Kerbala Journal of Nursing and Health Sciences. *(*2025) **Vol** 1, **No 3**

ISSN: 3007-9047 (online) 3007-9039 (Print)

Effect of Open and Closed Endotracheal Suction System on Oxygen Saturation Among Mechanically Ventilated Patient. A Comparative Study

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Received: 13 /7 /2025
Accepted: 4 /8 /2025
Published:29/ 10 /2025

Abstract

Background: Endotracheal suctioning is one of the fundamental procedures practiced in intensive care units. There are two methods used for suctioning: open and closed suction systems.

Objective: To compare the effects of open and closed suction system on oxygen saturation among mechanically ventilated patients. Comparative quasi experimental research design was carried out to achieve the study's objectives . A purposive sample included 80 patients taken from intensive care unit (ICU). Patient appraisal document was utilized for gathering data, which included three parts: bio-demographic data , health relevant data and an assessment sheet to monitor saturation level of oxygen.

Results: the results indicates that the closed suctioning has a significant effect on oxygen saturation. After the procedure, oxygen saturation (SpO_2) reduced significantly but recovered completely after 15 minutes, showing a highly significant ($p<.001$) .Whereas the majority of oxygen saturation is not greatly impacted by the open suction system, which exceeds the statistical significant level (> 0.05).

Conclusion: Using a closed suction system reduces fluctuations in oxygen saturation when compared to an open system among patients under mechanical ventilation.

Recommendation: Future studies should employ larger sample sizes to enable comparative analysis of suction techniques and their association with acquired infections in intensive care units (ICUs).

Keywords: Closed suction system, Open suction system, Oxygen saturation , Mechanical ventilated patient.

1. Introduction

Patients who are intubated often create more mucus and have a reduced capacity to clear their airways. This can increase the patient's risk of developing pneumonia, increased airway resistance, respiratory effort, hypoxemia, and hypercapnia (Raoof & Baeez, 2024) .Invasive mechanical ventilation (IMV) and intubation of the endotracheal tube are life-saving measures for patients with respiratory failure , and pulmonary suction is necessary to maintain airway integrity (GÜLSOY & KARAGÖZOĞLU, 2020) . (IMV) was essential for treating individuals with severe respiratory failure during the COVID-19 epidemic. Numerous research's statistics offer a variety of perspectives on the application of mechanical ventilation. Mechanical breathing was necessary for 2% to 75% of COVID-19 patients, with older people and those with pre-existing comorbidities having greater rates (WATTS et al., 2021). In ICU, to help patients with endotracheal tubes (ETTs) to preserve oxygenation and minimize the effort of breathing, clinicians frequently perform endotracheal suctioning; an invasive procedure to remove pulmonary secretions, maintain airway clearance and high oxygen level (Yılmaz & Özden, 2024) .Currently, open endotracheal suction and closed endotracheal suction are the two types of techniques used to suction sputum from patients on mechanical ventilation (Li et al., 2021) .Two nurses must participate in the open tracheal suction system OTSS method, which has the potential to temporarily impair the oxygen supply and ventilation since the patient could be removed from the ventilator device while being suctioned. Hypoxia is the main risk factor for this technique. ETT suctioning, on the other hand, can be administered using the closed tracheal suction system CTSS method through connections in a closed suction system and during ventilation without removing the patient from the ventilator (Ardehali et al., 2020) . When using an open system for suctioning, the patient is disconnected from the ventilator; therefore, oxygenated air and airway pressure are not delivered to them. As long as the patient is attached to the respiratory machine during suctioning, oxygenated air and pressure can still reach him in a closed system. In the process of suctioning, secretion-induced oxygen-rich air in the lungs is also exhausted (Yilmaz et al., 2021) .Many studies have looked at how open and closed suction systems affect physiological parameters; some have found significant differences between the two approaches for various measurements, such as oxygen saturation (SpO_2) (Sayed, 2019) .

1.1. Objective of the study

1. To evaluate oxygen saturation immediately following suctioning procedure, 5th minute and 15th minute .
2. To determine the effect of open and closed suction system on saturation level of oxygen among mechanically ventilated patients.
3. To find out the relationship between the effect of open and closed suction system on saturation level of oxygen with demographical and clinical data.

2. Methodology

The study was conducted among 80 ventilated patients in the intensive care units (ICUs) of two hospitals in Kerbala, Iraq: Imam Al-Hussein Medical City and Imam Al-Hassan Al-Mujtaba Teaching Hospital.With 40 patients in the closed suctioning group and 40 patients in the open suctioning group. While control group only received the usual care (open

endotracheal suction system) and the other group were to perform an interventional protocol(closed endotracheal suction system) .Before data collection, ethical planning is an essential phase in protecting the participant's integrity, dignity, and rights as humans. After a thorough review of the study protocol's contents, the ethics panel of the Nursing Faculty, University of Karbala, formally approved authorization to perform the study on October 27, 2024.Sample had been picked through a nonprobability (purposeful) technique of sampling. (25 December 2024 to 28 February 2025). The G*Power calculator was utilized to select the total number of subjects (Faul et al., 2009) was used to determine the suitable sample size for often requirement of analysis, a confidence level of 95%, a statistical power of 0.80, and a probability level of 0.05. In order to collect data, the methodology of observation was used.The quazi-experimental procedure for this study was established by the researcher after reviewing related past research. To make sure the patients fulfilled the inclusion requirements and were excluded from the criteria used for exclusion, the patient identification group performed an initial assessment. Following that, patients were randomized using the coin toss approach into two equal groups: the closed suction group and the open suction group. Following the American Association for Respiratory Care's (AARC) regulations, suctioning operations were administered. A researcher in the intensive care unit conducted the endotracheal suctioning. Suctioning was done in the OTSS group with disposable catheters and complete barrier precautions (gloves and hand washing). Just before suctioning, patients received two minutes of pre-oxygenation. The 14Fr Suction Catheter for Closed Suction Systems, which were utilized for respiratory system suctioning in the CTSS group, were changed. Suctioning was done without detaching from the ventilator, and patients were pre-oxygenated, just like the other group. All patients obtained the following prophylactic strategies: keeping cuff pressure between 20 and 30 mmHg, removing subglottic secretions continuously, avoiding unneeded estuation or intubation, elevating the head (30 to 40), performing suction only when needed, and avoiding routine changes in the respiratory circuitry unless necessary. The researcher conducted each and every intervention. And then, for around five patients each day during the morning shift, every session lasted 25 to 30 minutes. Data had been collected between January 19th, 2025, and April 19th, 2025.

After researching the relevant research, the researcher created this tool (Elmansy et al., 2024; Mahmood et al., 2017; Yildirim et al., 2024) . Two of the parts make it up. First Part: Socio-Demographic Characteristics and Health- Relevant Data:This part was used to gather information on the socioeconomic profile of the patients, such as their age, sex, occupation, and degree of learning. Additionally, it included essential health information about the patient, such as the date of being admitted, the type of endotracheal suctioning system, the length of vacuuming, the current diagnosis, and previous medical history. Second Part: Physiological Parameters, were adopted from (Elmansy et al., 2024; Sayed, 2019) , to monitor oxygen saturation at four different times.Thirteen knowledgeable individuals with at least four years of specialization in the field evaluated the study tool and acting strategy. The research instrument's application, clarity, significance, structure, and content were all examined by every expert member. A sample of ten subjects was chosen for the pilot study and reliability calculation and the Alpha Cronbach's values was ($r > 0.70$), which indicate that the surveys had sufficient levels of internal consistency and equivalency measuring. The statistical analysis programs SPSS version 25 and Microsoft Excel 2010 were used to investigate the data from the present study. Approaches for both descriptive and inferential data analysis were used:Tables were constructed applying the frequency (F), percentage (%), and basic statistics, such as means of score (MS) and standard deviation (SD), in order to evaluate the sample's

general findings and compare each variable. % = Percentage = Frequencies/Sample size * 100. A-Mean of Scores: The saturation of oxygen level for individuals are evaluated using the mean of scores. The following inferential statistics are employed to test the research's hypothesis: A. To assess the differences between two groups, the calculation of variance statistics employed one-way analysis of variance (ANOVA). B. The t-test for samples that are independent, which compares the results of the study and control groups before and after the experiment. C: A p-value was considered statistically significant if it was less than 0.05. E. Point Biserial Correlation ,it was used to find the significant relationships among effect of open and closed suction system with sociodemographic variables of patients' sex. F. Spearman's rank correlation coefficient, it was used to find the significant relationships among effect of open and closed suction system with sociodemographic variables of patients (age, level of education, occupation, chronic disease, smoking, and current diagnosis).G. Kolmogorov Smirnov Test, it used to determine the normality distribution of sample**.**

3. The results:

In this study, according to table **(4-1)** displays the sociodemographic features of the patients in a descriptive manner. The results show that the mean age of the patients is 62.8±15.7 years for the open suction group and 62.2±14 years for the closed suction group. For patients in both fields, the largest percentages were found in the 60–69 group (35% and 55%, respectively). Age-based differences between the two groups are not statistically significant, based on the variance test ($\Lambda = 1.495$, $P = 0.225$). In the open suction group, there is an equal proportion of male and female patients (50%), and in the closed suction group, male patients (55%) exceed female patients (45%). The variance test indicates that there is no statistically significant variance between the two groups according to sex ($\Lambda = 0.394$, $P = 0.532$).The patients' employment situation shows that greater numbers of both groups are "not working" (50 and 47.5%, respectively) than those who have free work (37.5% in the open suction group and 32.5% in the closed suction group, respectively). The variance test indicates a significant difference between the two groups subject to occupation ($\kappa = 4.391$, $P = 0.039$). Finally, that about 32.5% of patients in the closed suction group and 57.2% of patients in the open suction group smoke "1–20" cigarettes. Based on smoking habits, the variance test indicates a very significant difference between the two groups ($\Lambda = 11.854$, $P = 0.001$).

Table (4-1): Distribution of patients in open suction and closed suction according to their socio-demographic characteristics:

No.	Characteristics		Open Suction		Closed Suction		Variance test
			f	%	f	%	
1	**Age (year)**	20 – 29	3	7.5	3	7.5	Λ= 1.495 P= 0.225 Sig= N.S
		30 – 39	1	2.5	1	2.5	
		40 – 49	3	7.5	1	2.5	
		50 – 59	5	12.5	3	7.5	
		60 – 69	14	35	22	55	

		70 – 79	10	25	10	25	
		80 –89	4	10	0	0	
		Total	***40***	***100***	***40***	***100***	
		M ± SD	***62.8 ± 15.7***		***62.2 ± 14***		
2	**Sex**	Male	20	50	22	55	Λ= 0.394
		Female	20	50	18	45	P= 0.532
		Total	***40***	***100***	***40***	***100***	Sig= N.S
3	**Occupation**	Doesn't work	20	50	19	47.5	
		Employee	3	7.5	8	20	Λ= 4.391
		Free work	15	37.5	13	32.5	P= 0.039
		Retired	2	5	0	0	**Sig= S**
		Total	***40***	***100***	***40***	***100***	
4	**Smoking**	Never	17	42.5	18	45	Λ= 11.854
		1 – 20	23	57.5	13	32.5	P= 0.001
		21 – 40	0	0	9	22.5	**Sig= H.S**
		Total	***40***	***100***	***40***	***100***	

No: Number, f: Frequency, %: Percentage, Λ= Levene's Test, P: Probability value, Sig: Significance, N.S: Not significant, S: Significant, H.S: High significant

Table (4-2): Distribution of patients in open suction and closed suction according to their clinical characteristics

No.	Characteristics		Open Suction		Closed Suction		Variance test
			f	%	f	%	
1	**Chronic Diseases**	DM	1	2.5	1	2.5	
		Hypertension	4	10	10	25	
		CVA	2	5	1	2.5	Λ= 1.172
		Breast tumor	1	2.5	1	2.5	P= 0.282
		DM + HT	8	20	10	25	Sig= N.S
		DM+HT+CVA	7	17.5	3	7.5	
		HT+CVA	5	12.5	2	5	

		Kidney + HT	1	2.5	2	5	
		HF	4	10	4	10	
		HF + DM	1	2.5	0	0	
		No disease	6	15	3	7.5	
		Others	0	0	3	7.5	
		Total	***40***	***100***	***40***	***100***	
2	**Current Diagnosis**	CVA	27	67.5	31	77.5	Λ= 044 P= 0.834 Sig= N.S
		Hematoma	4	10	1	2.5	
		Brain tumor	2	5	1	2.5	
		Lung cancer	1	2.5	2	5	
		Shock	5	12.5	3	7.5	
		IHD	1	2.5	2	2.5	
		Total	***40***	***100***	***40***	***100***	

No: Number, f: Frequency, %: Percentage, Λ= Levene's Test, P: Probability value, Sig: Significance, N.S: Not significant, S: Significant, H.S: High significant

In This Table **(4-2)** shows the patients' clinical characteristics; revealed that while DM+HT+CVA (17.5% vs. 7.5%) and HT+CVA (12.5% vs. 5%) were more frequent in the open suction group, hypertension (10% vs. 25%) and DM+HT comorbidity (20% vs. 25%) were considerably higher in the closed suction group for chronic illnesses. Diabetes (2.5%) and heart failure (10%) were alike, whereas 15% of open suction patients and 7.5% of closed suction patients did not suffer from any chronic illnesses. A large number of current diagnoses were cerebrovascular incident (67.5% open vs. 77.5% closed), with open tracheal suction system having a greater incidence of hematoma (10% vs. 2.5%) and shock (12.5% vs. 7.5%). However, statistical tests (Λ values with $P > 0.05$) show no significant differences between the groups regarding current diagnosis or chronic conditions ($P = 0.282$).

Table (4-3): Effect of Open Suction System on Oxygen Saturation among Patients with Mechanical Ventilation :

Parameters	**Descriptive**		**Within-Subjects Effect (Greenhouse-Geisser)**						
	Time	**Mean (SD)**	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**P-value**	**Sig.**	**Partial Eta Squared**

Oxygen Saturation (SpO_2)	Before suctioning Immediately after suctioning 5-min after suctioning 15-min after suctioning	97.80(3.964) 92.15(1.270) 96.65(2.007) 97.60(3.972)	129.619	2.053	63.127	33.338	0.081	N.S	0.461

S.D: Standard Deviation, df: Degree of Freedom, f: F-statistics, P-value: probability value, Sig:Significance, H.S: High Significant

Table (4-3) indicates that the majority of saturation level of oxygen in patients on mechanical ventilation are not greatly impacted by the open suction system. which is greater than the significant level (> 0.05).

Table (4-4): Effect of Closed Suction System on Oxygen Saturation among Patients with Mechanical Ventilation :

Parameters	**Descriptive**		**Within-Subjects Effect (Greenhouse-Geisser)**						
	Time	**Mean (SD)**	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**P-value**	**Sig.**	**Partial Eta Squared**
Oxygen Saturation (SpO_2)	Before suctioning Immediately after suctioning 5-min after suctioning 15-min after suctioning	97.75(2.516) 95.87(2.402) 97.03(2.496) 98.27(2.630)	841.400	1.681	500.644	99.559	0.000	H.S	0.719

S.D: Standard Deviation, df: Degree of Freedom, f: F-statistics, P-value: probability value, Sig: Significance, H.S: High Significant

Table (4-4) indicates that in patients on mechanical ventilation, closed suctioning has a significant effect on saturation of oxygen. After the procedure, oxygen saturation (SpO_2)

reduced significantly but recovered completely after 5 minutes, showing a highly significant ($p<0.001$) and extremely significant effect ($\eta^2=0.719$).

Table (4-5): Significant Difference in Oxygen Saturation Score for Patients over Time in Studies Group

Oxygen Saturation	Closed Suction (N=40)	Open Suction (N=40)	P-value
	Mean ± SD	Mean ± SD	
Before suctioning	97.75(2.516)	97.80(3.964)	0.827
Immediately after suctioning	95.87(2.402)	92.15(1.270)	**0.001**
5-min after suctioning	97.03(2.469)	96.65(2.007)	0.076
15-min after suctioning	98.27(2.630)	97.60(3.972)	**0.004**

Table **(4-5)** shows little change prior to suctioning (P = 0.827). However, there are noticeable variations between the open suction group and the closed suction group both immediately after suctioning (P = 0.001) and 15 minutes later (P = 0.004). The closed suction group exhibits higher oxygen saturation. Five minutes after suctioning, there is no apparent alteration (P = 0.076). According to these results, the closed suction approach enhances oxygen saturation both immediately and 15 minutes after suctioning; however, the difference declines after 5 minutes.

Table (4-6): The Relationship among Effect of Open Suction System and Sociodemographic Characteristics of Patients

Variables		Open Suction System		
		Mean	SD	Relationship
Age (year)	20 – 29	95.33	2.309	r^s =0.307 P-value= 0.054 Sig= N.S
	30 – 39	95.00	-	
	40 – 49	94.67	12.858	
	50 – 59	89.80	3.493	
	60 – 69	79.86	17.146	
	70 – 79	86.60	14.308	
	80 +	86.25	12.010	
	Total	86.08	14.014	
Sex	Male	82.25	11.530	r^*= 0.369 P-value= 0.019 Sig= S
	Female	89.90	15.471	
	Total	86.08	14.014	

Occupation	Doesn't work	88.45	15.336	r^s =0.264 P-value= 0.100 Sig= N.S
	Employee	90.67	2.309	
	Free work	83.93	12.997	
	Retired	71.50	12.021	
	Total	86.08	14.014	
Smoking	Never	89.65	16.632	r^s =0.316 P-value= 0.047 Sig= S
	1 – 20	83.43	11.393	
	21 – 40	-	-	
	Total	86.08	14.014	

r^s: Spearman Correlation coefficient, r^*: Biserial correlation coefficient, P: Probability, Sig: Significance, N.S: Not Significant, S: Significant, H.S: High Significant

Table **(4-6)** exhibits how different patient demographic variables relate to the impact of the open suction system. Sex in the open suction system is shown to be significantly related; males have a lower mean score (82.25) than females (89.90), and this relationship is highly significant (P = 0.019, Sig = S). The impact of open suction system also was significantly associated with smoking the higher average score (89.65) of patients who have not smoked compared to smokers (P = 0.047, Sig = S), whereas the age (P = 0.054, Sig = N.S) and occupation (P = 0.100, Sig = N.S) do not show any significant associations.

Table (4-7): The Relationship among Effect of Open Suction System and Clinical Characteristics of Patients

Variables		**Open Suction System**		
		Mean	**SD**	**Relationship**
Chronic diseases	DM	88.00	-	r^s = 0.347 P-value= 0.028 Sig= S
	Hypertension	72.50	17.823	
	CVA	79.00	22.627	
	Breast tumor	89.00	-	
	DM + HT	83.13	14.798	
	DM+HT+CVA	85.57	7.807	
	HT+CVA	87.60	22.678	
	Kidney + HT	98.00	-	
	HF	91.25	9.979	
	HF + DM	86.00	-	

	No disease	94.50	8.142	
	Total	86.08	14.014	
Current Diagnosis	CVA	84.37	15.034	$r^s = 0.177$ P-value= 0.275 Sig= N.S
	Hematoma	98.00	4.899	
	Brain tumor	87.50	10.607	
	Lung cancer	95.00	-	
	Shock	83.40	14.415	
	IHD	86.00	-	
	Total	86.08	14.014	

r^s: Spearman Correlation coefficient, r^*: Biserial correlation coefficient, P: Probability, Sig: Significance, N.S: Not Significant, S: Significant, H.S: High Significant

Table **(4-7)** illustrates an association between the open suction system's impact and a number of patient clinical features. The open suction system was significantly associated with chronic disorders like diabetes mellitus (DM), as seen by their higher mean score (88.00) as compared to patients with other disorders like hypertension (P = 0.028, Sig = S). There were no significant correlations identified with the current diagnosis (P = 0.275).

Table (4-8): The Relationship among Effect of Closed Suction System and Sociodemographic Characteristics of Patients

Variables		**Closed Suction System**		
		Mean	**SD**	**Relationship**
Age (year)	20 – 29	97.67	14.742	r^s =0.385 P-value= 0.014 Sig= S
	30 – 39	84.00	-	
	40 – 49	73.00	-	
	50 – 59	95.67	3.786	
	60 – 69	97.45	16.315	
	70 – 79	106.60	16.208	
	Total	98.68	15.999	
Sex	Male	95.18	17.754	r^*= 0.172 P-value= 0.288 Sig= N.S
	Female	102.94	12.758	
	Total	98.68	15.999	
Occupation	Doesn't work	95.21	14.902	r^s =0.133

	Employee	108.38	15.684	P-value= 0.415 Sig= N.S
	Free work	97.77	16.513	
	Total	98.68	15.999	
Smoking	Never	101.06	11.435	r^s =0.010 P-value= 0.949 Sig= N.S
	1 – 20	93.62	22.209	
	21 – 40	101.22	12.979	
	Total	98.68	15.999	

r^s: Spearman Correlation coefficient, r^*: Biserial correlation coefficient, P: Probability, Sig: Significance, N.S: Not Significant, S: Significant, H.S: High Significant

Table **(4-8)** illustrates the connection between the patients' sociodemographic traits and the effect of the closed suction device. Younger patients may benefit more from the closed suction system than older ones, as revealed by the considerably greater mean score (97.67) for patients in the 20–29 age group (P = 0.014, Sig = S).There were not any significant correlations for occupation (P = 0.415), smoking (P=0.949) and sex (P = 0.288), indicating that these variables have no substantial impact on the effect of the closed suction system.

Table (4-9): The Relationship among Effect of Closed Suction System and Clinical Characteristics of Patients

Variables		**Closed Suction System**		
		Mean	**SD**	**Relationship**
Chronic diseases	DM	81.00	-	r^s = 0.260 P-value= 0.105 Sig= N.S
	Hypertension	106.00	11.185	
	CVA	98.00	-	
	Breast tumor	100.00	-	
	DM + HT	105.30	14.629	
	DM+HT+CVA	82.67	23.692	
	HT+CVA	102.50	16.263	
	Kidney + HT	69.50	7.778	
	HF	105.50	4.359	
	HF + DM	98.67	13.051	
	No disease	81.67	10.970	
	Total	98.68	15.999	
	CVA	101.35	15.911	r^s = 0.335

Current Diagnosis	Hematoma	81.00	-	P-value= 0.034 Sig= S
	Brain tumor	78.00	-	
	Lung cancer	74.00	1.414	
	Shock	95.00	4.583	
	IHD	106.50	.707	
	Total	98.68	15.999	

r^s: Spearman Correlation coefficient, r^*: Biserial correlation coefficient, P: Probability, Sig: Significance, N.S: Not Significant, S: Significant, H.S: High Significant

Table **(4-9)** presents the association between patient clinical variables and the closed suction system's effect. Patients with ischemic heart disease (IHD) had the highest average score (106.50), indicating a potential connection between particular disorders and the efficiency of the closed suction system. A significant correlation was found for current diagnosis (P = 0.034, Sig = S). Whereas the chronic illnesses (P = 0.105) did not show any significant associations.

4. Discussion

The results of this study, which was carried out with the objective of determining the effect of open and closed endotracheal suction systems on saturation of oxygen level (SpO2) among mechanically ventilated patients in the intensive care unit (ICU) at Imam Al-Hussein Medical City in Holy Kerbala and in the Imam Al-Hassan Al-Mujtaba Teaching Hospital's intensive care unit in the Kerbala Governorate. Indicated that based on sociodemographic characteristics. The highest rate of patients in the closed suction system and in the open suction system was in the 60-69 age group, making up 35% and 55%, respectively. Based on a previous study conducted by (Sagheer & Dawood, 2024) . The majority of patients in the closed suction system and open suction system were in the age > 60 years group, making up 61.7% and 53.25%, respectively. These findings were suggested according to the increasing need for mechanical ventilation with advancing age because they are more likely to have chronic conditions like diabetes and hypertension and then an increased risk for cerebrovascular accidents (CVA) and decreased level of consciousness (DLOC). Based on the study's sex variable, an experimental group (closed suction) consisted of 55% men and 45% women, while a control group (open suction) included 50% men and 50% women. The results of this study are supported by a study done by (Elmelegy & Ahmed, 2016) . The control group consisted of 73.3% males and 26.7% females, whereas the intervention group had 23.3% women and 76.7% men. It is believed that job stress increases the risk of stroke and ICU admission because most males work outside and face pressure like women have. Regarding occupational status, this study indicates that patients accounting for 47.5% and 50% of the study and control groups, respectively, do not have work. As well as this, this result is inconsistent with the randomized controlled trial that was conducted by (Elmansy et al., 2024) . The study results show 78% of the patient intervention group and about 84% of the control group were workers. The findings align with the idea that people without jobs may have low knowledge levels to check their health periodically. In addition, about 45% of participants in the intervention group are in the never-smoking group, and 57.5% of subjects in the control group were classified as in the 1-20 cigarettes group. This result is close to the study conducted by (Sayed, 2019). The study

results show that about 70% of patients in the intervention group and about 80% in the control group were non-smokers. Findings highlight that the smoking factor is a risk factor, not a cause, for CVA occurrence. Furthermore, the results demonstrate that the chronic diseases, diabetes mellitus (DM) + hypertension (HT) comorbidity (20%), were notably higher in the open suction group, while hypertension (25%) and HT+DM (25%) were more prevalent in the closed suction group. Based on researcher opinion, these findings show that the majority of chronic diseases that increase risk to CVA and ICU admission are hypertension and diabetes mellitus. The study results of (Sagheer & Dawood, 2024) revealed the similar results. In which about 51.1% of individuals in the interventional group suffer from cardiac disease, while about 57.4% of subjects in the control group have diabetes mellitus. In concern to the current diagnosis, the majority sample having a CVA diagnosis recorded about 67.5% and 77.5% for both the control and study groups, respectively. It is assumed that CVA disease isone of the major diseases needingICU admission and mechanical ventilation due to respiratory system depression. The study conducted by (Pakizeh et al., 2023) supported the study's results, which showed that half of the participants (50%) were diagnosed with a neurological disorder. According to the significant difference in oxygen saturation score for patients over time in the study group. The results demonstrate no significant difference before suctioning (P = 0.827). However, significant differences are observed immediately after suctioning (P = 0.001) and 15 minutes after suctioning (P = 0.004). With the closed suction group showing higher oxygen saturation compared to the open suction group. There is no significant difference 5 minutes after suctioning (P = 0.076). This was in line with a study by (Sayed, 2019) , who found that the closed suction method's mean oxygen saturation was higher than the open method's, with a highly statistically significant difference between the two approaches during and immediately after suctioning. From the researchers' point of view, these findings could be related to the fact that with the open suction approach, the suction tube disconnects from the mechanical ventilator, resulting in decreased oxygenation and hypoxia. In concern to the relationship between the effect of the open suction system and the sociodemographic characteristics of patients. A significant relationship is found between sex and the open suction system, with males having a lower mean score (82.25) compared to females (89.90), and the relationship is statistically significant (P = 0.019, Sig = S). However, no significant relationships are observed for age (P = .054, Sig = N.S), occupation (P = 0.100, Sig = N.S), and level of education (P = 0.947, Sig = N.S). This matched up with the study results by (Elmelegy & Ahmed, 2016) , showing a correlation between socio-demographic data and mean scores of vital signs in the open suction method. It was observed that regarding the patient's age, there was a significant negative correlation between age and diastolic blood pressure two and five minutes after suctioning. In addition, there was a significant negative correlation between sex and O_2 saturation five minutes after suctioning. The relationship between the effect of the open suction system and the clinical characteristics of patients illustrates an association between the open suction system's impact and a number of patient clinical features. Smoking and chronic diseases were found to be significantly correlated. Smoking significantly affects the open suction system, as revealed by the higher average score (89.65) of patients who have not smoked compared to smokers (P = 0.047, Sig = S). Furthermore, the open suction system was significantly associated with patients with chronic disorders like diabetes mellitus (DM), as seen by their higher mean score (88.00) as compared to patients with other disorders like hypertension (P = 0.028, Sig = S). This aligned with the results of the study conducted by [16] , which shows that there is a statistically significant difference in terms of the diagnosis of the

type of disease and underlying diseases ($P < 0.05$). In addition, the study result conducted by (Sayed, 2019) shows inconsistent results about smoking variables, which represents no statistical significance ($P = 0.317$). According to researcher opinion, smoking increases the risk of suffering from CVA but does not cause it. In addition, the relationship between the effect of the closed suction system and the sociodemographic characteristics of patients shows the connection between the patients' sociodemographic traits and the effect of the closed suction device. Younger patients may benefit more from the closed suction system than older ones, as revealed by the considerably greater mean score (97.67) for patients in the 20–29 age group ($P = 0.014$, Sig = S). This was in line with the study results confirmed by (Pakizeh et al., 2023) , showing a correlation between socio-demographic data and mean scores of vital signs in the closed suction method. It was observed that there was a significant negative correlation between age and O_2 saturation before suction. Regarding sex, there was a significant negative correlation between female patients and respiratory rate at every time of measurement, while in males therewas a significant positive correlation between male sex and respiration before and 5 minutes after suctioning. Whereas, the relationship between the effect of the closed suction system and the clinical characteristics of patients, the results present the association between patient clinical variables and the closed suction system's effect. Patients with ischemic heart disease (IHD) had the highest average score (106.50), indicating a potential connection between particular disorders and the efficiency of the closed suction system. A significant correlation was found for current diagnosis ($P = 0.034$, Sig = S). This aligned with the results of the study conducted by [16] , which shows that there is a statistically significant difference in terms of the diagnosis of the type of disease and underlying diseases ($P < 0.05$).

Based on the effect of the closed suction system on oxygen saturation level among patients with mechanical ventilation (n=40), the results show that after the procedure, oxygen saturation (SpO_2) reduced significantly but recovered completely after 15 minutes, showing a highly significant ($p<0.001$) and extremely significant effect ($\eta^2=0.719$). This was in agreement with the study performed by [16] , who show that there are differences in oxygen saturation values before and after using closed suction in patients who are fitted with mechanical ventilation in the Intensive Care room Dr. RSU Unit (ICU) Kariadi Semarang (Z-score = -2.585, p-value = 0.010). Whereas, in the open suction system the correlation was non-significant in (SpO_2). These results agreed with the study conducted by (Pakizeh et al., 2023) , who also show a nonsignificant correlation ($P=0.112$).

5. Conclusion

Compared to open suction systems, the use of closed suction systems causes less variation in the oxygen saturation level in patients on mechanical ventilation since they do not deprive them of oxygen supply or mechanical breathing.

6. Acknowledgment

The authors are very grateful to all patients who participated in this study and all nursing staff in the studied ICUs for their cooperation.

7. References

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