



## Effectiveness of Closed Versus Open Endotracheal Suctioning Upon Respiratory Outcome in Mechanically Ventilated Adult Patients

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### **Abstract**

**Objectives:** To assess the Effectiveness of Closed Endotracheal Suctioning (CES) as against Open Endotracheal Suctioning (OES) upon Respiratory Outcomes among Mechanically Ventilated Adult Patients.

**Materials and Methods:** A total of 100 Mechanically Ventilated Adult Patients were included in the study, 50 CES and 50 OES samples were collected using simple random sampling technique. Pretest posttest design was adopted. Respiratory outcome was assessed using an observational checklist. Mean and standard deviation before CES and OES, during suction and 15min after suction were compared, and respiratory outcome in CES and OES were observed. The mean and standard deviation of post suction respiratory outcome after 15min was high in closed and open endotracheal suctioning (M- 34.07, 34.2 & SD- 4.66, 4.29) respectively. Major variation was noted in the respiratory outcome ( $p < 0.001$ ) in both during suction, but the variation in OES ( $t = 35.8$ ) was higher than the CES ( $t = 22.38$ ). Thus the respiratory outcome was better in CES

**Conclusion:** Closed endotracheal suctioning system can be implemented to mechanically ventilated patients to attain a better respiratory outcome.

**Keywords –** Mechanically ventilated, Respiratory Outcome, Suctioning.

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## Introduction

Breathing is the greatest pleasure in life. Breath is spirit; the act of breathing is living. Breath is the bridge which connects life to consciousness, which unites your body to your thoughts. Airway management is the process of ensuring that there is an open pathway between a patient's lungs and the outside world and the lungs are safe from aspiration. Esteban A. et al. (2002)<sup>[1]</sup> did a prospective cohort study in 361 intensive care units among adult patients who received mechanical ventilation and they measured the mortality cause during intensive care unit stay. Overall mortality rate in the intensive care unit was 30.7% out of 15757 patients - 52% in patients who received mechanical ventilation because of acute respiratory distress and 22% in patients who received it for chronic obstructive pulmonary disease. Survival rate of patients receiving mechanical ventilation for more than 12 hours was 69%. The care of the mechanically ventilated patient is a fundamental component of a nurse's clinical practice in the intensive care unit (ICU).

The normal respiratory function of the mechanically ventilated patient is compromised placing them at risk of complications. Artificial airways bypass the humidification and filtering mechanisms of the upper airways (St John and Malen, 2004)<sup>[2]</sup>, oxygen is cold and dry and disease processes and therapies can impair the cough reflex (Jaber et al. 2004)<sup>[3]</sup>. Lung secretions should be assessed for colour, consistency and volume (Winters and Munro. 2004)<sup>[4]</sup>. The need to monitor the patient very closely for any signs and symptoms of complication also arises.

Nurses are essential members of the multidisciplinary team and often spend the highest proportion of time with patients. The care of mechanically ventilated patient is at core of a nurse's clinical practice in the intensive care unit (Couchman B.A. et al.)<sup>[5]</sup>. Suctioning is a fundamental nursing activity. Intubated patients may be unable to adequately cough up secretions. Endotracheal suctioning is therefore important in order to reduce the risk of consolidation and atelectasis that may lead to inadequate ventilation.

A cross over study (Tan et al. 2005)<sup>[6]</sup> compares the severity, incidence of desaturation and bradycardia between closed versus partially ventilated endotracheal suction in neonates. The closed tracheal suction system reported a significantly smaller degree of oxygen saturation fall ( $P < 0.005$ ) and significantly fewer incidences of desaturation. There was also a significantly smaller degree of heart rate reduction, although episodes of bradycardia were not significantly different between the two methods.

Fernandez et al., (2004)<sup>[7]</sup> conducted a prospective crossover study to compare changes in lung volume, oxygenation, airway pressure, and hemodynamic effects. The reductions in lung volume during suctioning were similar with the quasi-closed (386+/-124 ml) and closed system (497+/-338 ml), but significantly higher with the open system (1281+/-656 ml,  $P = 0.022$ ). There is no significant hemodynamic adverse effects, and no significant SpO<sub>2</sub> reductions with all the studied suctioning techniques. Therefore, the correct choice of suction system is based on handling and the cost. The choice of suctioning system (closed vs. open) remains unresolved in evidence-based guidelines

The purpose of study was to replicate and extend the existing body of knowledge pertaining to the normal relationship between suctioning and respiratory outcome. The study will provide guidance for practicing the suctioning in the clinical set up for nurses as an evidence based practice. The aim of the study is to investigate the influence of suctioning on respiratory outcome.

### Methods and Materials

An evaluative research approach and pretest posttest design was adopted. A total of 100 Mechanically Ventilated Adult Patients were included in the study, 50 CES and 50 OES samples were collected using simple random sampling technique. The study was conducted at Apollo Main Hospital and Apollo Speciality Hospital, Chennai. Demographic Variables Proforma, Clinical Variable Proforma, Observational checklist for respiratory parameters, Rating scale on level of satisfaction, Practice observational checklist were used as tools.

This observational checklist for respiratory outcomes comprised of patients' outcome including oxygenation, respiratory rate, normal breath sounds, use of accessory muscles,  $FiO_2$ , PIP, tidal volume,  $PaCO_2$ ,  $PaO_2$ , blood pressure, heart rate, number of days on ventilator, temperature, secretion characteristics and ET culture. The rating scale on the level of satisfaction consisted of 3 responses for closed endotracheal suctioning and for open endotracheal suctioning; the nurses could choose the acceptable option for it based on their level of satisfaction. The practice observational checklist consisted of 3 responses for closed and open endotracheal suctioning; the researcher collected information by observing the nurses while performing the procedure.

Among the 100 mechanically ventilated patients, 50 patients belonged to closed endotracheal suctioning and 50 patients belonged to open endotracheal suctioning. The baseline data was collected through the demographic variable and clinical variable proforma. Three consecutive observations were assessed for three days with data collection tool. The respiratory outcome was assessed by using the observational check list. The respiratory outcome was observed at an interval of pre-observation before suction, during suction, 5min and 15min after suction in both closed and open endotracheal suctioning. The observation was done for 3 consecutive days for each patient. Then the level of satisfaction of nurses was assessed using the rating scale in both closed and open endotracheal suctioning. The level of practice of nurses was also assessed by using the practice observational checklist in closed and open endotracheal suctioning.

The respiratory parameters were observed before Reliability was determined by using split half method and inter rater technique. Karl Pearson's 'r' was computed for finding out the reliability, Practice observational check list for nurses [Inter rater technique ( $r = 0.76$ )] and rating scale for nurses satisfaction [Split half method ( $r = 0.86$ )]. Validity was obtained from experts. The ethical principles were followed throughout the study.

### Statistical Analysis

Analysis and interpretation of the data were carried out by using descriptive and inferential statistics. Descriptive statistics like frequency distribution, percentage, mean standard deviation and inferential statistics like t-test and chi square test were used to analyze the data.

### Results

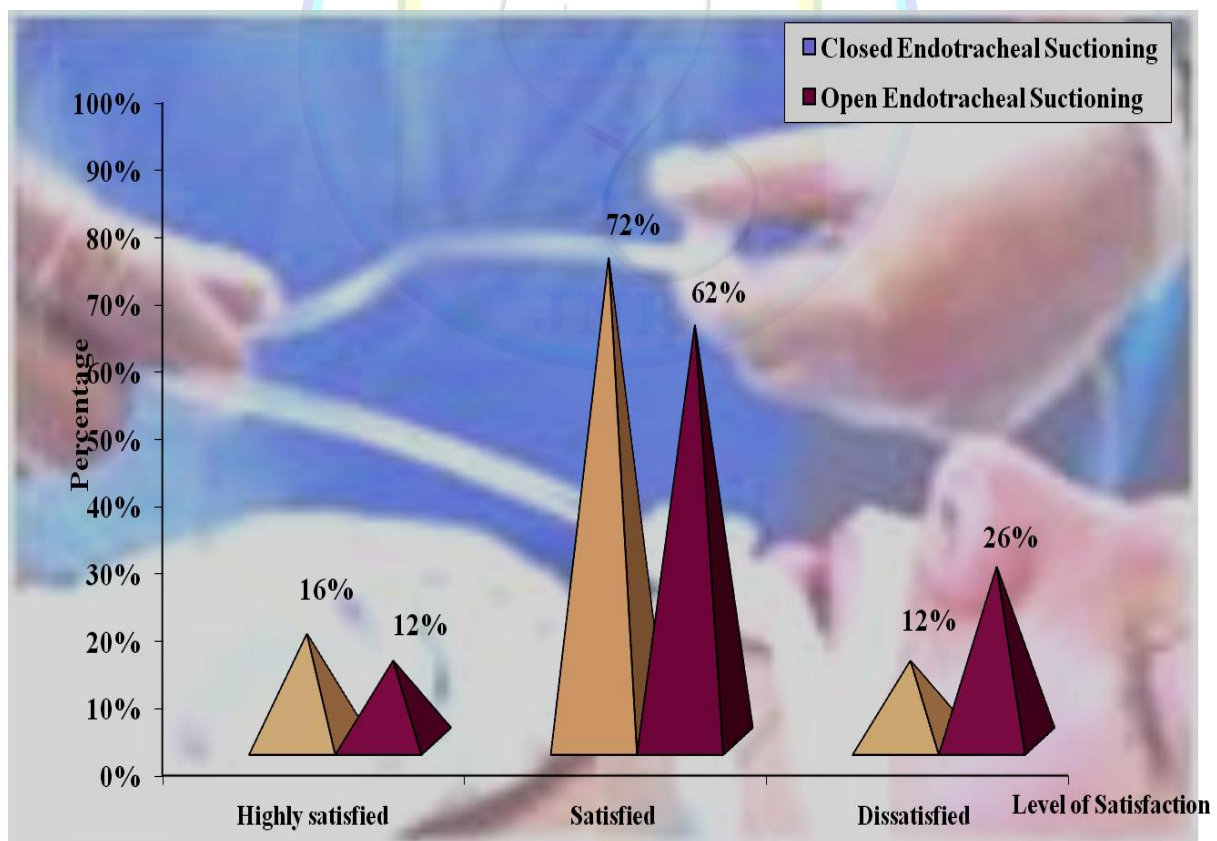
Most of the patients in the CES and OES were between the age group of 51-60 (52%, 46%), males were (64%, 68%), employed (44%, 46%) and indoor workers (66%, 60%) respectively. A significant percentage of patients had a history of alcoholism (30%, 20%) and history of smoking (24%, 26%) in closed and open endotracheal suctioning respectively. In the CES group, a significant number of patients' reason for ventilation was trauma (28%), (42%) were overweight, (40%) had humidifier, (16%) patients had history of previous respiratory illness, (12%) had history of trauma and (28%) had history of surgery (28%). Most of the patients in

CES were conscious (52%), (56%) received physiotherapy, (52%) had co-morbid illness and (54%) had undergone treatment for co-morbid illness.

In OES group, a significant number of the patients' reason for ventilation (36%) was trauma, (28%) patients got physiotherapy, (14%) had humidifier, (6%) had history of previous respiratory illness, (28%) had history of trauma and (24%) had history of surgery. Most of the patients were overweight (50%), sedated/ paralyzed (58%), (52%) had co-morbid illness and (50%) had undergone treatment for co-morbid illness in OES.

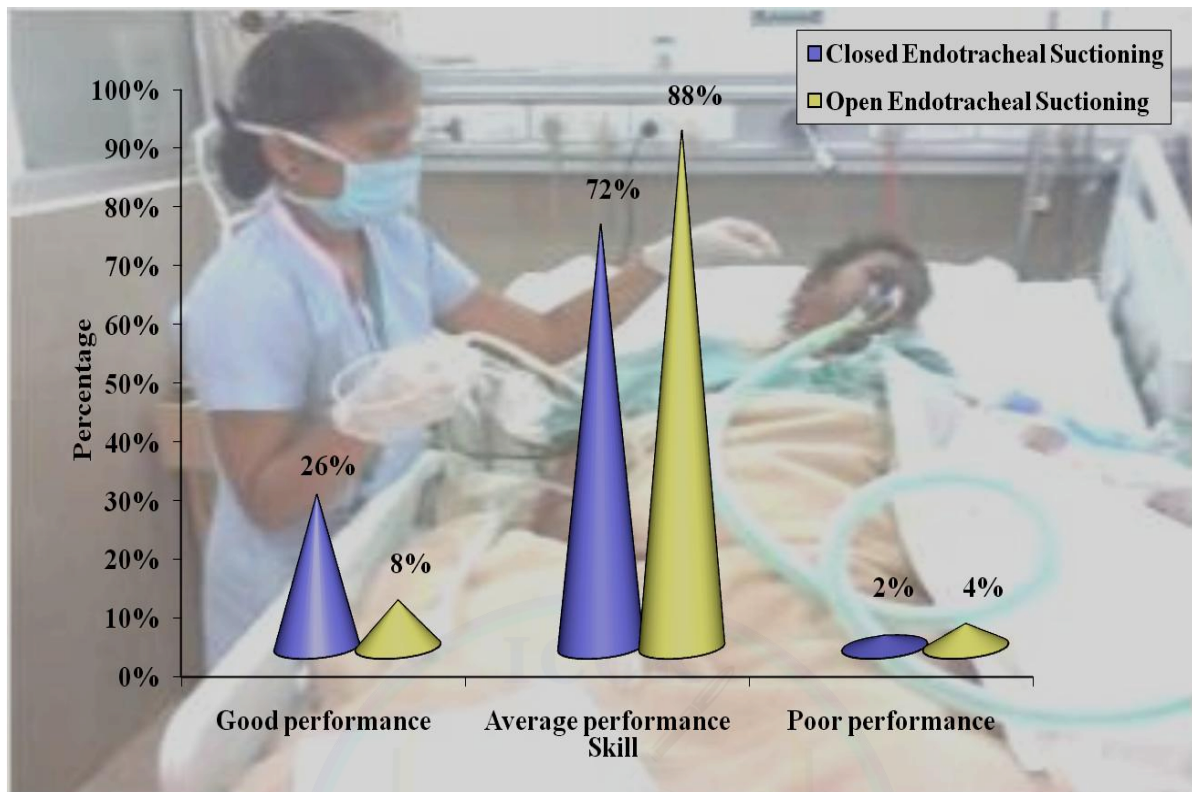
The study revealed that post suction respiratory outcome at 15min was high in both the suctioning. In CES, post suction respiratory outcome (mean 34.07 and SD 4.66) was higher than the pre observation (mean 33.07 and SD 4.49). In OES, post suction respiratory outcome (mean 34.2 and SD 4.29) was higher than pre observation (mean 33.53 and SD 3.94). There was a significant difference in the respiratory outcome during suction between CES and OES ( $t=3.69$ ).

Mean and standard deviation of respiratory outcome of each category was noted in both the suctioning systems. The vital signs were within normal limits in closed endotracheal suctioning (CES) during suction (mean 7.27 & SD 1.59) while comparing to the open endotracheal suctioning (OES) (mean 6.98 & SD 1.73) and sign of respiratory distress was significantly lower in CES (mean 9.35 & SD 2.40) while comparing it to the OES (mean 8.97 & SD 2.40). There was a significant difference ( $p < 0.001$ ) in the respiratory outcome during suction between CES and OES ( $t=3.69$ ).



**Figure 1: Percentage Distribution of Level of Satisfaction of Nurses regarding Closed and Open Endotracheal Suctioning in Mechanically Ventilated Adult Patients**





**Figure 2: Percentage Distribution of Practice of Nurses on Closed and Open Endotracheal Suctioning in Mechanically Ventilated Adult Patients**

In CES, the majority of patients had positive outcome during pre-observation (58%), during suction (74%), after 5minutes (56%) and highly positive outcome (66%) after 15minutes. In OES, a majority of patients had positive outcome in pre-observation (54%), during suction (28%) negative outcome and (68%) positive outcome. Most of the patients after 5minutes (64%) had positive outcome and (52%) had highly positive outcome after 15minutes.

The majority of nurses were satisfied (72%) with closed endotracheal suctioning (Figure 1). With regard to the level of performance of nurses, 26% of nurses had good performance and 72% had average performance in CES than in the OES which had only 8% of good performance (Figure2).

### Discussion

Chi square test was used to find out the association between selected demographic variables and the respiratory outcome and inferred that there was no significant association between the respiratory outcome and the selected demographic variable ( $p > 0.05$ ). Mean and standard deviation in the respiratory outcome of the mechanically ventilated adult patients before performing closed and open endotracheal suctioning was (M-33.07, 33.53 & SD- 4.49, 3.94), whereas there was a significant decline at the time of suction. The mean and standard deviation of post suction respiratory outcome after 15min was high in CES and OES. (Table 1)

**Table -1: Comparison of Mean and Standard Deviation of Respiratory Outcome of Mechanically Ventilated Adult Patients with Closed and Open Endotracheal Suctioning**

N=100

DURATION	Closed Endotracheal Suctioning n=50		Open Endotracheal Suctioning n=50		't' value independent test
	Mean	S.D	Mean	S.D	
Pre observation	33.07	4.49	33.53	3.94	0.54
During suction	28.3	4.53	25.0	4.41	<b>3.69***</b>
After 5 minutes	32.5	4.66	32.6	4.04	0.15
After 15 minutes	34.07	4.65	34.2	4.29	0.15

\*\*\*p &lt; 0.001

**Table -2: Comparison of Paired 't' Test of Respiratory Outcome of Mechanically Ventilated Adult Patients with Closed and Open Endotracheal Suctioning**

N=100

DURATION	Closed Endotracheal Suctioning 't' value	Open Endotracheal Suctioning 't' value
Pre observation & during suction	22.38***	35.8***
Pre observation & After 5min	3.56***	6.92***
Pre observation & after 15min	2.57*	1.74

\*\*\*p &lt; 0.001, \*p &lt; 0.05

There was a major variation noted in the respiratory outcome on both suctioning during suction, but the variation in OES is higher than the CES (Table 2). American Association for Respiratory Care (AARC)<sup>[8]</sup> clinical practice guidelines suggests that the use of closed suction is suggested for adults with high FiO<sub>2</sub>, PEEP, at risk for lung de-recruitment, and for neonates. Hence, it is concluded that closed endotracheal suctioning has better respiratory outcome than the open endotracheal suctioning. The same is supported by the study of Zolfaghari M, et al.(2008)<sup>[9]</sup> to assess the effect of open and closed endotracheal suctioning on vital signs of ICU patients, which showed, Blood pressures and heart rate showed higher increase 2 and 5 minutes after the open method.

Mean and standard deviation of respiratory outcome of each category is noted in both the suctioning systems (Table 3). CES results in lower disturbances in the vital signs than OES. Therefore, to obtain better results upon respiratory outcome, the closed endotracheal suctioning is suggested. In the present study also vital signs were within normal limit in CES (mean 7.27 & SD 1.59) while comparing it to the OES (mean 6.98 & SD 1.73). In the present study, the ventilator settings in CES (mean 5.5 & SD 1.07) were better than the OES (mean 2.28 & SD 0.67). It has been supported by the study conducted by ElMasry A, et al. (2005) to assess the impact of closed endotracheal suctioning system on mechanical ventilator performance with 11 ventilators. Closed suctioning does not cause mechanical ventilator malfunction. However, closed suctioning can decrease end-expiratory pressure during suctioning. Similarly, the signs of infection in OES (mean 6.88 & SD 2.05) were lesser than

the CES (mean 6.13& SD 2.76).CES failed to reduce cross contamination in this study but it is not significantly noted. Many studies have suggested that the closed suction system will increase the process of colonization but it has not been significantly proved in this present study.

**Table 3: Comparison of Mean and Standard Deviation of Respiratory Outcome of Each Category of Mechanically Ventilated Adult Patients with Closed and Open Endotracheal Suctioning**

**N=100**

CATEGORY	DURATION	Closed Endotracheal Suctioning n=50		Open Endotracheal Suctioning n=50		't' Value
		Mean	SD	Mean	SD	
Vital signs	Pre observation	9.23	1.72	9.2	1.58	0.09
	During suction	7.27	1.59	6.98	1.73	0.88
	After 5 minutes	8.78	1.54	8.38	1.70	1.25
	After 15minutes	9.42	1.55	9.06	1.74	1.09
Signs of respiratory distress	Pre observation	9.73	2.36	9.91	2.29	0.39
	During suction	9.35	2.40	8.97	2.40	0.79
	After 5 minutes	9.7	2.41	9.81	2.27	0.23
	After 15 minutes	10.50	2.47	10.83	1.97	0.73
Ventilator settings	Pre observation	8.04	0.99	7.64	1.28	1.73
	During suction	5.5	1.07	2.28	0.67	3.65*
	After 5 minutes	7.92	1.10	7.62	1.29	1.30
	After 15 minutes	8.02	0.99	7.64	1.28	1.65
Signs of Infection	Observation	6.13	2.76	6.88	2.05	1.56

\*\*\*p < 0.001

### Clinical Implications

#### In Nursing Practice

The findings of the study revealed that the mechanically ventilated patients in the intensive care unit are in need of suctioning frequently to maintain the patent airway. The closed and open endotracheal suctioning systems are found to have better respiratory outcome. The best effective strategies of suctioning - preoxygenation and post oxygenation should be mandatory, frequent instillation of distilled/sterile water needs to be avoided, duration of suction should be less than 15sec, must follow a circulatory movement and the suction tubing needs to be cleansed well after the procedure.

With the above mentioned strategies closed endotracheal suctioning is found to be effective. All nurses play a vital role in caring the mechanically ventilated patients. Strategies/policies can be formed for the nurses to follow a better suction system.

**In Nursing Education**

With the emerging health care demands and newer trends in the field of nursing education, we must focus on the innovations to enhance the nursing care. The nursing students should be taught the proper protocol in performing the procedure. Therefore, student nurses should be taught the clinical importance of endotracheal suctioning for maintaining patent airway. Demonstration of proper technique and use of simulation in the clinical setup help the students to acquire an adequate knowledge and incorporate it in their practice.

**In Nursing Administration**

With technological advances and the ever growing challenges of healthcare, administrators have the responsibility to provide continuing nursing education opportunities to understand the intervention in improving the respiratory outcome. This enables the nurses to update their knowledge and to render cost effective care to the public.

**In Nursing Research**

Further studies can be conducted on infection precaution in both interventions. Closed Suction can cause colonization and thus lead to infection. Hence, an extensive study can be conducted to assess the incidence of ventilator associated pneumonia (VAP) in closed and open endotracheal suctioning system among mechanically ventilated adult patients. Researchers must focus on various measures in maintaining patent airway and develop appropriate protocol for attaining early weaning of mechanically ventilated patients and thus, minimizing the complication.

**Conclusion**

The findings of the study revealed that the respiratory outcome is better in closed endotracheal suctioning whereas major variation is noted in the open endotracheal suctioning. Thus, the study concludes that closed endotracheal suctioning is the best method for mechanically ventilated adult patients. Hence, from the present study it is proved that the need for evidence based education is required for nurses to improve their practice competence.

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**Conflict of Interest:** None Declared

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