The effect of cough-assist on the hemodynamic status and oxygenation of arterial blood in patients admitted to intensive care units

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ABSTRACT

Background: Many patients need critical care. The effect of cough on the excretion of respiratory secretions implies that coughing may be more helpful than lung physiotherapy and other breathing exercises. We aimed to determine the effect of cough-assist device on the hemodynamic status and arterial oxygenation in patients admitted to the critical care unit.

Methods: This experimental study was done on 50 eligible patients admitted to the intensive care unit of Imam Khomeini Hospital, Urmia, North-West Iran. The patients were selected randomly using the simple randomization method and divided into intervention and control groups. Patients in the intervention group underwent the cough-assist device that simulated the physiological cough reflex and their vital signs were checked and recorded 5 minutes after the intervention. Data were collected using the physiological data sheet; and were analyzed by SPSS software, version 16. Descriptive statistics and inferential statistics (Chi-square test) were used as appropriated.

Results: We found that the rate of blood pressure and heart rate were considerably increased in the control group respectively after the cough-assist device was applied. Oxygen saturation in arterial blood was significantly raised after the use of cough-assist device ($P< 0.05$).

Conclusion: The cough-assist device leads to less hemodynamic disturbances and enhances arterial oxygenation.

KEY WORDS: Cough-assist device, Arterial oxygen saturation, Hemodynamic status.

1. INTRODUCTION

Patients admitted to Intensive care units (ICUs) exhibit an ICU simulation of respiratory secretions and disorders in oxygenation (Hadjikoutis and Wiles, 2001). One of the potential problems of such is disorder in blood gas exchange which can threaten all living tissues (Arora and Gal, 1981). According to the statistics and reports, the number of patients in ICUs is on the rise (Gozal, 2000; Jahangiri, 2016); consequently the number of such units has had a considerable growth in the last 20 years so that almost 25-30 thousands of patients are admitted to ICUs each day (DiMarco, 1999). These patients experience complications such as decrease in pressure of arterial blood oxygen, cardiac arrhythmia, laryngospasm, bronchus, infection and increased intracranial pressure, as well as hemodynamic changes such as hypertension, hypotension and increased and decreased heart rate (HR) (Sancho, 2004; Ghannad, 2016).

Sudden hemodynamic changes are potentially dangerous incidents that should be considered important to each member of the medical care team (Jelic, 2008), and if left untreated it could lead to patient's death (Jelic, 2008). Sudden hypertension can cause severe vascular damages and hemorrhage in renal, retinal, cephalic, adrenal and intestinal vessels (Loudon and Shaw, 1967). Hypotension can cause syncope, irreversible brain and kidney damage, acidosis, increased respiration, shock and death. Because of prolonged hospitalization and paresis, these patients lose the ability to cough effectively and excrete respiratory secretions (Brooks-Brunn, 1997). Therefore, the use of cough-assist device for stimulating the patients to cough in order to keep the lungs clear of secretions is of utmost importance (Guglielminotti, 2000). Among The main advantages of this technique which can reduce the cost and hospitalization time, are the reduction in micro-organisms entering airways, decrease in use of instruments and equipment used for suctioning, shortening the time for nursing care, and reduced complications such as atelectasis and pneumonia (Schechter, 2007).

Cough-assist device excretes respiratory secretions effectively, reduces the risk of respiratory complications, and eliminates the symptoms of respiratory secretions such as asthma, stress, and distress (Gomez-Merino and Bach, 2002). In this method the lungs are gradually distended by creating a positive pressure in the airways and then the pressure rapidly and suddenly falls to negative (Tomori and Widdicombe, 1969), resulting in a quick exhalation and cough leading to the excretion of secretions (Dohi and Gold, 1979). This technique protects the airways against damage, relaxes the patients, and enhances their quality of life without the use of invasive techniques (Celikel, 1998). Cough-assist is a care given by the nurses alongside respiratory exercises and respiratory physiotherapy to keep airways clear patients admitted to ICUs (Lange, 2006) and nurses use it regularly to take the secretions out of airways (Brasher, 2003; Ghaffari, 2015; Ghaffari, 2015).

Since hemodynamic instability and alterations in arterial oxygen saturation might occur during the monitoring of patients exposed to this method, and considering the few studies in this regard, we aimed to assess the effect of cough-assist device on hemodynamic status and arterial oxygenation in patients admitted to ICUs.

2. METHODS & MATERIALS

Patients and Method: This experimental study was done on all the patients (n=50) aged 30-65 that were admitted to the ICU of Imam Khomeini Hospital, Urmia, northwest Iran. The study was approved by the Ethics Committee of Urmia University of Medical Sciences. The patients' consent was obtained from those who agreed to take part in the research. Sampling was done using the convenient sampling method. The patients were randomly divided into equal intervention and control groups. The patients in the intervention group were exposed to the physiological cough-assist device (Dima, Italy) and the patients in the control group the routine care at the ICU, including changing the patients' position, mouthwash in, physiotherapy, and controlling their vital signs.

Data were collected by observing changes in vital signs that were obtained through monitors and recording these changes in data collection sheets. The sheets' scientific validity was evaluated using content validity. To ensure the reliability of Siemens monitoring device it was calibrated; and the cough-assist device was also identical for all patients.

The inclusion criteria were being over 18 years of age, having no history of lung diseases such as asthma, no physical or mental disability, and willingness to participate in the study. Patients who met the inclusion criteria during daily visits to the ICU of Imam Khomeini Hospital were selected. Patients who did not meet the mentioned inclusion criteria were excluded from the study. Patients' records were used to obtain any other necessary data. The remaining data about vital signs were completed through physiological measurement via pulse oximeter and the monitoring system connected to the patient. After sample selection, the patients initially underwent the cough-assist procedure and their vital signs were measured and recorded 2 and 5 minutes later by the monitor attached to the patient. Data were analyzed using SPSS software, version 16. Chi-square and *t* tests were used as appropriated.

3. RESULTS

The mean age of the patients was 42 (range: 30-65). 35% of the patients were 50-60 years old and 63% were men. Most patients (42%) were admitted to the ICU for at least 1 day, and the duration of admission was 1 to 5 days. Table.1, summarizes the medical diagnosis of the participants.

The reasons for admission to the ICU were decreased consciousness (20%), respiratory distress (5%), and trauma (17.5%). 45% of the patients were ventilated with 30-40% inspired oxygen. The vital signs were checked and recorded before, 2 minutes and 5 minutes after the intervention.

We found no significant difference between the demographic variables (including age, sex, positive end-expiratory pressure, pressure support, inspired oxygen percentage) and mean vital signs (including systolic blood pressure [BP], diastolic BP, percentage of arterial oxygen saturation, HR, and respiration rate) when cough-assist device was applied (P=0.592). Therefore, vital signs were not affected by demographic factors. However there was a significant difference between the mean HR recorded 2 and 5 minutes after using cough-assist device; in the control group HR had more alterations compared with the intervention group (P=0.03). Also there was a significant difference in the mean respiratory rate recorded 2 and 5 minutes after using the cough-assist device, implying that the method had significantly influenced the respiratory rate (P=0.02). Moreover, arterial oxygen saturation in the intervention group differed significantly compared with the control group; implying that the cough-assist device had enhanced arterial oxygenation (table.1).

Table.1. Mean± SD of vital Signs of the patients

Time Vital Sign	Before Intervention		after intervention
Systolic BP	Intervention	110.35± 11.72	122.25±12.09
	Control	122.23±11.52	149.22±13.07
Diastolic BP	Intervention	85.45±8.57	82.2±8.88
	Control	87.25±8.57	90.2±7.78
Oxygen Saturation in Arterial Blood	Intervention	97.60±2.52	99.47±2.52
	Control	97.80±2.52	94.27±2.52
Heart Rate	Intervention	75.99±9.42	79.35±10.32
	Control	78.77±9.42	98.25±10.32
Respiratory rate	Intervention	18.06±1.62	19.65±1.82
	Control	17.08±1.62	24.85±1.82

DISCUSSION

We found that the mean Systolic BP, Diastolic BP, and MAP in control group were considerably increased compared with intervention group. Michael and colleagues found that Systolic BP was significantly different in the control group compared with intervention group (Edlin, 1992). In another study, the researchers found a significant difference between MAP in the control group compared with the intervention group (Edlin, 1992).

We also found that arterial oxygen saturation had decreased more in the control group. This finding is consistent with another related study (Chatwin, 2003). Our study showed that HR had had a greater increase in the control group compared with the intervention group. Also found that the control group showed a significant

difference in HR recorded 10 minutes after using cough-assist device compared with intervention group (P=0.02) (Jelic, 2008).

Moreover, our study also revealed a significant difference in RR after using cough-assist device (P<0.05). Another study showed that RR increased significantly when cough-assist device was used. Another study by Marino and colleagues found that RR has a significant increase in the control group (Fishburn, 1990). In this study demographic variables did not affect the patients' vital signs in both groups. The cough-assist device caused significant differences in hemodynamic status and arterial oxygen saturation between the patients of both groups. One of the limitations of our study was that of the patients' personal and physiological responses to the questions varied, which was beyond the researcher's control. Moreover, despite being trained prior to the study, some patients were not cooperative in the intervention.

4. CONCLUSION

Considering the patients' inability to excrete lung secretions, the cough-assist device can be used to assist ventilation and keep the airways clear of lung secretions. Moreover, this device has fewer effects on hemodynamic status and arterial oxygen saturation, and interferes less with the hemodynamic signs of patients admitted to the ICU.

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