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# Effect of saline instillation on haemodynamic parameters during endotacheal suctioning in patients with pulmonary infections: A randomized controlled trial

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ABSTRACT

Objective: Saline instillation is one of the ways to improve secretion removal during endotracheal suctioning. In the present study we compared the saline instillation to no saline instillation group on haemodynamic parameters. Design: Randomized Controlled trial. Settings: Fifty - bedded mixed intensive care unit of a tertiary care teaching institute. Materials and Methods: The study included sixty mechanically ventilated subjects, diagnosed with pulmonary infections were randomly assigned to saline and no saline group with thirty subjects in each group. Following single session of suctioning procedure, haemodynamic parameters such as oxygen saturation, heart rate, blood pressure, and respiratory rate were measured at baseline, immediate and 1st, 2nd, 3rd, 4th, 5th, 10th, 15th and 30th minutes. Measurements: Two way ANOVA was used to find the difference between two groups. Comparison between groups with respect to baseline data was done by Mann-Whitney U test. Results: Comparison of two groups on oxygen saturation resulted in significant decrease in saline group compared to no saline group ($P<0.05$).The extent of reduction was 98% to 95% with significant drop at 2nd, 3rd and 5th minutes. There was no significant difference between groups on heart rate, blood pressure, and respiratory rate. Conclusion: The present study concludes instillation of saline for secretion removal to be used judicially as it leads to decreased oxygen saturation.

Key words: Endotracheal suctioning, Pulmonary infections, Saline instillation.

## INTRODUCTION

In intensive care unit pulmonary infection is a common clinical problem, it leads to morbidity and mortality of critically ill patients. Airway obstruction in critically ill patients is caused by retained secretion, foreign bodies, and structural changes such as oedema, tumour, or trauma. Retained secretions increase airway resistance and the work of breathing and likely to cause hypoxemia, hypercapnia, atelectasis and infection. Difficulty in clearing secretions may be due to their thickness or to the patient's inability to generate an effective cough. [1]The removal of airway secretions is required for patients in the intensive care setting, because these patients breathe solely through an artificial airway, clearance is essential. Partial or total airway occlusion can lead to several serious physiological abnormalities and even death. [2] Suctioning involves application of negative pressure to the airway through a collecting tube to remove retained secretions. [1]

Endotracheal suctioning is required to maintain a patent airway for optimal ventilation and oxygenation. Additionally, critically ill patients often have too weak a cough to move secretions from the bronchi to the tip of the endotracheal tube. Several techniques intended to enhance the removal of secretions have emerged over the past few years. One such technique is the

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routine instillation of normal saline during endotracheal suctioning which has been a widespread practice in intensive care units. [3]

There are two system of suctioning, open and closed. Open-system suctioning, by definition, requires the patient to be disconnected completely from the ventilator circuit; therefore, oxygen, humidity and positive end expiratory pressure (PEEP) are not delivered during suctioning. Opening of the ventilator circuit leads to opportunity for contamination with pulmonary secretions to patient. But in closed-suctioning ventilator is not disconnected, therefore oxygen, humidity and PEEP are delivered during suctioning, also exposure to the patient's secretions is minimal. The closed suctioning allows hyperventilation and hyper oxygenation because the patient remains connected to the ventilator. Still evidence lacks in use of closed suction system prevent infection in intensive care unit. [2]

Earlier studies have been performed in closed suctioning system which had adverse effect on hemodynamic parameters. [4, 5, 6] One study on effect of saline instillation during open suctioning resulted in significant reduction in mixed venous oxygen saturation. [7]Two studies didn't describe the method of suctioning procedure. [8, 9, 10] Since open suctioning is commonly used in our intensive care unit, effect of saline instillation need to be studied. Study on saline instillation before tracheal suctioning on the incidence of ventilator associated pneumonia concluded that saline instillation group had decreased incidence of ventilator associated pneumonia. [11] Recent systematic review on efficacy and safety of normal saline instillation has concluded that there is little evidence of benefit and minimal evidence of safety risk. [12] There is conflicting literature regarding the usage of saline instillation during suctioning procedure. There is a need to further investigate the effect of saline instillation during suctioning procedure.

So aim of the study is to find effect of isotonic saline instillation on haemodynamic parameters such as oxygen saturation, heart rate, blood pressure and respiratory rate in mechanically ventilated patients with pulmonary infections.

## MATERIALS AND METHODS

The study design was randomized controlled trial conducted at a tertiary care hospital. The total number of patients recruited for this study was 60 (30 in saline group and 30 in no saline group). Ethical committee clearance was obtained from the institutional ethical committee. Patients on mechanical ventilator with age greater than 18 years, diagnosed with pulmonary infection were included in the study. Pulmonary infection is defined as change in the amount, color and consistency of sputum ;growth of infectious organisms on sputum cultures; evidence of infiltrates on chest radiographs; a white blood cell count of 12000 / $mm^3$ or less; and body temperature of 39$^{o}$c or higher. [5]

Patients were excluded if they have unstable parameters (heart rate, blood pressure, respiratory rate, oxygen saturation). A written informed consent was taken from the patients, his or her proxy. The patients were selected as per the inclusion criteria. Patients were randomly assigned into two groups, saline group and no saline group using block randomization. Baseline characteristics such as age, gender and diagnosis were recorded. Further Murray Lung Injury score and clinical pulmonary infection score were recorded for severity of the disease. Baseline haemodynamic parameters such as oxygen saturation, heart rate, blood pressure, and respiratory rate of both saline group and no saline group were noted before suctioning procedure.

Pre-oxygenation by the delivery of 100% oxygen for at least 30 s prior to and after the suctioning procedure. Ambu of five breaths was used for hyper oxygenation before suctioning. In saline group, isotonic saline of approximately 5ml has been instilled before inserting suction catheter into the endotracheal tube. Suction pressure of 150mmHg for 15sec was used with intermittent ambu for 10 secs. This sequence was carried until

the airway was clear as clinically indicated with minimal frequency.

Hemodynamic parameters (oxygen saturations, heart rate, blood pressure, and respiratory rate) , was noted at baseline , immediate and $1^{st}$ , $2^{nd}$ ,$3^{rd}$ ,$4^{th}$ ,$5^{th}$ ,$10^{th}$ ,$15^{th}$ and $30^{th}$ minutes for both the groups.

## RESULTS

The observation from the study were recorded and analized. Base line variables such as age, gender and diagnosis is demonstrated in table 1. Murray lung injury score and Clinical pulmonary infection score between saline and no saline group were analized using Mann-Whitney U test, which showed no significant difference between two group as shown in table 2 and 3 respectively. Comparison of heart rate ,respiratory rate, systolic blood pressure and diastolic blood pressure between two groups was performed at base line, immediate ,$1^{st}$ min,$2^{nd}$,$3^{rd}$,$4^{th}$,$5^{th}$,$10^{th}$ ,$15^{th}$ and $30^{th}$ minutes with two way ANOVA is shown in table 4,5,6 and 7 respectively. It showed statistically insignificant difference ($P>0.05$). Figure 1,2,3,4 shows trends of change in haemodynamic measures between groups. Comparison of oxygen saturation between groups resulted in significant decrease in saline group compared to no saline group ($P<0.05$) as shown in table 8. Figure 5 shows trends in change between groups on oxygen saturation. Significant drop in oxygen saturation was observed from baseline 98.70 ± 1.95 to $2^{nd}$ minute 94.80 ± 3.21 and it reached baseline at $30^{th}$ minute 98.40 ± 1.58.

## DISCUSSION

In this study instillation of saline has a

Table 1. Baseline characteristics

| Characteristics | | Saline | No saline |
|---|---|---|---|
| Age in years (Mean± SD) | | 55±17 | 55±13 |
| Gender | Male | 21 | 22 |
| | Female | 9 | 8 |
| Diagnosis | ARDS | 5 | 5 |
| | COPD | 6 | 5 |
| | Asthma | 3 | 0 |
| | Congestive Cardiac Failure | 2 | 4 |
| | Abdominal surgery | 3 | 4 |
| | Cardiac surgery | 1 | 0 |
| | Thoracic surgery | 1 | 0 |
| | Head injury | 0 | 2 |
| | Stroke | 4 | 7 |
| | Renal failure | 5 | 3 |

ARDS: Acute respiratory distress syndrome, COPD: Chronic obstructive pulmonary disease

Table 2. Murray lung injury score

| | | Mean± SD | T value | P value |
|---|---|---|---|---|
| Murray lung injury score | Saline | 1.66±0.23 | .620 | .538 |
| | No saline | 1.70±0.27 | | |

Table 3. Clinical pulmonary infection score

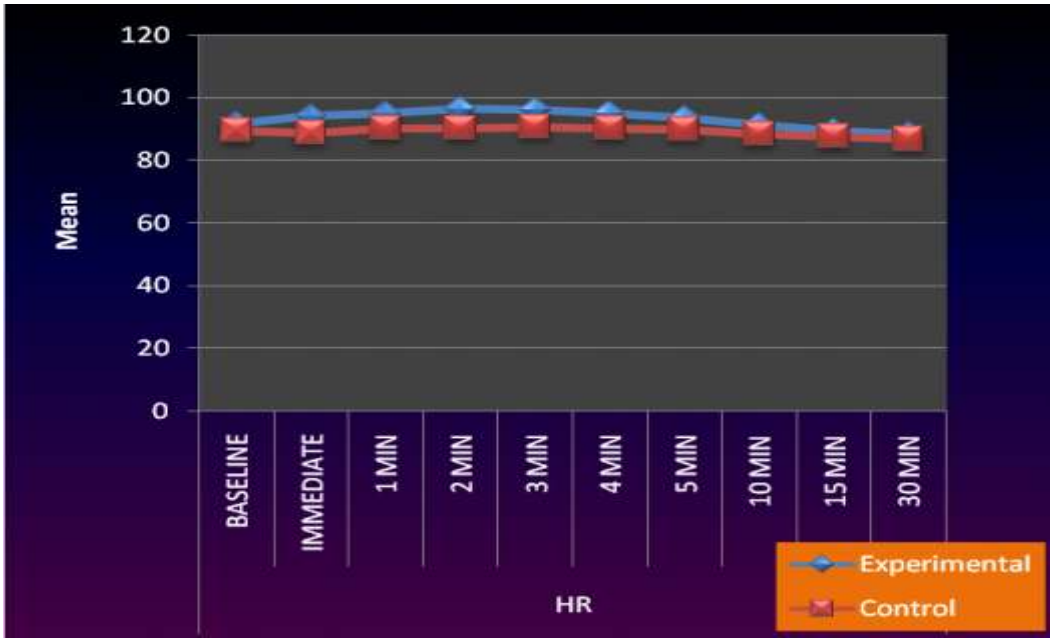
| | | Mean± SD | T value | P value |
|---|---|---|---|---|
| Clinical Pulmonary Infection Score | Saline | 5.20±1.157 | -1.010 | .317 |
| | No saline | 4.93±.868 | | |

Table 4: Between group comparison of heart rate (HR) for saline & no saline group

| HR | | BL | IM | 1min | 2min | 3min | 4min | 5min | 10min | 15min | 30min | F value | P value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saline | Mean ± SD | 91.73 ±14.58 | 94.13 ±13.14 | 95.13 ±13.14 | 96.47 ±13.64 | 96.27 ±12.75 | 95.10 ±11.31 | 93.53 ±12.03 | 91.30 ±11.83 | 89.40 ±11.94 | 88.43 ±12.17 | 1.814 | 0.063 |
| No saline | Mean ± SD | 89.50 ± 13.88 | 88.80± 11.19 | 90.43 ± 11.42 | 90.43 ±11.10 | 90.73 ±10.58 | 90.47 ±11.06 | 89.90 ±10.92 | 88.40 ±13.19 | 87.63 ±12.86 | 86.80 ±12.71 | | |

p<0.05, BL - baseline, IM – immediate

Figure 1. Between group comparison of heart rate for saline & no saline group



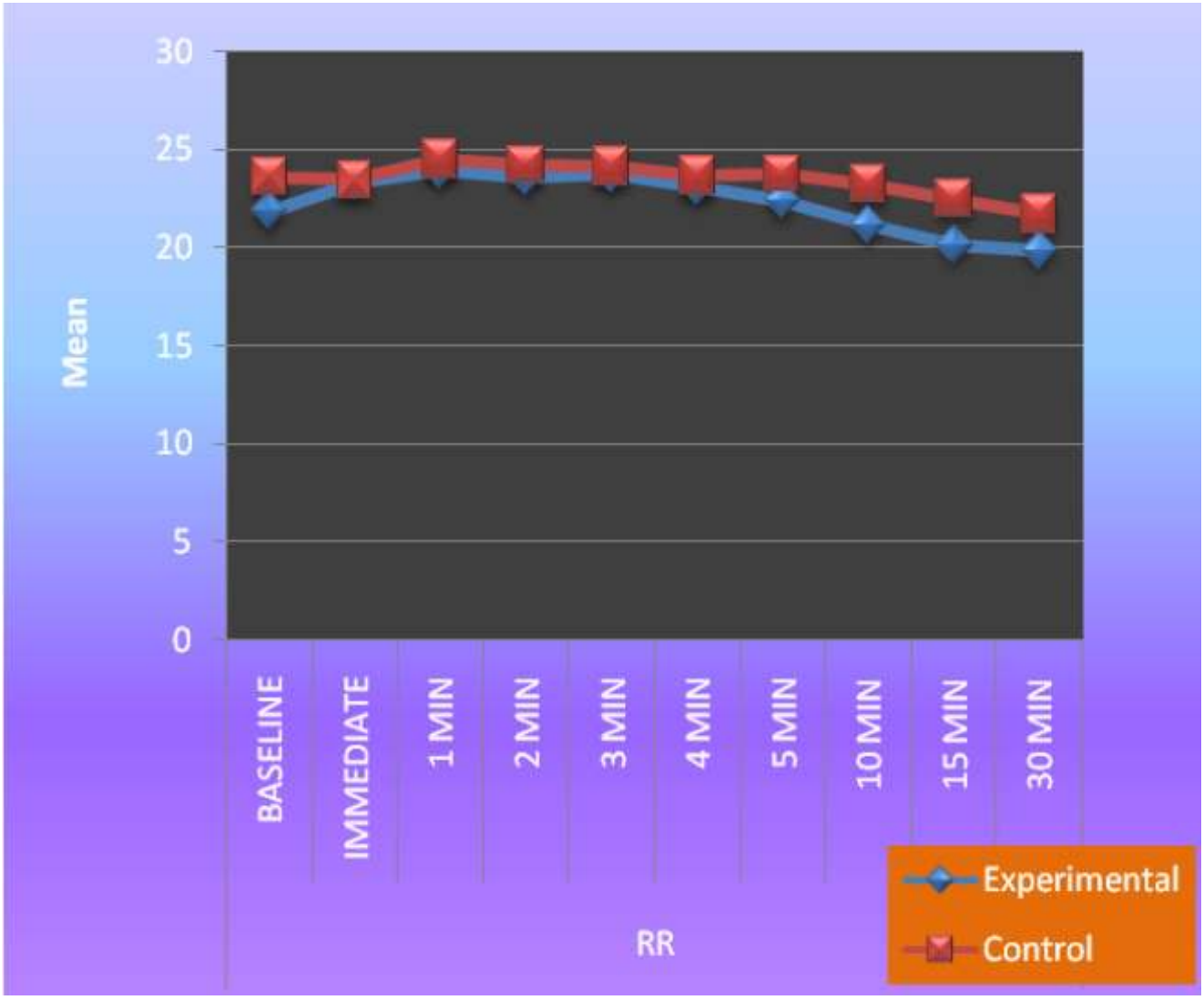

HR : Heart rate

Table 5. Between group comparison of respiratory rate (RR) for saline & no saline group

| RR | | BL | IM | 1min | 2min | 3min | 4min | 5min | 10min | 15min | 30min | F value | P value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saline | Mean ± SD | 21.87 ±5.07 | 23.33 ± 5.61 | 23.97 ±5.42 | 23.63 ±6.20 | 23.77 ±5.45 | 23.10 ±4.55 | 22.40 ±4.60 | 21.17 ±3.48 | 20.13 ±3.23 | 19.87 ±3.67 | 1.814 | 0.063 |
| No saline | Mean ± SD | 23.60 ±3.56 | 23.43 ±4.96 | 24.50 ±4.96 | 24.23 ±5.33 | 24.13 ±5.31 | 23.67 ±5.37 | 23.77 ±5.53 | 23.23 ±5.94 | 22.47 ±5.68 | 21.70 ±5.57 | | |

$p<0.05$, BL - baseline, IM immediate

Figure 2. Between group comparison of respiratory rate for saline & no saline group



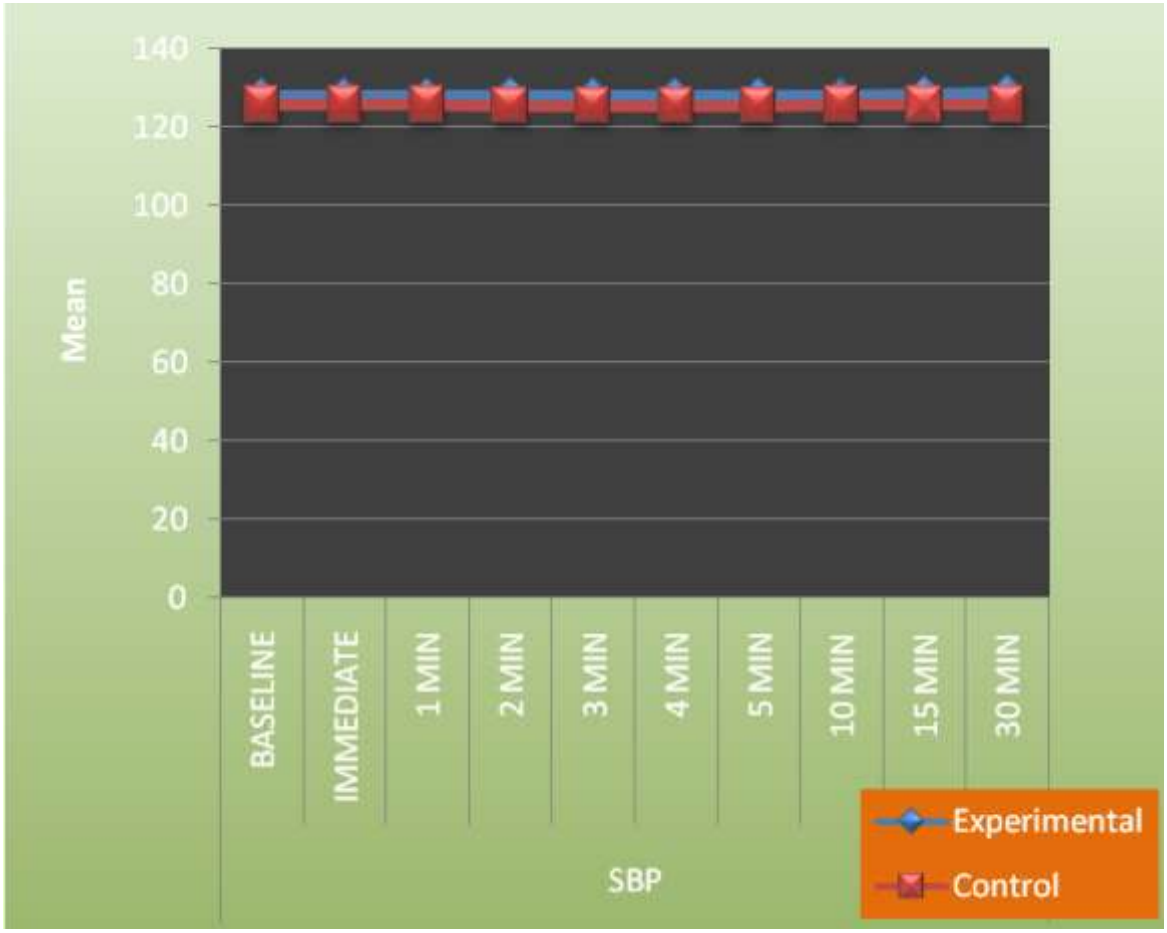

RR: Respiratory rate

Table 6. Between group comparison of systolic blood pressure (SBP) for saline & no saline group

| SBP | | BL | IM | 1min | 2min | 3min | 4min | 5min | 10min | 15min | 30min | F value | P value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saline | Mean ± SD | 128.00 ±12.97 | 129.00 ±13.72 | 129.23 ± 13.88 | 129.20 ± 13.78 | 128.80± 13.67 | 128.60± 12.97 | 128.45 ±12.90 | 128.40 ±12.90 | 128.33 ±12.88 | 128.67 ±12.79 | 0.611 | 0.788 |
| No saline | Mean ± SD | 125.67 ±13.04 | 126.83 ±13.25 | 126.80 ±13.20 | 126.78 ±13.33 | 125.90 ±13.02 | 125.85 ±13.30 | 125.70 ±13.62 | 125.67 ±13.09 | 125.67 ±13.99 | 125.67 ±13.39 | | |

p<0.05, BL - baseline, IM immediate

Figure 3. Between group comparison of systolic blood pressure for saline & no saline group



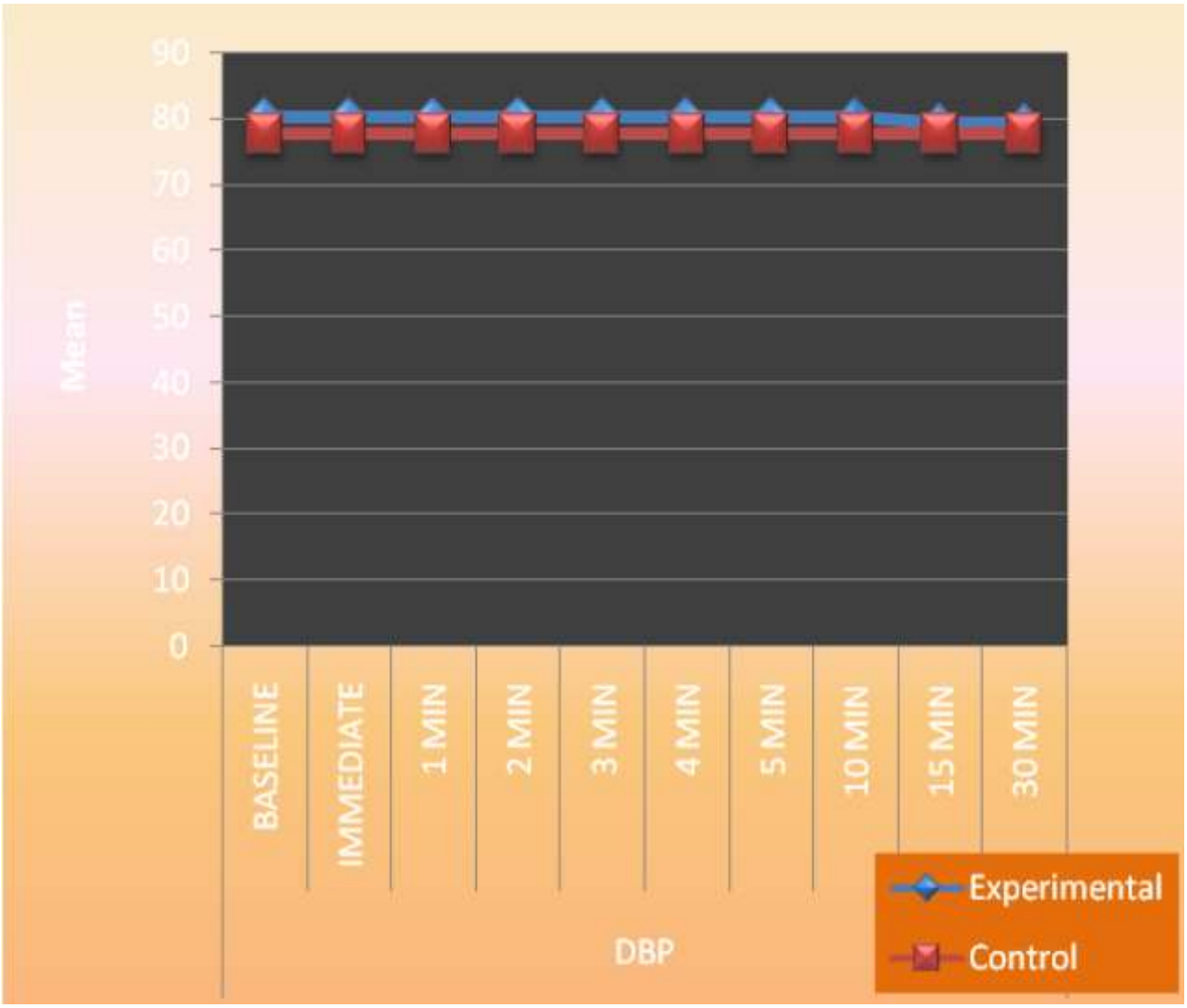

SBP: Systolic blood pressure

Table 7. Between group comparison of diastolic blood pressure (DBP) for saline & no saline group

| DBP | | BL | IM | 1min | 2min | 3min | 4min | 5min | 10min | 15min | 30min | F value | P value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saline | Mean ± SD | 80.33 ±7.18 | 81.70 ±7.84 | 81.67 ±7.77 | 81.56 ±7.81 | 81.58 ±7.56 | 80.79 ±7.44 | 80.58 ±7.10 | 80.17 ±7.84 | 79.33 ±6.97 | 79.33 ±6.39 | 1.715 | 0.61 |
| No saline | Mean ± SD | 77.67 ±8.17 | 78.67 ±8.92 | 78.55 ±8.72 | 78.70 ±8.01 | 78.38 ±8.19 | 78.67 ±8.14 | 77.67 ±8.03 | 77.55 ±8.38 | 77.38 ±8.72 | 77.25 ±8.28 | | |

p<0.05, BL - baseline, IM immediate

Figure 4. Between group comparison of diastolic blood pressure for saline & no saline group




DBP : Diastolic blood pressure

Table 8. Between group comparison of oxygen saturation (OS) for saline & no saline group

| OS | | BL | IM | 1min | 2min | 3min | 4min | 5min | 10min | 15min | 30min | F value | P value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saline | Mean ± SD | 98.70 ±1.95 | 96.10 ±3.06 | 95.30 ±3.62 | 94.80 ±3.21 | 95.37 ±3.55 | 96.13 ±3.61 | 96.77 ±2.81 | 97.70 ±2.49 | 98.10 ±2.04 | 98.40 ±1.58 | 2.241 | 0.018 * |
| No saline | Mean ± SD | 97.27 ±3.61 | 96.17 ±3.56 | 95.70 ±5.01 | 96.27 ±4.33 | 96.43 ±4.27 | 96.80 ±4.21 | 97.50 ±3.09 | 97.93 ±2.59 | 97.83 ±2.75 | 98.07 ±2.23 | | |

* indicates p <0.05, BL - baseline, IM immediate

Figure 5. Between group comparison of oxygen saturation for saline & no saline group


SpO2: Saturated oxygen

detrimental effect on oxygen saturation. Study subjects comprised of patients with pulmonary infections who were incubated and receiving mechanical ventilation. The severity of lung disease was scored with Murray lung injury score which showed mild to moderate lung injury. The Clinical pulmonary infection score for both groups showed low to intermediate infection.

Heart rate was increased in saline instillation group, but it was statistically insignificant. The other parameters such as respiratory rate and blood pressure between the two groups were not significant.

Oxygen saturation decreased in both groups. However, oxygen saturation for the group who had instillation of normal saline decreased markedly following suctioning. Differences in oxygen saturation between the two groups were highly significant at $2^{nd}$, $3^{rd}$, and $5^{th}$ minutes post suctioning. Saturation began to decrease at 1minute post suctioning and returned to baseline at 30minutes whereas without saline group reached the base line at 5minutes following suctioning. The reason for the adverse effect of oxygen saturation may be due to movement of the mucous to the periphery of the lung along with the saline. Instillation of saline was followed by manual hyperinflation. In these circumstances, the flow of air into the lungs is accelerated, which is likely to transports these secretions down the bronchial tree. As a result removal of secretions may be difficult with suction catheter.[5] This leads to accumulation of secretion in the lower airways and can interfere in gaseous exchange leading to drop in oxygen saturation.[13]

The extent of drop in saturation in this study was 3% from 98% to 95%. According to oxy hemoglobin curve, oxygen saturation is relatively stable above 80%. In this study, drop of 3% saturation within 90% to 100% of oxygen saturation may not be clinically significant. Still future studies are required to know the effect of saline instillation with oxygen saturation below 80%.

Earlier studies on hemodynamic changes in closed suction following saline instillation, concluded instillation of saline before suctioning had an adverse effect on oxygenation, [3, 5] but there was no change in heart rate, respiratory rate, and blood pressure.[5] In our study only 2ml of saline was instilled to 50% of the study population, since patients started coughing after saline instillation. The number of suctioning passes were not controlled since termination criteria was depended upon the clinical findings, once the airway was patent suction was stopped for all the subjects.

## CONCLUSION

The present study concludes instillation of saline for secretion removal to be used judicially as it leads to decreased oxygen saturation.

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