# Effects of Normal Saline Instillation on Haemodynamic Parameters and Oxygen Saturation after Suctioning of Mechanically Ventilated Patient

Nikita Chauhan[1], Krina Patel[2]

**Abstract**

*When patient is critically ill the function of removal of secretions may be compromised leading to excessive pulmonary secretions. Airway suction is one of the most popular methods of clearing airway secretion. This study aimed to assess effects of normal saline instillation on haemodynamic parameters and oxygen saturation before and after suctioning and to find out the association with demographic variable. Pre-experimental (one group pre-test post-test) study design was used; 52 patients were enrolled using convenient sampling from Intensive Care Units. Observation checklist was used to collect needed data on haemodynamic parameters and oxygen saturation before 5 min and after 5, 10 and 15 min of suctioning. As a part of intervention normal saline was instilled during suctioning. Paired t test values with regard to blood pressure (t=11.41), heart rate (t=1.50), systolic blood pressure (t=8.43) and respiratory rate (t=13.64) were found significant (p<0.05) after suctioning with normal saline. Repeated measures of analysis of variance F test suggest that there was significant difference in respiratory rate (F=10.98) and oxygen saturation (F=62.16) among patients was significant at level p<0.05. Chi-square test concluded that level of consciousness was found significant with level of heart rate and age was significant with systolic blood pressure at p-value <0.05.*

*The study findings revealed that saline instillation should not be used as a routine clinical practice as it increases the heart rate, respiratory rate and systolic blood pressure also there was no change in oxygen saturation.*

**Key words:** Normal saline instillation, Suctioning, Hemodynamic parameters, Oxygen saturation

The Respiratory System is vital to every human being. It is a physiological function that is almost synonymous with being alive and without it, we would cease to live outside of the womb (Hinkle & Cheever, 2016). The respiratory system enhances the gas exchange. Inspiration brings oxygen-rich air into alveoli. The upper airway and lower airway filters and humidify inspired air. Gas exchange between the air and the blood occur in the alveolus. Oxygen diffuses into the blood and carbon dioxide diffuses from the blood into the alveolar air. The large number and surface area of alveoli are necessary to meet both resting and exercise gas exchange requirements (Black & Hawk, 2009).

Critical care is the process of looking after patients who either suffer from life-threatening conditions or are at risk of developing them (Jackson & Cairns 2021). Mechanical ventilation is indicated when the patient's spontaneous ventilation is inadequate to maintain life (Premkumar, 2014). Artificial airway and positive pressure ventilation induce increased production of bronchial secretions because the patient loses the ability to cough while mechanical ventilation, secretions tend to accumulate and obstruct the airway (Black & Hawks, 2009). Airway suctioning is one of the most common methods done in patients with artificial airways. The number of suctions is based on patient needs (Aplhonse, 2017). A patent airway is very important for effective gas exchanges. Airway patency is naturally maintained by the action of the mucocilliary system when the normal amount of mucus is produced by the local immune system and by cough reflex (Mohamed, 2016).

Airway clearance cannot be accomplished via involuntary physiological mechanisms, hence collaborative nursing intervention such as endotracheal suctioning is mandatory to maintain the patient airway (Argent 2009).

*The authors are: 1. Assistant Professor; and 2. MSc Nursing Student, at Shri GH Patel College of Nursing (Bhaikaka University), Gokalnagar Karamsad, Anand (Gujarat).*

Since tracheostomy or endotracheal intubation was first undertaken, potential obstruction of the endotracheal tube by mucus has been a consistent and life-threatening problem. The obvious solution is adequate humidification and suctioning (Mohamed, 2016). ETS is a necessary practice to be carried out in intensive care units. It involves the removal of pulmonary secretions from a patient with an artificial airway in place (Wood, 1998).

As a crucial procedure, if ETS is not performed with correct techniques, it will lead to numerous adverse effects, such as tracheobronchial oedema, ulceration, and denudation of the epithelium (Favretto et al, 2012). These areas of mucosal damage increase the risk of infection and bleeding (Leddy & Wilkinson, 2015). Moreover, ETS is considered an extremely distressing and painful experience for ICU patients (Palak et al, 2004). Study findings showed that ETS performance by well-educated health care professionals based on the best evidence can diminish its side effects (Ansari et al, 2012).

This study on endotracheal or tracheostomy suctioning with normal saline to assess its effect on haemodynamic parameters and oxygen saturation in intubated patients was conducted to assess its effect for better patient care outcome.

## Objectives

- To assess the effects of normal saline instillation on haemodynamic parameters and oxygen saturation before and after suctioning of mechanically ventilated patients
- To find out the association between the effects of normal saline instillation on haemodynamic parameters and oxygen saturation after suctioning with demographic variable

### Hypothesis

H1: There will be significant difference between the pre- and post-test score of suctioning with normal saline instillation on oxygen saturation and haemodynamic parameters.

H2: There will be significant association of suctioning with normal saline instillation on oxygen saturation and haemodynamic parameters with demographic variables.

### Review of Literature

Esmaeili M, Abbasi Z, Shafei Lashkarian M, Sadeghi T (2020) examined the effects of using normal saline and distilled water for tracheal suctioning on the incidence of ventilator-associated pneumonia and hemodynamic indexes. The study was randomised clinical trial conducted from 2017 to 2018 on 60 ventilator-dependent patients in the ICUs of Jafar Sadeg Hospital. Patients were allocated to the intervention and control groups by block random allocation method. The haemodynamic parameters of patients (respiratory rate, heart rate, blood pressure, and $SpO_2$) were recorded in a form 5 minutes before and after the suctioning in each Shift to compare the incidence of VAP and changes in haemodynamic indexes in the two groups. The two groups did not differ from each other significantly (p=0.79) in terms of tracheal culture and incidence of VAP. The results showed that intra-group haemodynamic indexes did not differ significantly before and after the suctioning in normal saline and distilled water groups. The inter-group test showed that two groups only had a significant difference in the level of arterial oxygen saturation after the intervention (p = 0.006). As the level of $SpO_2$ was higher in the normal saline group, it is better to use normal saline as a diluent for pulmonary secretions before tracheal suctioning.

Schults J, Mitchell M L, Cooke M & Schibler A (2018) conducted an integrative review on efficacy and safety of normal saline instillation (NSI) during endotracheal suction in paediatric intensive care unit. The data sources used were Cochrane Library, PROSPERO, the National Health Service Centre for Reviews and Dissemination, PubMed and CINAHL. Data were extracted using a standardised data extraction form. Outcome measures included oxygen saturation (SpO2), serious adverse events and ventilation parameters. Endotracheal suction with NSI was associated with a transient decrease in blood oxygen saturation. In children with obstructive mucous, NSI may have a positive effect. Research protocols did not include interventions to mitigate alveolar de-recruitment. Studies were not powered to detect differences ETT occlusion or VAP.

## Material and Methods

*Research approach and design:* The quantitative approach with pre-experimental research with one group pre- and post-test design was adopted to fulfil the study objective.

*Population and sampling:* A total of 52 samples (only experimental group) were enrolled using non-probability: convenient sampling from Intensive Care who met the inclusion and exclusion criteria.

### Criteria for sample selection

*Inclusion criteria:*

- Patients between the age group of 18 to 68 years
- Patients on mechanical ventilation both tra-

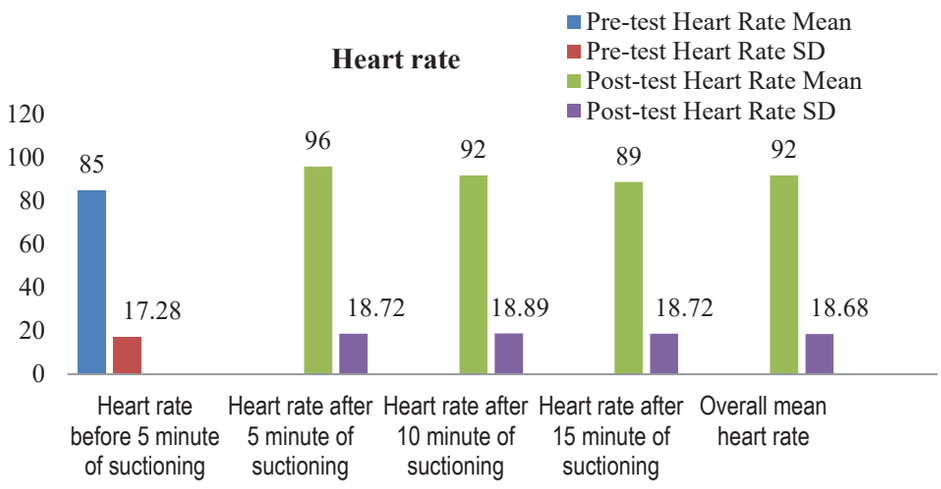


**Figure 1: Pre-test mean and standard deviation of heart rate.**

cheostomised and endotracheal intubated

- Patients after 24 hour of intubation
- Patients who are on weaning mode.

*Exclusion criteria*

- Patients with perceived spine injury
- Patients with tracheo-bronchial anomalies
- Patient with known risk of bleeding disorder
- Nasal intubated patient
- Haemodynamically unstable patient on vasopressor support.

**Table 1: Paired t-test analysis for the significance of pre-test and post-test normal saline instillation on haemodynamic parameters and oxygen saturation before and after suctioning of mechanically ventilated patient.**

| Variables | Pre-test score | | Post-test overall mean | | Enhancement | | Paired t test | p-value table value |
|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | | |
| Heart rate | 85 | 17.28 | 92 | 18.68 | 7 | 4.71 | 11.14** | p<0.05 |
| | | | | | | | S | Sig=0.00 |
| | | | | | | | df= 51 | 2.021 |
| Respiratory rate | 21 | 2.65 | 24 | 1.91 | 3 | 1.5 | 13.42** | p<0.05 |
| | | | | | | | S | Sig=0.00 |
| | | | | | | | df= 51 | 2.021 |
| Systolic blood pressure | 121 | 13.57 | 125 | 13.77 | 4 | 8.43 | 3.141** | p<0.05 |
| | | | | | | | S | Sig=0.03 |
| | | | | | | | df= 51 | 2.021 |
| Diastolic blood pressure | 79 | 7.99 | 80 | 5.63 | 1 | 9.91 | 0.378 | p>0.05 |
| | | | | | | | NS | Sig=0.70 |
| | | | | | | | df= 51 | 2.021 |
| Oxygen saturation rate | 99 | 0.699 | 98 | 0.77 | 1 | 0.86 | 13.64** | p<0.05 |
| | | | | | | | S | Sig=0.00 |
| | | | | | | | df= 51 | 2.021 |

*Ethical consideration:* After getting ethical approval, data collection was done. Informed consent was obtained from all the study participants, first degree relatives, and the researcher emphasised that participation in the study is entirely voluntary, and the confidentiality of their responses was assured.

*Tools:* The data was captured by the tool developed by the researcher and validated by the experts which consisted of 3 parts.

Part A: Demographic variable

Part B: Checklist of suctioning

Part C: Observation checklist for hemodynamic parameters and oxygen saturation

*Data collection procedure*

Data was collected in four phases that is before 5 min of suctioning and after 5, 10 and 15 min of suctioning. Before suctioning pre-test before 5 min instillation of normal saline was observed and haemodynamic parameters and oxygen saturation were monitored and documented in the observation checklist. After that the normal saline was instilled and suctioning was performed. After 5, 10 and 15 min of the suctioning, post-test was under taken and the haemodynamic parameters and oxygen saturation were again monitored and documented in the observation checklist from the monitor.

*Data analysis*

Data was analysed using SPSS software using descriptive and inferential statistics. Descriptive statistic was used for the demographic data and presented in form of percentage frequency and standard deviation. RMANOVA F test and paired t test was used to compare the means of pre-test and post-test. Chi square test was applied for categorical variables

## Results

*Frequency and percentage distribution of demographic variables*

Out of 52 samples, majority were in age group of 58 years and above (n=60, 30.8%), male

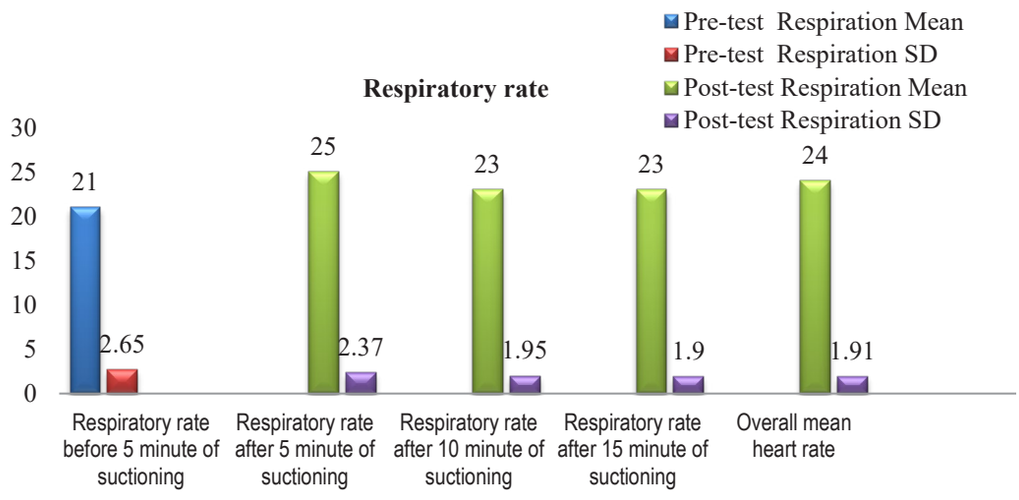


**Figure 2: Pre-test and post-test mean and standard deviation of respiratory rate.**

(n=29, 55.8%), endotracheal intubated (n=39, 75%), having surgical diagnosis (n=26, 50%), not having any pre-morbid condition (n=29, 55.8%), semiconscious (n=27, 51.9%), on volume control and assist control mode (n=27, 51.9%), requiring suction every 4 hourly (n=28, 53.8%), intubated for 4-6 days (n=23, 44.2%).

*Mean and standard deviation of haemodynamic parameters and oxygen saturation*

Table 2 shows the effectiveness of the saline instillation on haemodynamic parameters and oxygen saturation among patients. Repeated measures ANOVA F-test was carried out to find out significant effectiveness. The ANOVA test showed that normal saline instillation is significantly effective on haemodynamic parameters (respiratory rate) and oxygen saturation among patients at the level of $p<0.05$. The obtained 'f' was significant at 0.05 levels.

*Association between haemodynamic parameters and oxygen saturation on normal saline instillation among mechanically ventilated patients with their select demographic variables*

Chi square analysis was carried out to bring association between haemodynamic parameters and oxygen saturation on normal saline instillation with demographic variables. The level of consciousness variable was found significantly associated at p-value <0.05 with level of heart rate. Age variable was found significantly associated at p-value <0.05 with level of systolic blood pressure. As for respiration and demographic variable, there was no significant association. Regarding the association between oxygen saturation and demographic variable, no significant association was found.

## Discussion

According to Abraham Maslow's Hierarchy of Needs, physiological needs are at the first level of needs. Unless one fulfils their physiological needs, one can't address higher needs. The basic needs are air, food, water, and shelter. Among these, oxygen is very important for all living organisms (Black & Hawks, 2009). Hence for this patent airway is necessary. Whenever an artificial airway is inserted the need of suctioning arises (Day et al, 2002). Patients receiving mechanical ventilation require endotracheal intubation to their airway.

**Table 2: Repeated measures ANOVA analysis for the significance of effectiveness in pre-and post-normal saline instillation on haemodynamic parameters and oxygen saturation before and after suctioning of mechanically ventilated patients**

| Variable | Before suctioning | | After suctioning | | | | | | Repeated measures ANOVA F-test |
|---|---|---|---|---|---|---|---|---|---|
| | | | After 5 min | | After 10 min | | After 15 min | | |
| | Mean | SD | Mean | SD | Mean | | Mean | SD | |
| Heart rate | 85 | 17.3 | 96 | 17.29 | 93 | 18.73 | 89 | 18.72 | F=1.979 |
| | | | | | | | | | DF=2 |
| | | | | | | | | | p= 0.142 |
| Respiratory rate | 21 | 2.65 | 25 | 2.38 | 24 | 1.95 | 23 | 1.9 | F=10.98 |
| | | | | | | | | | DF=2 |
| | | | | | | | | | p= 0.00** |
| Systolic blood pressure | 122 | 13.6 | 126 | 18.19 | 124 | 19.85 | 126 | 12.09 | F=0.154 |
| | | | | | | | | | DF=2 |
| | | | | | | | | | p= 0.857 |
| Diastolic blood pressure | 80 | 8 | 82 | 7.8 | 80 | 12 | 80 | 8 | F=1.128 |
| | | | | | | | | | DF=2 |
| | | | | | | | | | p= 0.326 |
| Oxygen saturation rate | 100 | 0.7 | 97 | 1.01 | 98 | 0.85 | 98 | 0.73 | F=62.16 |
| | | | | | | | | | DF=2 |
| | | | | | | | | | p= 0.00** |

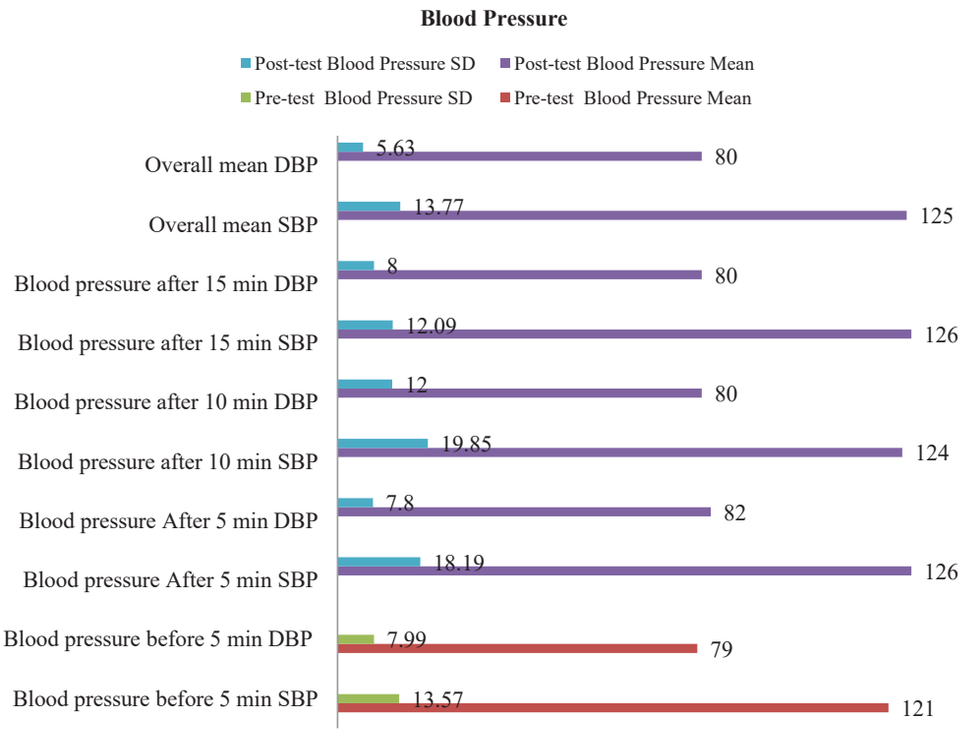


**Figure 3: Pre-test and post-test mean and standard deviation of blood pressure.**

Endotracheal tube causes several problems for the patient, including weakened cough reflex due to the closure of the glottis and more concentrated secretions due to the removal of a part of the upper airway which keeps the air warm and humid (Black & Hawks, 2009). In intensive care units, health care professionals often use normal saline and sodium bicarbonate as mucolytic agents rather than doing plain endotracheal or tracheostomy suctioning.

The study was supported by Wang CH et al (2017) who conducted a systematic review and meta-analysis of randomised controlled trials (RCTs) to evaluate the necessity of NS instillation before suctioning in ICU patient by using PubMed, Embase, Cochrane Library, and Scopus databases and the ClinicalTrials.gov before May 2016. RCTs evaluated the outcome of NS instillation before suctioning in ICU patients undergoing endotracheal intubation or tracheostomy. The primary outcome was oxygen saturation immediately and 2 and 5 min after suctioning. The secondary outcomes were the heart rate and blood pressure after suctioning; 5 RCTs including 337 patients were reviewed. Oxygen saturation was significantly higher in the non-NS group than in the NS group 5 min after suctioning. The pooled mean difference in oxygen saturation was -1.14 (95% confidence interval: -2.25 to -0.03).

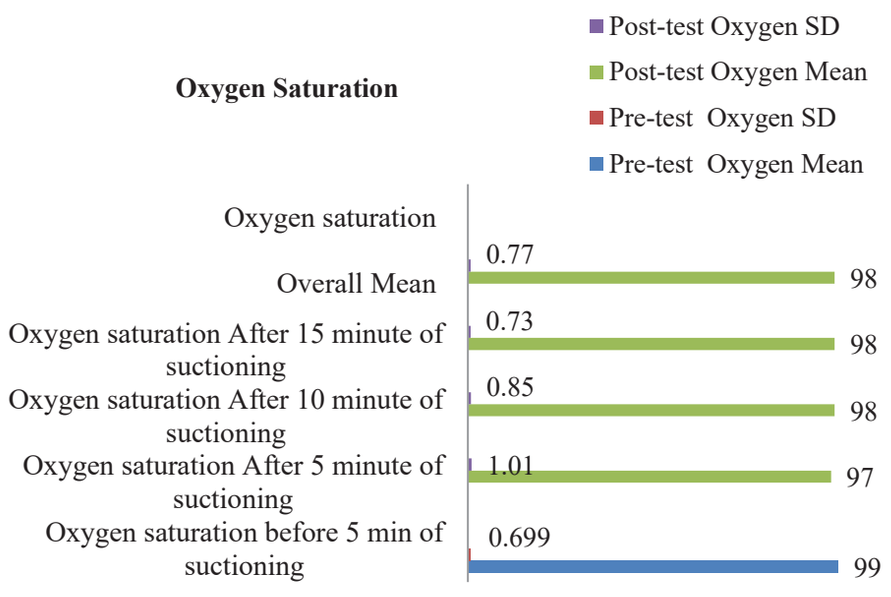


**Figure 4: Pre-test and post-test mean and standard deviation of oxygen saturation.**

In this study majority of participants were of age group 58 years and above and this is because as age increases the mucociliary clearance reduces. In this study normal saline was used as a mucolytic agent to loosen the secretion thus its effects on haemodynamic parameters and oxygen saturation was monitored.

There is a significant difference in haemodynamic parameters oxygen saturation before and after the normal saline instillation. It increases the overall mean and standard deviation of the post-test thus it is not recommended to use normal saline during suctioning as it increases the

haemodynamic parameters and oxygen saturation that remain elevated for about 15 min after suctioning. Similar results were obtained by Ayhan et al (2015), where haemodynamic parameters were increased after suctioning with normal saline and declined after 5 min of suctioning.

Where looking towards to the association with demographic variables level of consciousness variable, it was significantly associated at p-value <0.05 with level of heart rate. Age variable found significantly associated at p-value <0.05 with level of systolic blood pressure.

## Conclusion

The study findings revealed that saline instillation should not be used as a routine clinical practice as it increases the heart rate, respiratory rate and systolic blood pressure; also, there was no change in oxygen saturation noticed. Thus, nurses should consider other interventions to promote secretion clearance include adequate hydration, humidification, chest percussion and vibration.

### Recommendation

Based on the finding of the study (a) comparative study can be done between normal saline endotracheal suctioning and other mucolytic agent can be conducted; and (b) similar study can be conducted in other settings like intensive respiratory care unit, paediatric intensive care unit.

### Nursing Implications

*Nursing practice:* Education programmes can be conducted for the nurses regarding suctioning and practice of suctioning.

*Nursing education:* Educate the nurses that endotracheal suctioning is essential to remove the bronchial secretion and to maintain patent airway in intubated patients; Effective endotracheal suctioning can prevent complication of VAP, airway obstruction and hypoxia.

*Nursing research:* This study helps the nurse researcher to develop insight into new and current modalities in endotracheal suctioning. Nursing administration should take initiative in creation plan and implementation for the continuing education programme to the students and staff nurses regarding suctioning and monitoring the patient.

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