing the association between ICU stay duration and 1-year mortality among elderly patients discharged from hospitals in the US. Relative to pre-existing chronic illnesses, the majority of patients (55%) had hypertension previously. In a meta-analysis study conducted by Khairy et al. (2022), hypertension was reported as a prevalent comorbidity among hospitalized COVID-19 cases, particularly in critical care settings.

In addition, more than half (81.3%) of the subjects were classified medically as non-traumatic patients. This was attested to by the study of Oliveira et al., (2019), presented in a cross-sectional study with quantitative design to assess pain and the utilization of analgesia in critically ill hospitalized patients admitted in the emergency and intensive care services of a government institution where there were in excess of two thirds (73.1%) of patients classified as having clinical non-traumatic conditions.

The results of this study in table (2) suggests that endotracheal suctioning causes significant changes in physiological parameters, the findings in the pre-procedure time indicate that the mean of systolic blood pressure (131.0), diastolic blood pressure (79.6), mean arterial pressure (91.5), heart rate (97.1), respiratory rate (18.6) and saturation of oxygen (96.4). During the endotracheal suctioning, the results revealed a high increase in the mean of systolic blood pressure (148.6), diastolic blood pressure (89.3), mean arterial pressure (108.8), heart rate (109.9), and respiratory rate (24.5) except for the saturation of oxygen, which is decreased (93.1). This is consistent with previous research showing that suctioning triggers significant physiological changes in ICU patients (Irajpour et al., 2014). Post-procedure, all physiological parameters returned to baseline, and there were no differences during the post-procedure period. This is because the sympathetic nervous system is activated by the irritation caused by suctioning the endotracheal tube. Stimulation of nociceptors and the cough reflex elicits stress responses and increased cardiovascular activity (Rass et al., 2020).

According to the descriptive statistics of behavioral pain response, which indicate distinguishable changes in the behaviors before, during, and following the procedure of endotracheal suctioning. Facial expressions revealed increased tension and discomfort (55%). Body movement revealed retracted movement during suctioning (40%). Ventilation compliance shifted completely, with patients no longer accepting ventilation and increased coughing (76.3%) during the procedure. After the procedure, the behavior returned to baseline. Wojnar-Gruszka et al. (2022) conducted a study to test the validity of the BPS and CCPOT behavioral pain scales for identifying pain in mechanically ventilated ICU patients under sedoanalgesia. It enrolled 81 patients, with pain measured at rest, during, and following the suctioning procedure. The study found that pain scores increased significantly during procedures. According to researchers, this occurs through stimulation of sensory receptors in the respiratory system (the larynx and bronchi) during suctioning, as well as through reflex activation of the sympathetic nervous system. This resulted in increased blood pressure, heart rate, and respiratory rate as a response to noxious stimuli. In addition, involuntary behavioral reactions such as muscle tension or movement occur (Rass et al., 2020).

Additionally, regarding the distribution of pain before, during, and after the procedure. Most patients felt no pain or slight pain. Consequently, moderate (37.5%) to extreme (52.5%) pain during the procedure was reported. After the procedure, most patients felt no pain or very slight pain, and their pain decreased considerably. Bachi & AL-Fayyadh (2022) conducted a study to determine pain after nursing interventions and found that pain scores are elevated during the procedure, especially during endotracheal suctioning.

The association between patients' sociodemographic and clinical information and the effect of endotracheal suctioning on different physiological and behavioral pain responses is illustrated. The p-values indicate the statistical significance of these associations. Age, sex, the reason for ICU admission, and the length of unconsciousness are among the characteristics examined. Heart rate (HR), respiratory rate (RR), and oxygen saturation (SPO2) were significantly associated with the reason for ICU admission, sex, and length of

unconsciousness; SPO2 was also significantly related to length of unconsciousness. SBP, DBP, MAP, and behavioral pain responses did not significantly associate with any of the clinical or sociodemographic factors. Petrini et al. (2015) reported that the pain threshold differed significantly between the elderly and younger age groups, with the elderly experiencing significantly less severe pain than the younger patients (Hădăreanu et al., 2025).

There is a strong, statistically significant association between the reasons for ICU admission and patients' cardiac and respiratory rates, as indicated by P-values of 0.01 and 0.04, respectively. This is a predicted outcome because the physiology of the disease, such as in patients with CVA and RTA, induces cardiac and respiratory instability in most patients who enter the intensive care unit. These results were approved by Hădăreanu et al. (2025), who looked into the fact that the majority of patients admitted to the ICU had serious cardiac or respiratory issues that required quick attention. Arrar & Al-Abedi (2021) reported that cardiovascular illnesses today are the fundamental causes of morbidity and mortality globally. Long recovery durations are linked to more severe hypoxemia and low SPO2 levels. In a prospective, cross-sectional study that sought to identify risk factors for procedure severity, assess self-reported pain severity during the procedure relative to the initial pain, and examine changes in pain severity over the course of operations. According to the study, there was no statistically significant correlation between procedural discomfort and the patient's age, gender, or coexisting conditions such as chronic pain and anxiety (Puntillo et al., 2018). Ineffective pain management increases care costs, length of hospital stay, and mortality rates associated with catheters (Ada & Yılmaz, 2019).

Endotracheal suctioning produced a significant increase in physiological parameters (systolic and diastolic blood pressure, heart rate, and respiratory rate) and a decrease in oxygen saturation during the procedure, with these parameters returning to baseline later. The behavioral pain scores revealed heightened pain during endotracheal suctioning, with increased body movement, facial tension, and ventilator non-compliance. These responses diminished post-procedure, highlighting the temporary but extreme pain caused by endotracheal suctioning.

More studies with larger sample sizes are required, particularly focusing on patients to measure pain in critical care settings. It is strongly advised that nurses in the intensive care units should measure pain using the most recent clinical guidelines. Due to the lack of use of objectively validated pain assessment methodologies, the adoption of well-known behavioral pain assessment instruments is equally essential, especially in Iraqi intensive care units. Improving patient recovery and maximizing the quality of care. Educating nursing staff in intensive care units on evaluating and managing pain in patients who are unable to express it verbally can improve patient outcomes, reduce complications, and enhance healthcare quality.

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Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants. Ethical considerations in this study included the fact that participation was entirely optional.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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Authors' Contributions

All authors equally contribute to this study.

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