

Relationship between Demographic Characteristics, Clinical Parameters and Extubation Time in Post-Cardiac Surgery Patients

Nooredin Mohammadi¹, Elham Shahsavari¹, Rasoul Azarfarin¹, and Hooman Bakhshandeh²

¹Iran University of Medical Sciences

²Rajaie Cardiovascular Medical and Research Center

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Abstract

Understanding influencing factors on extubation in cardiac surgery patients has great importance. The aim of this study was to determine the relationship between demographic characteristics, medical and clinical variables as well as extubation time in this patients, in Cardiovascular Center. This research is a casual-comparative study, conducted on 210 adult patients underwent cardiac surgery, in 2018, in Tehran. Study samples were selected by convenience sampling method. The data collection tool was a researcher-made observation checklist that included four sections on patients' demographic characteristics, high risk factors related to the disease, patients' clinical condition in ICU, and clinical variables during surgery. The required data was collected. Study subjects were categorized into two study groups of more than 6 hours mechanical ventilation group and less or equal to 6 hours mechanical ventilation group based on their mechanical ventilation time. Using multivariate analysis test, the factors affecting endotracheal tube extubation were determined. IBM SPSS Statistics software version 21 was used for statistical analysis. Study subjects were 210 post-cardiac surgery patients including 142 males and 68 females with median age of 55. Findings indicated that age, sedation and duration of pulmonary circulation had a significant influence on extubation time in post-cardiac surgery patients. Findings indicated that age, sedation and duration of pulmonary circulation has impact on the process of extubation. Implementation of a precise discontinuation program from mechanical ventilation with considering these factors, are recommended in order to prevent long-term mechanical ventilation as well as reducing days of admission to ICU.

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Nooredin Mohammadi¹, PhD; Elham Shahsavari², MS; Rasoul Azarfarin³, MD; Hooman Bakhshandeh Abkenar⁴, MD

1. Associate professor, Nursing Care Research Center, Iran University of Medical Sciences, Tehran, Iran
2. Master of critical Care Department, Nursing and Midwifery Faculty, Iran University of Medical Science, Tehran, Iran. * Address: Rashid Yasemi St., Vali Asr St., Nursing and Midwifery Faculty, Iran University of Medical Science, Tehran, Iran. * Email: elhamshahsavari93@gmail.com,
3. MD, associate Professor of Cardiac anesthesia, Echocardiography research center, Rajaie Cardiovascular Medical and Research Center, Iran University of Medical Science, Tehran, Iran.
4. MD, PhD, associate Professor of Epidemiology, Rajaie Cardiovascular Medical and Research Center, Iran University of Medical Science, Tehran, Iran

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Keywords: Extubation of endotracheal tube, Cardiac surgery, Intensive care, Mechanical ventilation

Introduction

The first goal after mechanical ventilation and endotracheal intubation is to begin the process of discontinuing mechanical ventilation and removing the endotracheal tube (1-3). Typically, there are two common methods to discontinue mechanical ventilation and remove endotracheal tube. In the conventional method, the process of extubation is performed within 12 to 24 hours after the surgery. However, in the fast or rapid method, the process of discontinuation from mechanical ventilation is done within 1 to 6 hours. Today, the method of rapid discontinuation is referred to performing the extubation within the first 6 hours after the surgery. The purpose of rapid extubation method includes faster recovery, faster discharge from the ICU, and preventing potential complications of long-term mechanical ventilation and intubation (4).

Historically, it was recommended since 1960s that patients who undergo cardiac surgery should be mechanically ventilated for 24 hours due to frequent post-cardiac surgery respiratory complications. However, attention was paid to the rapid method of discontinuation from mechanical ventilation in the post-cardiac surgery care program in 1990 in order to reduce the complications of respiratory function and gas exchange during the recovery period. Since 1994, the protocol of rapid discontinuation method from mechanical ventilation in ICUs has been proposed (5) and finally used since 1995 as routine protocol.

Rapid discontinuation from mechanical ventilation and endotracheal tube removal in post-cardiac surgery patients is clinically important because of its benefits and fewer complications compared to long-term mechanically ventilated patients (4, 6). Besides, using short-acting anesthetics such as Propofol and minimizing drug use are to facilitate the removal of the endotracheal tube and mechanical ventilation discontinuation (7). Although the results of various studies indicate that the process of fast discontinuation from the mechanical ventilation and endotracheal tube removal in most patients underwent cardiac surgery is safe, there is a controversy to use the process in some settings. In addition, there are many factors affecting the process which facilitate or limit the implementation of the process. Identifying the factors influencing the endotracheal tube extubation, plays an important role in the proper rapid discontinuation from the mechanical ventilation and extubation leading to better estimation of the patient's survival time in the ICU. Knowing the factors affecting the removal of the endotracheal tube, allows to plan and implement a more effective care program after extubation by anticipating possible problems in patients (8, 9). The results of various studies suggest that some demographic variables such as age, obesity or preoperative medical factors such as renal failure, pulmonary disease, heart disease, and left ventricular ejection fraction may have an impact on the time of endotracheal tube removal (10).

Rapid discontinuation from mechanical ventilation reduces cost of hospitalization stay and days-of-stay

in intensive care unit and hospital. In addition, fast discontinuation from mechanical ventilation enables patients to communicate verbally and reduces their anxiety and less sedative agents use (11, 12). On the other hand, the consequences of late endotracheal tube extubation include lung damage caused by air leaks during mechanical ventilation, resulting in excessive pressure increase in alveoli and causing alveoli collapse, as well as hospital-acquired pneumonia caused by air conditioning and risk of airway contamination, decreased cardiac output due to impaired venous return by positive pressure ventilation, decreased renal perfusion, gastrointestinal dysfunctions, patients' inconsistency with ventilation and their mental distress, which can be mentioned here.

Since the highly number of patients who need cardiac surgery is high-priced for health care system, the process of fast discontinuation from mechanical ventilation is considered as a helpful approach to decrease health care cost in this group of patients. However, identifying the factors which impact on the process is crucial to commence the process safely. Although several studies have examined the relationship between one or more of these demographic factors and clinical variables with endotracheal tube removal, few studies have investigated the relationship of a large numbers of demographic factors and clinical variables with the time of extubation. The purpose of this study was to investigate the relationship between demographic characteristics, clinical parameters and extubation time in post-cardiac surgery patients in Shahid Rajaie Cardiovascular, Medical and Research Center.

Method

Research population of this casual-comparative study were patients admitted to the intensive care units in Shahid Rajaie Cardiovascular, Medical and Research Center after cardiac surgery due to the need for mechanical ventilation. The research sample in this study was selected using the available sampling method from the research community and based on inclusion and exclusion criteria. Data collection tool was a demographic data collection sheet and a researcher-made observational checklist of clinical variables taken from patients' documents. The study research proposal has been approved in institutional ethics committee (No.: IR.IUMS.REC1396.9511449004) . Our study method was observational and there was not any intervention -that needs written informed consent. We informed the patients that their medical data were kept confidential. Data was collected and recorded by a researcher engaged with the patient. Inclusion criteria consisted of potential candidates for coronary artery bypass grafting or replacement (or repair) of one or more heart valves between 18 and 70 years of age, complete alertness and lack of pulmonary-renal and hepatic dysfunction. Exclusion criteria included cognitive impairment and renal failure after surgery, emergency surgery, and unstable cardiovascular condition (tamponade, myocardial infarction, ventricular tachycardia, ventricular fibrillation, and cardiac arrest in ICU). In addition, those with extensive vascular instability of the coronary arteries caused using an aortic pump balloon or an external membrane oxygenation device or in need of surgery, were excluded from the study.

After surgery, from the time of patients' admission into ICU, after undergoing mechanical ventilation with a well-defined protocol (agreement) by the nurses of the ICU and under the supervision of an anesthesiologist (assistants of the anesthesiology course), the discontinuation began and its beginning time (ICU admission) and the time of endotracheal tube extubation were recorded. The arterial blood gas test was taken every two hours until the endotracheal tube was removed. Taking into account the duration of extubation and using the statistical test of logistic regression, patients were divided into two groups of respiration with mechanical ventilation for more than 6 hours or equal and less than 6 hours, which all were recorded and registered by the researcher. Also, information on four main areas of **demographic characteristics of patients** (including four variables of age, sex, height and weight and marital status), **risk factors associated with heart disease** (including six variables of disease diagnosis, left ventricular ejection fraction, history of diabetes, high blood pressure history, history of smoking and drug use, history of respiratory disease), **clinical condition of the patient in the intensive care unit** (including 13 variables of the patient's alertness, the volume of fluid leak from chest tubes, abnormal blood gas laboratory findings from arterial blood gases [Arterial oxygen partial pressure, a P_aO_2 less than 60 mm Hg, arterial carbon dioxide partial pressure (P_aCO_2) greater than 50, base excess (BE) less than minus 10], hemoglobin level, creatinine level,

urine output volume [if reduced to less than 0.5 cc per kg of patient's weight per hour], left ventricular ejection fraction, need for sedatives, blood products) and **clinical criteria during surgery** (which include 6 variables of aortic clamp duration, duration of cardiac-pulmonary pumping and surgical duration, use of intra-aortic balloon pump, type of operation and cardiovascular performance-enhancing drugs) were collected and recorded by the researcher engaged with patients.

Results

Examination of clinical findings and information during surgery by performing a single variable analysis in Table 1 showed that age, duration of pulmonary circulation, duration of clamping aortic artery, duration of surgery, sedative, blood product usage, lung liquid secretion and the use of inotropic agents in the ICU were significantly different compared to patients in the two groups (P-Value >0.05). Multivariate analysis, using logistic regression model revealed that age, sedative and duration of pulmonary circulation had a significant and justified correlation with mechanical ventilation for more than 6 hours (P-Value >0.01). The significance for sedatives has been higher than other factors (Table 2).

Discussion

The aim of this study was to determine the relationship between demographic and medical factors of patients and clinical variables with the time of extubation of the endotracheal tube after cardiac surgery in the ICU of Shahid Rajaie Cardiovascular, Medical and Research Center. Based on the results of this study, age, duration of pulmonary circulation, lung liquid secretion and sedatives had a significant relationship with mechanical ventilation for more than 6 hours. Regarding the age variable, studies that are not consistent with this study include Bansal et al., Savari et al., and Banskar et al., 2013. (13-15)

On the other hand, Faghani et al. in their research considered age variable to be related to the extubation of the endotracheal tube (16).

This study showed that there was a significant difference in the following variables: duration of clamping aorta, duration of surgery, and duration of pulmonary circulation (P-Value > 0.05). Regarding the relationship between pulmonary circulation and endotracheal tube extubation time, this finding is not supported by research results of Barkhordari with $p = 0.66$ (17), however in Rezaianzadeh's study with $p=0.01$, this relationship is significant (18). Also, the time of aortic clamping, which is significant in this study, is not consistent with the research of Barkhordari and Rezaianzadeh (17, 18), but is consistent with the study conducted by Sato et al (19). Prolonged aortic clamping is an effective factor in delaying the extubation time in ventricular defect surgery (20).

The results of the present study showed that patients who underwent painless infusion and sedation of Propofol were significantly different during the time of discontinuation from the mechanical ventilation. The present study does not correspond to the study of Jafroudi et al. (21). It has been reported that rapid removal of the endotracheal tube compared to routine removal in patients undergoing cardiac surgery indicates that they show fewer depressive symptoms in the first three days after surgery. Monitoring anesthetic drugs during cardiac surgery may play an important role in patients' health by reducing the prevalence of postoperative depression. Propofol modulates mood, which may be responsible for reducing the prevalence of postoperative depression (22). However, Angwin et al. declared that Dexmedetomidine shortens the time of extubation, ICU and hospital admission compared to Propofol, by bearing in mind the fact that sedative protocols still need to be developed (23).

For long-term tranquilizing of patients with mechanical ventilation, regardless of the rapid extubation, Zhou et al. concluded that the use of Midazolam and Propofol together, which are a safe and effective sedative protocol, had a higher clinical efficacy and were more cost-beneficient compared to each of them independently (24). Safavi's research findings showed that preoperative training in cardiac surgery about mechanical ventilation and its discontinuation reduced the consumption of sedatives while mechanically ventilating as well as during discontinuation and it also reduced the duration of intubation (25). The results of a study by Mirinezhad et al. indicated that the use of propofol in patients with coronary artery surgery

reduced postoperative mechanical ventilation and length of stay in the ICU, compared to Midazolam, without increasing hemodynamic and ischemic complications (26).

In a prospective clinical study of 180 patients, underwent heart surgery from January to June 2004, a comparison of three anesthesia strategies with respect to extubation time after coronary artery bypass graft surgery was considered after induction of anesthesia. Generally, patients were divided into three groups. All of them received a continuous intravenous injection of propofol before and after surgery. Group one received simultaneous injection of Fentanyl (60 patients), group two, concomitant Diclofenac suppository (60 patients), and group three, simultaneous injection of Remifentanyl (60 patients). Postoperative ventilation until endotracheal tube extubation, inotropic need, analgesic infusion time, arterial blood gas analysis after intubation, pain assessment and duration of stay in the cardiac surgery unit were assessed in each patient. The results indicated that the Diclofenac group showed the shortest time to remove the endotracheal tube, the lowest inotropic dose, and the lowest anti-pain dose compared to patients in the other two groups. Based on the findings of this study, intravenous Propofol combined with nonsteroidal anti-inflammatory drugs (NSAIDs) had the best improvement in patients undergoing cardiac surgery compared to the other two methods (27). This study showed that the volume of tubular secretions from the chest was affected by the duration of mechanical ventilation of cardiac surgical patients. The results are consistent with a study by Brims et al. in 2015, a retrospective study, examined the effect of extracting pleural fluid on pulmonary function of patients in need of mechanical ventilation. Both of them prove that pleural fluid evacuation was concomitant with rapid and sustained improvement in oxygen delivery, and the accumulation of these fluids in the lungs prolonged mechanical ventilation (28).

Limitations of the Study

One of the inclusion criteria, which is the non-emergency nature of cardiac surgery, in one of the limitations of this study. Therefore, sampling after surgery was not possible on formal and informal holidays.

Conclusion

According to the results of this study, there was a significant relationship between demographic and medical factors in patients undergoing cardiac surgery and their clinical outcomes during the surgery. Paying attention to these factors allows the proper process of endotracheal tube extubation, the implementation of a precise care planning programs to prevent long-term mechanical ventilation and reduces hospitalization time in the intensive care unit. Rapid endotracheal tube extubation is performed for almost all patients after thoracic and cardiac surgery due to the many benefits. With proper techniques while extubation, cardiac surgical patients can be discharged without major complications within 6 hours. The variables affecting the duration of mechanical ventilation in this study were age, duration of pulmonary circulation, duration of clamping aortic artery, duration of surgery, sedatives, blood product use, lung liquid secretion, and inotropic agents in the ICU. The severity of the relationship for sedatives has been higher than other factors. It is recommended that nurses pay more attention to evaluating the variables affecting the duration of mechanical ventilation when examining patients' readiness for discontinuation of mechanical ventilation device and endotracheal tube removal.

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Conflict of Interest

There is no conflict of interest in the compilation of this article.

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Table 1: Comparison of individual characteristics of participants in the two studied groups

Variables	Extubation < 6 hrs. (n=17)	Extubation > 6 hrs. (n=193)	P Value
Age (Range)	34 (61-21)	55 (63-46)	0.023
Sex (female/male)	Sex (female/male)	Sex (female/male)	Sex (female/male)
Male (%)	10 (58/8)	132 (68/4)	0.419
Female (%)	7 (41/2)	61 (31/6)	
BMI kg/m ² (Range)	25 (22. 1-27.5)	26 (23. 62-29)	0.117
History of smoking (%)	2 (11/8)	50 (25/9)	0.251
History of addiction (%)	1 (5/9)	32 (16/6)	0.483
Disease history	Disease history	Disease history	Disease history
Diabetes (%)	1 (5/9)	52 (26/9)	0.078
High blood pressure (%)	5 (29/4)	79 (40/9)	0.353

Variables	Extubation < 6 hrs. (n=17)	Extubation > 6 hrs. (n=193)	P Value
Pulmonary disease (%)	2 (11/8)	46 (23/8)	0.371
Clinical findings	Clinical findings	Clinical findings	Clinical findings
Number of breaths (Range)	12 (12-2)	12 (12-2)	0.778
Number of heartbeats	88 (76.5-100)	87 (100-78)	0.907
Left ventricular ejection fraction (%)	50 (37/50-50)	45 (50-35)	0.934
Arterial_sys mmHg-	120 (130-110)	110 (130-98)	0.095
Arterial_dia mmHg-	70 (60-77.5)	67 (55-72)	0.100
Paraclinical findings	Paraclinical findings	Paraclinical findings	Paraclinical findings
Creatinine mg/dl-(Range)	0.7 (0.6-0.85)	0.8 (0.1-7)	0.097
Hemoglobin gr/dl-(Range)	10.9 (10.1-11.7)	10.5 (9. 35-11.3)	0.107
Surgical findings	Surgical findings	Surgical findings	Surgical findings
Duration of Pulmonary circulation (Range)	66 (47.5-90.5)	85 (67.5-106.5)	0.034
Duration of aortic artery clamping (Range)	30 (22.5-50)	45 (65-35)	0.004
Duration of surgery (Range)	180 (165-210)	220 (180-255)	0.024
CVP mmHg-(Range)	12 (2-12)	12 (2-12)	0.690
SPo2 (%)	88 (76.5-100)	87 (78-100)	0.247
Inotropic agents during surgery (%)	2 (11/8)	59 (30/6)	0.161
Sedatives (%)	6 (35/3)	136 (70/5)	0.005
Blood products (%)	2 (11/8)	72 (37/3)	0.036
Findings of arterial gases	Findings of arterial gases	Findings of arterial gases	Findings of arterial gases
PaO2 <60 mmHg-(%)	1 (5/9)	24 (12/4)	0.71
PCO2> 50 mmHg-(%)	1 (5/9)	25 (13)	0.701
BE <-10 (%)	0 (0)	31 (16/1)	0.083
Clinical findings	Clinical findings	Clinical findings	Clinical findings
Lung liquid secretion	100 (250-50)	250 (400-125)	0.007
Inotropic agents in ICU	2 (11/8)	55 (28%/5)	0.0165

Table 2: Multivariate analysis to investigate the correlated relationship of factors affecting the time of mechanical ventilation for more than 6 hours

Variable	CI 95% for OR	CI 95% for OR	Odds Ratio	P Value	SE	Coefficient
Age	1.084	1.008	0.045	0.017	0.019	0.044
Duration of Pulmonary circulation	1.031	0.999	1.015	0.068	0.008	0.015
Lung liquid secretion	1.006	0.999	1.003	0.117	0.002	0.003
Sedatives	10.952	1.184	3.601	0.024	0.568	1.281

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