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The impact of open vs closed suction on cardio-respiratory parameters in mechanically ventilated patients

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Abstract

Suctioning of the endotracheal tube in ventilated patients is one of the ways to maintain the airway open. There are various risks associated with this procedure. Suctioning methods that are appropriate for the situation can help to avoid acute problems. The purpose of this study was to compare the effects of open vs closed suction on cardio-respiratory parameters in patients on mechanical ventilations. Patients hospitalized to Neuro-ICU and Medical ICU with ventilator support was studied in a non-randomized clinical trial with a time series study design. Sixty samples were chosen using a convenient sampling procedure, including 30 for open suction and 30 for closed suction. Before and during suction, data such as demographic factors and cardio-respiratory parameters such as respiratory rate, heart rate, mean arterial pressure, and SpO₂ were measured. In this study, statistically significant changes (p=0.001) in Mean Arterial Pressure (MAP) and SpO₂ were identified when open and closed suction systems were compared. According to the findings, closed suction has a significant favourable impact on cardiopulmonary parameters.

Keywords: Cardio Respiratory parameters, mechanical ventilation, SpO₂, Mean Arterial Pressure (MAP), open suction, closed suction

Introduction

The cardiac respiratory system is a vital component of human body. The cardiac and respiratory systems are always integrated as a single system that cannot function as a distinct organ. Both are interconnected in order for humans to have a normal healthy life. When a patient undergoes any cardiopulmonary surgeries, as their cardiopulmonary functions are compromised due to post anaesthetic effect and due to any other adverse effects of surgery, they are transported to the intensive care unit after surgery for hemodynamic monitoring, sufficient volume therapy, and treatment with positive inotropic medications and vasopressor medicines (ICU).

Intubation and mechanical breathing greatly decrease airway secretion clearance; intubated patients require intermittent suctioning of secretions due to their inability to clear their airways spontaneously^{1, 2}. In the ICU, tracheal suctioning is done to remove secretions from intubated patients who are on mechanical ventilation^{3, 4}. Suctioning is thus advised in mechanically ventilated patients to minimize airway obstruction and to lessen the amount of effort necessary to breathe due to retained secretions. Nonetheless, this manoeuvre has the potential to be dangerous and can result in serious and life-threatening consequences.⁵

Bleeding, infection, atelectasis, hypoxemia, cardiovascular instability, elevated intracranial pressure, and tracheal mucosa lesions are the complications of endotracheal suction. Patients have described the suctioning procedure as painful and unpleasant^{6,7} because it increases the workload and oxygen consumption of the heart, which has also been linked to significant postoperative consequences, particularly in coronary artery bypass graft (CABG) patients.

Endotracheal suction (ES) maintains airway patency and cleanliness by removing secretions, allowing for successful and uncomplicated breathing. The two ES techniques are the open suction system and the closed suction system. If a mechanical ventilator is present, the patient is first disconnected from it; the airway is then suctioned with a disposable sterile catheter coupled to the vacuum system; and the patient is then attached to the ventilator (Gunn, 1996; Cereda et al., 2001; Jongerden et al., 2007).

The effects of open and closed ES on patient oxygenation, lung volume, and haemodynamic status were investigated, and it was observed that weaning the patient off mechanical ventilation during open ES reduced lung volume as well as arterial and venous oxygen saturation. Because the method removes air from the lungs, hypoxemia may occur. During this transition, the patient's arterial blood pressure and heart rate (HR) may rise, potentially disrupting the cardiac rhythm (Johnson et al., 1994; Masry et al., 2005). While the patient is still on mechanical ventilation during closed ES, complications like reduced lung volume, hypoxemia, elevated blood pressure, and cardiac arrhythmia are avoided.

As a result, the purpose of this study was to compare the effects of open vs. closed suction on cardio-respiratory parameters mechanically ventilated patients.

Materials and Methods

The research design chosen for this study was non-randomized clinical trial, time series study. The study was conducted in a multi specialty hospital in which the patients aged more than 25-69 years and those who were admitted in Neuro-ICU and Medical ICU with ventilator support were included in the study. The exclusion criteria were the patients with lung injury and cardiac

surgery and not willing to participate for this study. By Purposive sampling technique, a total 60 samples were selected from that 30 for open suction, 30 for closed suction were allotted. Data collection tools contain two sections such as demographic variable such as age, sex, type of ICU, education, duration of suction and cardio-respiratory parameter was assessed before and during suction such as respiratory rate, heart rate, mean arterial pressure(MAP) and SpO2. Ethical

clearance was obtained from the hospital and no harm certificate was obtained for the interventions. The participants and the close blood relatives, whoever was feasible, signed the consent form for the study. The suctioning procedure and frequency was followed as per the protocol of the hospital for both the groups. Descriptive and inferential statistics was used to analyse the data.

Results and Discussion

Table 1: Distribution of demographic variables of patients

Demographic variables		Group			
		Open method suction		Closed method suction	
		n	%	n	%
Age	Below 30 years	3	10.0%	2	6.7%
	30 - 40 years	6	20.0%	7	23.3%
	40 – 50 years	12	40.0%	10	33.3%
	>50 years	9	30.0%	11	36.7%
Gender	Male	18	60%	22	73.3 %
	Female	12	40%	8	26.7 %
Education	Primary	5	16.7%	7	23.3%
	H. Sc	11	36.7%	7	23.3%
	Graduate	9	30%	14	56.7%
	Post graduate	5	16.7%	2	6.7%
Type of ICU	NICU	11	36.7%	13	43.3%
	IMCU	19	63.3%	17	56.7%
Duration of suction	1 - 2 sec	13	43.3%	11	36.7%
	3 - 5 sec	17	56.7%	19	63.3%

Table 1 shows that the majority (40%) of the patients in the open suction group were 40-50 years old, 18 (60%) were males, 11 (36.7%) of them had higher secondary education, 19 (63.3%) were in IMCU, and 17 (56.7%) were in 3-5 second suction duration. Comparatively, 36.7

% of the patients in the closed suction group were >50 years old, 22 (73.3 %) were men, 14 (56.7 %) were graduates, 17 (56.7%) were in IMCU, and 19 (63.3%) patients had the duration of suction for 3-5 seconds. In general, the patients in both the groups had similar characteristics.

Table 2: Comparison of oxygen saturation of patients with different suction methods

		Group				Independent t-test
		Open method suction		Closed method suction		
		Mean	SD	Mean	SD	
Before	SpO ₂ 1	98.50	1.10	97.60	8.43	t=0.36, p=0.71
	SpO ₂ 2	98.50	0.95	93.10	6.13	t=4.17, p=0.001
	SpO ₂ 3	98.60	1.00	93.40	4.84	t=5.18, p=0.001
	SpO ₂ 4	98.75	1.50	94.50	7.24	t=2.67, p=0.01
	SpO ₂ 5	98.50	0.80	93.30	8.20	t=2.91, p=0.01
During	SpO ₂ 1	96.50	0.70	98.10	1.20	t=6.10, p=0.001***
	SpO ₂ 2	95.50	1.70	98.50	1.10	t=6.13, p=0.001***
	SpO ₂ 3	95.80	1.00	98.00	1.20	t=7.89, p=0.001***
	SpO ₂ 4	95.50	1.40	98.50	1.40	t=7.27, p=0.001***
	SpO ₂ 5	95.70	1.50	98.50	0.90	t=8.19, p=0.001***

Table 2 reveals that during suction, there is a considerable change in SpO₂ between open and closed suction methods. The results demonstrate that during suction, there is a significant difference between open and closed suction which was significant. (t=8.77 and P=0.001). Similar study findings were reported in a study which concludes that desaturation, lung collapse, and bacterial contamination are all caused by open system suctioning. Closed suction system reduces

desaturation and lung collapse by allowing breathing to continue while suctioning¹⁰. Also, few more studies concluded that the closed suctioning was first used for sanitary reasons, as well as to avoid desaturation¹¹⁻¹³ and reduce lung volume loss during suctioning. A study by Ali Mohammadpour et al., (2015)¹⁴ also concluded that oxygenation and ventilation are better preserved with closed suctioning system.

Table 3: Comparison of MAP among patients with different suction method

		Group				Independent t-test
		Open method suction		Closed method suction		
		Mean	SD	Mean	SD	
Before	MAP1	101.07	7.67	101.05	7.71	t=0.00, p=1.00
	MAP2	99.6	7.0	99.61	7.00	t=0.00, p=1.00
	MAP3	104.1	6.9	104.10	6.91	t=0.00, p=1.00
	MAP4	107.02	11.10	107.2	11.3	t=0.00, p=1.00
	MAP5	104.20	7.10	104.4	7.21	t=0.00, p=1.00
During	MAP1	115.70	10.05	101.0	7.8	t=6.01, p=0.001***
	MAP2	115.00	9.3	99.5	7.0	t=5.87, p=0.001***
	MAP3	116.12	9.80	104.40	6.9	t=4.97, p=0.001***
	MAP4	112.90	7.90	107.10	11.18	t=3.01, p=0.04*
	MAP5	116.9	8.80	104.10	7.20	t=6.13, p=0.001***

Table 3 demonstrates that there is no significant difference between open and closed methods of suction before suctioning, but there is significant differences in MAP during the suctioning procedure at p=0.001. In this study, the difference in heart rate (HR), respiratory rate (RR), and mean SaO₂ values measured before,

shortly after, and at the 5th and 15th minute after suctioning which was also found to have significant difference in patients who underwent open as well as closed suctioning. During suctioning, the difference in mean SpO₂ values was found to be significant in both open and closed suction methods, and statistically

significant differences in MAP ($p=0.001$) and SpO₂ ($p=0.001$) were detected when comparing the open and closed suction systems. Magda Mohamad (2007) conducted a quasi-experimental study to examine the impact of cardiac respiratory parameters in open and closed suction. A total of 60 patients who were mechanically ventilated were chosen. Closed suction has a significant impact on cardiopulmonary parameters, according to the findings of the study. Hence, it is a wise option to choose the closed method of suction in patients on ventilation to maintain their oxygen saturation and give safe, quality care to the patients.

There was no statistical significant association found between the methods of suction and demographic variables of the patients. To elicit the association, may be larger samples with longer duration studies needed.

Conclusion

As per the findings of the present study, while comparing the open and closed suction systems closed suction has a considerable positive impact on cardiopulmonary parameters. Hence, this method can be considered while suctioning the patients in the mechanical ventilation.

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Declaration of Conflicting Interests

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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