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Instillation of Normal Saline before Suctioning in Patients with Pneumonia

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This study was conducted to investigate the effects of a no saline, a 2 ml and a 5 ml saline instillation prior to endotracheal suctioning on oxygen saturation in patients with pneumonia. The subjects in this study were 16 pneumonic patients with a tracheotomy tube, who had been admitted to the neuro-surgical intensive care unit at a university hospital in Seoul Korea. All three (0, 2 and 5 ml) saline instillation methods were applied to the 16 patients. The methods were randomly assigned to each patient. Each of the instillation methods was applied in a four-step sequence: 1) recording the level of oxygen saturation (baseline levels), 2) instilling normal saline, 3) supplying oxygen and suctioning, and 4) recording the level of oxygen saturation. The oxygen saturation was evaluated using pulse oximetry.

The recovery times for oxygen saturation to return to baseline levels following suctioning were, just after suctioning, 45seconds after suctioning and in excess of 5 minutes with 0, 2 and 5 ml saline instillations, respectively.

Instillation of normal saline before suctioning could have an adverse effect on oxygen saturation, and should be used carefully as a routine intervention in patients who have pneumonia.

Key Words: Normal saline instillation, suctioning, oxygen saturation, pneumonia.

INTRODUCTION

Instillation of normal saline prior to suction in patients with an artificial airway is a traditional nursing intervention. Lacking empirical evidence to support this practice, nurses may arbitrary decide when instillation of saline is appropriate. Nurses routinely instill 3 - 10 ml of normal saline solution into the airway prior to suction to loosen secretions, lubricate the suction catheter and increase secretion clearance.[1] Generally, 5 or 10 ml of normal saline solution is used prior to suction.[1-8] Research on the instillation of normal saline for oxygenation in intubated patients, or those receiving mechanical ventilation, has been inconclusive. Of these, Ackerman's study demonstrated possible adverse effects of a 5 ml bolus of normal saline solution instillation on oxygen saturation levels of critically ill male patients in a medical ICU, surgical ICU or coronary care unit. These patients required a tracheal or endotracheal tube and mechanical ventilation.[1] This study demonstrated decreased oxygen saturation, as a result of a saline bolus instillation, at 2, 3, 4, and 5 minutes after instillation. These results indicated that instilling saline prior to suction had an adverse effect on oxygen saturation.

Ackerman et al. reported that patients with a pulmonary infection, the decreased oxygen saturation, occurring immediately after suction, was greater in patients having a 5 ml bolus of normal saline than in those that did not,[6] but the limitation of these studies include the deficiencies in the various normal saline instillation amount.

In our study, we investigated the effects of no, 2, and 5 ml saline instillations prior to endotracheal suctioning on oxygenation in patients with pneumonia.

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MATERIALS AND METHODS

Research design

A repeated-measure design was used to allow subjects to serve as their own controls.

Subjects

The subjects of this study were 21 patients with a tracheotomy tube, who were admitted, between September 1999 and February 2000, to a neuro-surgical intensive care unit at a university hospital in Seoul, Korea. Of the 21 subjects enrolled, 16 completed the study. One subject was dropped due to loss of data during data collection, and 4 were excluded due to non-pneumonic conditions. Patient with a disease, tracheobronchial anomaly or trauma, or a prior pulmonary condition requiring medical or surgical treatment, were excluded from this study.

Selected sample characteristics are presented in Table 1. The ages of the subjects range from 37 to 80, with a mean of 65.1 years. Of the 16 patients completing the study, 4 (25.00%) had intra-cranial hemorrhages, 5 (31.25%) had brain tumors, 5 (31.25%) had cerebral aneurysms, and 2 (12.50%) had a hydrocephalus. Pneumonia was diagnosed from the subject's medical record.

Instruments

A component monitoring system (M78338A Hewlett Packard, Germany, Boeblingen), with a pulse oximetry transducer, was used to monitor for oxygen saturation.

Table 1. Characteristics of Subjects (N=16)

Characteristics		N(%)
Age(years)	37 - 49	1 (6.25)
	50 - 59	4 (25.00)
	60 - 69	5 (31.25)
	70 - 80	6 (37.50)
Gender	Male	8 (50.00)
	Female	8 (50.00)
Diagnosis	Intracranial hemorrhage	4 (25.00)
	Brain tumor	5 (31.25)
	Cerebral aneurysm	5 (31.25)
	Hydrocephalus	2 (12.50)
Hospital duration(days)	5 - 10	1 (6.25)
	11 - 20	6 (37.50)
	20 - 30	5 (31.25)
	30 - 122	4 (25.00)
Intubation period(days)	2 - 10	6 (37.50)
	11 - 20	7 (43.75)
	20 - 30	3 (18.75)
Tracheotomy tube size (inner diameter: mm)	7.0	3 (18.75)
	7.5	10 (62.50)
	8.0	2 (12.50)
	9.0	1 (6.25)
O_2 supply volume (liter/min)	0	1 (6.25)
	2	5 (31.25)
	3	7 (43.75)
	5	3 (18.75)

Procedures

This study was approved by the review board of the Catholic Medical Center in Seoul, Korea. Data was collected by a master student in nursing, who functioned as a research assistant. The investigators discussed the methodology with the staff nurse caring for a patient at the time of the data collection. The staff nurse was instructed not to suction the patient during the period of investigation unless the nurse felt that it was required, in which case the patient was dropped from the study. No other limitations regarding the nursing care of these patients was requested.

All three (0, 2 and 5 ml) saline instillation methods were applied to the 16 patients, and were randomly assigned to patients: 1) no normal saline instilled before suctioning; 2) 2 ml of normal saline instilled into the endotracheal tube before suctioning; and 3) 5 ml of normal saline instilled into the endotracheal tube before suctioning. For each of the selected methods the procedure applied composed of a four-step sequence: 1) recording the level of oxygen saturation (baseline levels), 2) instilling normal saline, 3) supplying oxygen and suctioning, and 4) recording the level of oxygen saturation ($PostSaO_2$). Instillations were performed in the following sequence: firstly, the baseline oxygen saturation levels were recorded at 15 second intervals for one minute (4 times) prior to saline instillation; this was followed by the saline instillation. The oxygen was supplied, and suctioning performed in the following sequence: 1) supplying oxygen for 15 seconds, 2) endotracheal suctioning at 170mmHg for 10 seconds, 3) supplying oxygen for 15 seconds, 4) endotracheal suctioning for a further 10 seconds, 5) supplying oxygen for 15 seconds and 6) oral suctioning for 10 seconds. For the last step, the level of $PostSaO_2$ was measured and recorded immediately after, and at 15, 30, 45 seconds, and then at 1, 2, 3, 4, and 5 minutes (9 times) (Fig. 1).

After finishing the procedure, patients rested for 80 minutes. Another saline instillation method was then randomly assigned to each patient, and the whole procedure repeated, and the patient rested for a further 80 minutes. Finally, a last saline instillation method was performed on the

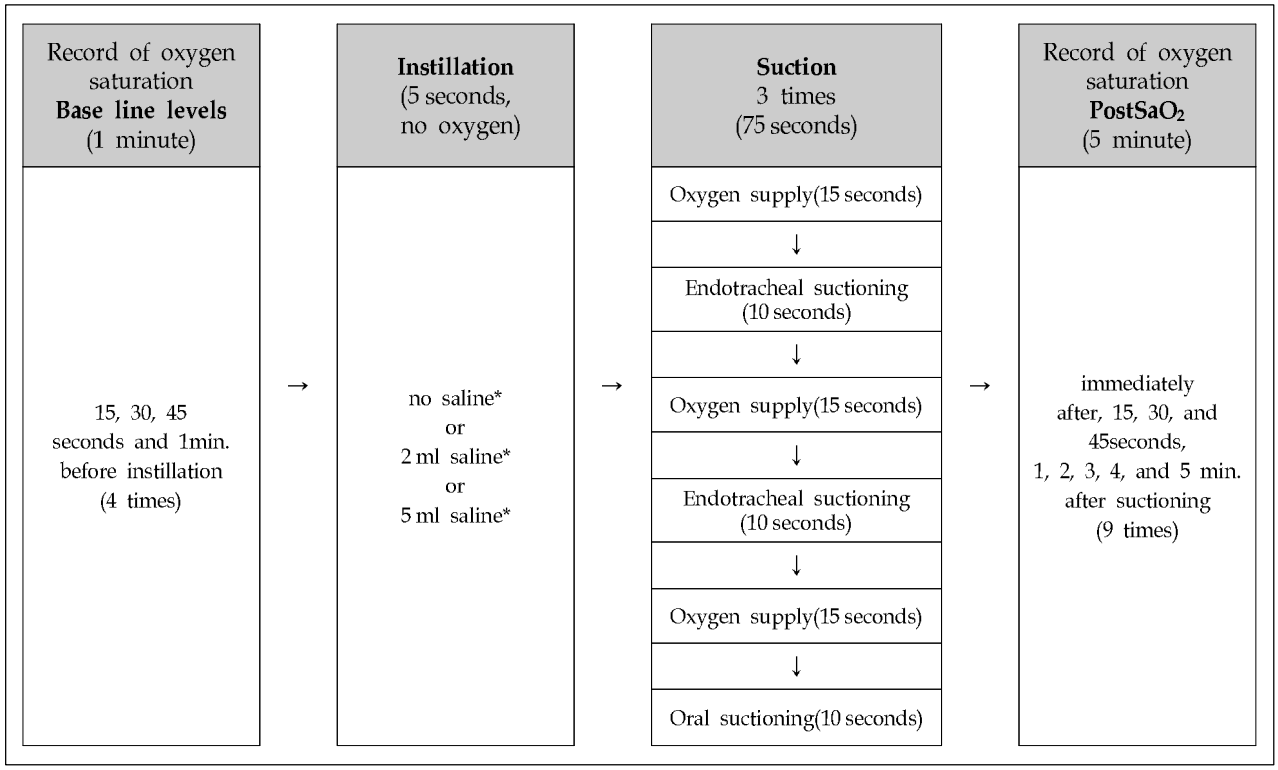

Fig. 1. Sequence of events for instillation, suction, and record of oxygen saturation for 7 minutes and 20 seconds. *Saline amount was randomly assigned

patient. The complete procedure took 4 hours 22 minutes, including the rest periods (Fig. 2). No oxygen was supplied during the saline instillations, and no hyperinflation or hyperventilation were applied during the investigation.

Data analysis

All Data is presented as means ± SD. Statistical analyses were conducted using SAS for Windows. Repeated-measures analysis of variance (ANOVA) was used to determine the difference between baseline values and values obtained after suctioning for oxygen saturation. When a significant difference was found by repeated-measures ANOVA, paired t-tests, with Bonferroni correction, was applied to identify specific differences.

RESULTS

The oxygen saturation values significantly differed, with the various saline volumes (p-value =.02), and the times to oxygen saturation recorded (p-value=.0006) with the patients, but there was interaction between saline volume and suction time (p-value=.002).

The recovery time for oxygen saturation to return to baseline levels following suctioning was; just after suctioning, 45 seconds and no return of the oxygen saturation to baseline levels at 5 minutes following suctioning, for 0, 2 and 5 ml saline instillations, with p-values=0.54, 0.06 and 0.003, respectively (Table 2).

DISCUSSION

The purpose of endotracheal suctioning is to clear secretions from the airway to maintain a patent airway and to optimize ventilation and oxygenation. Reasons for saline instillation include: enhancing cough stimulation, mobilizing secretions and dilution of secretions.[9] However,

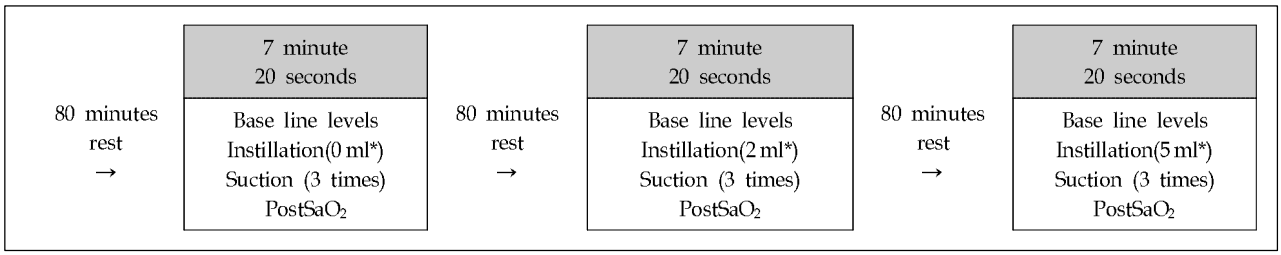

Fig. 2. Time Sequence of events for rest, instillation and suction. *Saline amount was randomly assigned

Table 2. Oxygen Saturation Among Endotracheal Saline Volumes at Each Time with Pneumonia Patients (N=16)

Saline volume	Time of oxygen saturation record										
	Base-line	Immediately after	15 sec	30 sec	45 sec	1 min	2 min	3 min	4 min	5 min	F (p)
0 ml	98.06	97.56	97.50	97.31	97.47	97.63	97.69	98.06	97.91	98.09	Saline volume
	(1.51)	(1.74)	(1.88)	(2.29)	(1.79)	(1.82)	(1.61)	(1.62)	(1.68)	(1.55)	4.23 (0.02)
2 ml	98.01	96.69[a]	96.72	96.88[a]	96.75	97.16	97.03	97.22	97.53	97.78	Time
	(1.70)	(2.17)	(2.76)	(2.22)	(2.14)	(2.13)	(2.1)	(1.95)	(2.05)	(2.02)	6.44 (0.0006)
5 ml	98.38	96.91[b]	96.53[b]	96.56[b]	96.38[b]	96.63[b]	96.03[b]	96.38[b]	96.69[b]	96.56[b]	Saline volume
	(1.42)	(1.82)	(2.09)	(1.95)	(2.00)	(1.98)	(2.15)	(2.04)	(1.92)	(1.94)	*Time 3.55 (0.002)

Data are Mean(SD).
All three (0, 2 and 5 ml) saline instillation methods were applied to 16 patients.
[a]Significantly difference with 2 ml baseline 98.01% ($p<0.05$).
[b]Significantly difference with 5 ml baseline 98.38% ($p<0.05$).

suctioning has been associated with potentially serious and life-threatening complications, such as hypoxemia, cardiac dysrhythmia, cardiac arrest, respiratory arrest, bronchospasm, increased bronchial mucous production, hypertension, vagal stimulation, increased intracranial pressure, atelectasis, damage to tracheo-bronchial mucosa, pulmonary hemorrhage, patient anxiety and fear, nosocomial infection and death.[9,10] In order to minimize complications, and maximize outcomes, much more research is required on the effects of normal saline instillation in intubated patients or those receiving mechanical ventilation.

In this study we used a repeated-measure design to determine if the use of saline instilled down a patient's tracheotomy tube had an effect on oxygen saturation values. We selected 16 critically ill pneumonic patients in the neurosurgical intensive care unit. Our results show that the recovery times for oxygen saturation to return to baseline levels, following suctioning, were just after suctioning, 45 seconds and in excess of 5 minutes in the cases of 0, 2 and 5 ml saline instillations in the pneumonic patients. This result is in accordance with the data from Bostick and Wendelgass who examined the relationship between normal saline solution instillation, and oxygenation, in 45 post open-heart adult patients.[9] Each patient was randomly assigned to one of three groups (no, 5 ml and 10 ml saline). In their study, the PaO_2 was measured 5 minutes prior to suctioning, and 20 minutes following. No statistically significant differences in mean PaO_2 values were found between the saline and non-saline groups. However, the trend was toward lower $PaOS_2$ with larger volumes of saline instillation, and the researchers concluded the decrease might be the result of instilled normal saline impeding the alveolar-capillary oxygen exchange. Ackerman and Gugerty used a single-case experimental design to determine if the use of saline instilled down a patient's tracheotomy, or endotracheal tube, had an effect on the amount of aspirated sputum and/or SaO_2 values.[2] They selected 26 patients based on the established criterion of the patient having an endotracheal or tracheotomy tube. They found that the oxygen saturation, in the group receiving saline, was lower at 45 seconds through to 5 minutes. Ackerman used a quasi-experimental, single, counter-balanced design to study 40 men requiring suctioning.[1] Ackerman used 5 ml saline with every other suctioning procedure, and measured the O_2 saturation immediately before and after the procedure, and at 1-minute intervals up to 5 minutes. The indications from these results was that the use of saline had a significant effect on O_2 saturation, which worsened at 2, 3, 4 and 5 minutes following instillation and suctioning. Ackerman and Mick also reported a greater decrease in O_2 saturation immediately after suctioning in patients receiving instillation of a 5 ml bolus of normal saline than in those who did not.[6] They also reported that in those patients with pulmonary infections, receiving instillation of a 5 ml bolus of normal saline, the O_2 saturation had not returned to baseline values 10 minutes after suctioning.

In contrast, Gray et al. examined the physiologic responses of heart rate, blood pressure, respiratory rate, PH, PCO_2, POS_2, O_2 saturation, peak inspiratory pressure, minute ventilation , amount of material suctioned, and degree of discomfort, with and without saline.[3] They used a repeated-measure design, involving 15 critically ill patients, randomly suctioned, once with normal saline solution, and once without, over a 90-minute period. The researchers assessed hemodynamics, gas exchange and respiratory mechanics before, and 15 minutes after, each method. There was no statistically significant difference in heart rate, BP, respiratory rate or arterial blood gases between the two treatment methods immediately, or 15 minutes, after suctioning.

In the evaluated 4 non-pneumonic patients evaluated in this study, their oxygen saturation values did not differ significantly with the various saline volumes, or with time.

In conclusion, our finding confirms that instillation of normal saline before suctioning could have an adverse effect on O_2 saturation, and should be used with care as a routine intervention in patients with pneumonia.

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