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Extubation time and postoperative blood pressure in CABG patient

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ABSTRACT

Background and Purpose: One of the essential steps after open-heart surgery is extubation of patients. It is necessary to know variables that may influence extubation time in patients to be able to decide on the suitable time for this procedure. This research intended to determine the correlations between extubation time after open-heart surgery and age, gender, and homeodynamic status.

Methodology: This was a descriptive study, and the sample population consisted of patients who had undergone coronary artery bypass surgery in Ahvaz Golestan Hospital. Files of 100 patients qualified to take part in the study were selected by employing the simple sampling method, and the required information was extracted from them using a checklist. The chi-square test and regression analysis were used to analyze the data.

Findings: 45% of the patients were extubated 6 hours or less and 55% more than 6 hours after surgery. The mean and standard deviation of extubation time for all the patients were 7.19±3.00 with the range of 3-18.25 hours. Only the age of the patients had a significant correlation with extubation time ($p<0.05$).

Conclusions: Based on our findings, age is one of the variables related to the duration of mechanical ventilation in coronary artery bypass surgery. Therefore, nurses should exercise greater care and caution when deciding on extubation time for old patients.

Keywords: Cardiovascular Surgery Methods, Coronary Artery Bypass, Gender-Related Matters, Age
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INTRODUCTION

The heart is a vital organ in the human body, and if there is any disruption in its performance, the life of the person will be in danger. However, heart diseases are more common and heart diseases mortality is higher than other diseases.[1] In the United States, there has been a 30% reduction in death cases resulting from cardiovascular diseases since the early 1980s. For example, 37.8% of death cases in 1975 were caused by heart diseases; however, this percentage dropped to 27.2% in 2004,[2,3] although more than one-fifth of all annual death cases in the United States are still due to ischemic diseases and narrowing of the coronary arteries.[2] At present, about 500000 CABG (coronary artery bypass graft) operations are performed annually in the United States, each one costing about 44000 dollars.[4] Cardiovascular diseases are usually considered diseases that occur in industrialized countries, but they are also on the rise in developing countries. In countries such as Bahrain, Egypt, Kuwait, Iraq, Jordan, and Qatar, cardiovascular diseases have been reported as the main cause of deaths.[5] In Iran, based on the report published by the Ministry of Health and Medical Education, there were about 500000 cases of myocardial infarction in 2000 and 50000 people died of heart diseases.[5,6] According to the prediction of the World Health Organization, about 44.8% of death cases in Iran in 2030 will be due to cardiovascular diseases.[3] Twenty-five thousand open-heart surgeries are annually performed in Iran, 50-60% of which are coronary artery bypass grafts (which are very costly).[7] After open-heart surgeries, patients are directly transferred to the intensive care unit (ICU) and remain under careful control of experienced nurses, who are equipped with special knowledge and skills in managing and looking after such patients, until they recover consciousness and enjoy sufficient oxygenation and homeodynamic stability.[8] Therefore, a major part of the estimated costs of CABG operations is related to the postoperative ICU stay. Researchers attribute the high costs of these surgeries to the lengthy period of mechanical ventilation, which requires a long stay in the ICU, and they believe moderating these two factors will make it possible to control the costs and prevent complications resulting from long ventilation periods and lengthy stay in the ICU.[9] With this goal in mind, many changes have taken place in recent years in relation to the care open-heart surgery patients receive, and new clinical strategies have been introduced to improve the quality of care provided for these patients and to reduce their stay in ICUs. Development of new techniques and methods for treating and taking care of these patients (including new anesthesia methods, open-heart surgery without using cardiopulmonary bypass pumps, and minimally invasive

coronary bypass surgery) are among these changes. All of these changes have been meant to somehow decrease surgical duration, lower intubation period, shorten ICU stay, and, hence, reduce complications and costs.[10,11] Rapid removal of tracheostomy tubes from patients (early extubation), which has been one of the important scientific topics in the past two decades, is one of the new strategies for providing care following open-heart surgery and many economic, physiological, and clinical reasons have been mentioned in support of it in various studies. Chang et al. estimated costs for two groups of patients who were extubated 1-6 or 12-22 hours after their CABG operations to see if earlier extubation was an effective factor in reducing heart surgery costs. They found that each patient in the early extubated group saved 7000 dollars, and the researchers attributed this to lower nursing care and to shorter ICU stay. Moreover, early extubation not only caused no complications but also reduced them compared to the group extubated 12-22 hours after the surgery.[12] Early extubation of patients after open-heart surgery has beneficial clinical effects besides economic advantages. Among these effects are increased comfort of patients, reduced respiratory complications, ease of controlling and managing patients, savings in costs, earlier return of patients to normal life, and easier engagement in activities (which in itself will prevent complications resulting from low mobility).[10,13] It will be possible to decrease effectively the negative effects of positive pressure ventilation by reducing the period patients require for mechanical ventilation. Gall et al. studied the effects of early extubation on cardiopulmonary function and found that increased left ventricular filling, improved ventricular performances, and, hence, increased cardiac output resulted from early extubation. On the other hand, reduced positive pressure ventilation also has beneficial effects on the respiratory system including lower risks of hospital-acquired pneumonia and of damage to lung tissues.[14] Since positive effects of early extubation have become clear, there has been great interest in this practice in most parts of the world. Therefore, early extubation after open-heart surgery has become quite an established procedure, although there is no consensus on the definition of early extubation. Maxam-Moore et al. consider extubation 8 hours after surgery early extubation, while Doering et al. and a group of other researchers believe extubation is early if it is carried out 6 and 8 hours after surgery, respectively.[15,16] Ignoring the little differences in time in the definitions of early extubation, many researchers investigated factors related to extubation time or ways of achieving early extubation. In this relation, studies can mention investigated variables such as advanced age, being female, taking diuretics before surgery, unstable angina, respiratory function, and left ventricular ejection fraction (EF). For example, in a prospective study in 1998, Doering et al. studied predictors for early and delayed extubation in patients undergoing CABG operations before, during, and after the surgery. Patients who were extubated 6 hours or less after the surgery were put in the early extubation group, while those extubated more than 6 hours after surgery formed the delayed extubation group. Results showed 23.3% of the patients were in the early extubation group, 67.2% in the delayed extubation group, and only 9.5% in the group that were extubated more than 24 hours after the surgery. Moreover, it was found that most patients with delayed extubation were older than 70 and under long CPB. Furthermore, the researchers noticed only age among the preoperative variables and only homeodynamic instability were correlated with intubation period. Therefore, they stated that the older the patient and the longer the duration of disrupted homeodynamic stability, the longer the patient would need ventilator and that such patients were not suitable for early extubation, and, hence, they should be under closer observation and treated cautiously.[9] Results of other studies on this subject were similar to the one mentioned above, and many of them suggested advanced age, being female, low EF values, homeodynamic instability, and so forth influenced extubation time in patients.[4,9,15,17] However, other researchers rejected the existence of such a correlation.[11,18,19] Walthall et al. conducted a study in 2001 with the purpose of determining the effects of variables before the surgery on extubation time in patients undergoing CABG operations. They divided the patients into early extubation (extubated 6 hours or less after the surgery) and delayed extubation groups (extubated more than 6 hours after the surgery) and found most patients of 70 years of age or older were in the delayed extubation group. However, there was no significant correlation between these two factors. There were no significant correlations between extubation time and gender or between extubation time and other studied variables such as existence of pulmonary diseases, arterial blood O2 saturation, blood pressure level, heartbeat, and heart rhythm. The only significant variable was the status of the left ventricle: patients with severe disruption in their left ventricular performance (EF≤20) had longer intubation periods ($p<0.05$). They stated the reason why many of the variables did not become significant could be that the volume of the sample, which was taken using the simple random sampling method, was small.[19] Regardless of the results of this study, what is certain is that many factors influence extubation time of patients. Therefore,

knowing these factors will help healthcare providers and nurses in open-heart surgery ICUs to separate patients suitable for early extubation from those under risk and taking the specific conditions of each patient into consideration act in a way that the process of removing patients from ventilators is short and cost effective but also safe and without risks.[11] Because of the reasons mentioned above, this research was designed to determine correlations between extubation time for patients and age, gender, and homeodynamic status after coronary artery bypass surgery.

METHODOLOGY

This was a cross-sectional study conducted in Ahvaz Golestan Hospital, and the patients that had undergone CABG operations by a surgeon at the hospital constituted the sample population. The convenience sampling method was used based on entry criteria. The selected patients had CABG operations performed through a median sternotomy using a cardiopulmonary bypass (CPB) pump, their surgery was not urgent, and they had no previous open-heart surgery. Moreover, they were operated on by the same surgeon in the same center (the surgeon was selected at random from the list of surgeons working at the center), and the same protocols for anesthesia, cardioplegy, hypothermia, medications before surgery, and patient separation from mechanical ventilation were followed for all patients. These factors had to be the same to reduce intervening variables. For sampling, the researchers visited the hospital archives, received the files of patients who had undergone CABG operation in the period from late 2013 until late 2014, and selected patients who met the entry criteria for the research. Ninety-three patients were selected who had been candidates for CABG surgery and capable of autonomous breathing before surgery. In all of them, surgery had been performed through median sternotomy using cardiopulmonary bypass pumps. Their temperatures had been lowered to 32 C˚ during CPB and cold Ringer's solution used for cardioplegy. At the completion of surgery, patients had been immediately transferred to ICU and attached to volumetric ventilators with the identical specifications of intermittent mandatory ventilation, 10-12 breaths/min, tidal volume of 10 cc/kg, and 100% FiO2. Nurses looking after patients provided all postoperative care under the supervision of charge nurses. After the patients woke up, they were extubated if they met all the standard clinical extubation criteria (Table 1).

Table 1 Clinical extubation criteria

Pulmonary status
10-30 spontaneous breaths per minute
Percentage of arterial blood oxygen saturation <90%
Partial pressure of oxygen in arterial blood (PaO2) 0.4 or ≥70 mm HG
Partial carbon dioxide pressure in arterial blood (PaCO2) ≤ 50mm Hg
Homeodynamic status
Mean arterial blood pressure >70 mm Hg
Average heartbeat per minute 50-100
Without dangerous arrhythmia requiring intervention therapy
Bleeding from chest tubes less than 100 mm in 2 hours

Patients who were returned to the operating room for any reason (such as bleeding) or for any reason needed cardiopulmonary resuscitation after surgery were excluded from the study. Data was collected using a checklist that consisted of two parts. The first part included the demographic variables of age, gender, and some clinical records such as high blood pressure, pulmonary diseases, and history of nicotine addiction. The second part consisted of variables related to postoperative homeodynamic status such as extent of bleeding, mean arterial pressure (MAP), central venous pressure (CVP), arterial blood oxygen saturation (SaO2), arterial blood oxygen saturation (SpO2), and heart rhythm. The scientific validity of the checklist had been previously confirmed through content validity and simultaneous observation with 95% reliability. All required information was extracted from reports written by nurses and physicians in the files and ICU report sheets and was recorded in the checklist. It must be mentioned that SpO2 values were taken from ABG test results, and the basis for calculating other homeodynamic variables was their mean values during the first six hours after the surgery. Intubation period was the main variable in this research and was calculated from the moment the patient entered the ICU until the extubation time. Based on this, the patients were divided into the two groups of early extubation (≤6 hours) and delayed extubation (>6 hours). Moreover, if patients were intubated again from the time of extubation until entry into the ICU (before being transferred to the cardiology ward), they were considered repeated-orotracheal-intubation cases. Descriptive statistical methods, the chi-square test, Fisher's exact test, and regression analysis were used to analyze the data, and the significance level for all variables was $p<0.05$.

RESULT

64.7% of the patients were male, 80% of whom were less than 65 years old, with the average age of 60.12±7.2.

64% of the patients had high blood pressure levels, and few of them had histories of pulmonary

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Table 2 **Demographic features of patients and their homeodynamic status after surgery**

Features	(%)
Gender	36
Female	64
Male	
Age	80
<65	20
≥65	
Blood pressure	64
Pulmonary diseases	6
MI	36

Table 3 **Statistical relationships between extubation time, demographic features, and homeodynamic status of patients after surgery**

	Early extubation group ≤6 hours N = 40	Delayed extubation group >6 hours N=53		Results
Features	Number	Number		
Gender				
Female	14	23	NS	X^2= 0.72
Male	32	37		Df = 1
				P=0.39
Age (years)	60.35± 8.58	61.75 ±10.07	S	r= 0.24
				F=5.70
				P= 0.01
Bleeding (cc)	245.88 ± 170.12	230.83 ± 200.12	NS	r= 0.05
				F=0.62
				P= 0.62

diseases (6%). 35% were smokers and 36% had history of MI.

Total average bleeding during the first 10 hours after the surgery was 270.73 with a range of 110-1500 cc, and the mean blood pressure during the same period was 10-13 for systole and 6-10 for diastole(Table 2).

The overall mean and standard deviation of intubation period were 7.19 ± 3.00 with a range of 3-18.25 hours. Forty-three percent of the patients were extubated 6 hours or less and 57% more than 6 hours after the surgery and were put in the early and delayed extubation groups, respectively. As for correlations between the variables, results of regression analysis showed there was a significant correlation between age and extubation time ($p = 0.01$, $r = 0.24$). In the early extubation group, a higher percentage of them (46%) were male, while in the delayed extubation group the majority (63.3%) were female (but this was not a significant difference) (Table 3). The chi-square and Fisher's tests did not indicate any significant correlations between extubation time and any of the variables of high blood pressure, pulmonary diseases, or smoking. In relation to bleeding, although patients with low bleeding volumes (< 1200 cc) had a higher probability (43.5%) of belonging to the early extubation group and patients with high volumes of bleeding (≥ 1200 cc) a higher probability (100%) to belong to the delayed extubation group, regression analysis did not show any significant correlations between volume of bleeding and extubation time.

DISCUSSION AND CONCLUSIONS

Among the variables in this study, only age had a significant correlation with extubation time. Results of similar previous research also confirmed that age was the predictive variable for delayed extubation so that intubation period increased with advancing age.[9,11,17,21] In a study conducted by Doering et al. in 1997 on 62 patients who had undergone CABG operations, it was concluded that for every one-year increase in age over the age of 60, the probability of delayed extubation was enhanced 11.25-fold.[15] It must be noted that cardiac reserve declines in old people and incidence rates of chronic diseases such as heart and kidney failure and hypertension rise (especially in women). On the other hand, decreased health capacity and physical stamina in old people may influence recovery after the surgery and the intubation period. Reduced mass and tone of skeletal muscles or, in other words, weakness and respiratory muscle fatigue, are among other factors that contribute to the lengthening of intubation period in old people. Moreover, disruption in the function of diaphragm muscle and reduced filtration of anesthetics by the liver and kidneys are among conditions that may make extubation difficult in old people after CABG operations.[9,19,21] Goodwin et al. also, in their study on open-heart surgery patients in 1999, stated that advanced age is related to long intubation and plays a role in deciding on the time to remove the tracheostomy tube.[13] It cannot be denied that aging contributes to the decline in all body systems, especially the heart, the kidneys, and the respiratory system. Inclination of old patients for diaphragmatic breathing, reduced muscular strength, and rigidity and hardness of lungs and also increased heartbeat and hypertension in the elderly make their early extubation difficult,[18] although studies such as that by Arom et al. did not confirm the correlation between age and extubation time.[30] In our study, no significant correlation was found between extubation time and age either, and these results are confirmed by those found in research Walthall et al., Bezansons et al., and Ingensoll et al. conducted.[18,19,21] Nevertheless, Arom et al. found different results in their study and stated that age was one of the factors influencing

extubation time and that female patients were extubated later than male patients. These results contradicted those in the literature of that time, and researchers expressed the opinion that the results Arom et al. found were probably because most of the female patients they studied were old.[20] It must also be mentioned that Konstantakos et al. found a significant correlation between being female and long intubation period.[22] Our findings on health and clinical history suggested there were no significant correlations between the mentioned variables and extubation time in patients undergoing CABG operations, and these results conform to those of previous studies.[18,19,22] For example, Ingensoll et al. reported pulmonary status before and after open-heart surgery and history of addiction to nicotine did not have a significant correlation with consequences of extubation after open-heart surgery.[18] Our findings regarding homeodynamic variables suggested there were no significant correlations between these variables and extubation time in patients undergoing CABG operations, while Bezansons et al. stated it seemed history of affliction with hypertension delayed extubation (but changes in blood pressure were not a predictive factor of long intubation).[21] Walthall et al. studied the effects of extubation on homeodynamic status and found that removing the tracheostomy tube did not influence any of the MAP, CVP, SpO2, or heart rhythm variables but significantly increased heartbeat (231). Doering et al. and Johnson et al. studied the effects of bleeding on extubation time and found that in 36.7% of the cases bleeding was one of the factors preventing early extubation.[9,24] It must be mentioned that the lack of significant correlations between these factors and extubation time in our study can be attributed to the fact that most patients had desirable homeodynamic status and clinical histories. Findings of our research showed that only advanced age had a significant correlation with intubation period of longer than 6 hours in CABG patients; that is, patients older than 65 were extubated later compared to other patients. Therefore, nurses in ICUs of open-heart surgery patients and the supervising teams must evaluate extubation standards more carefully for old people and decide more cautiously on removing tracheostomy tubes from them. As mentioned previously, the reason why there were no significant correlations between homeodynamic status and extubation time may be that the patients in the two groups were in desirable and almost identical conditions. Moreover, the sample volume was small, and the retrospective nature of the research project may have influenced the findings. Therefore, it is better to repeat the study on the relationship of these factors with extubation time in a comparative or prospective study on patients with stable and unstable homeodynamic conditions using a larger sample volume. Moreover, since this study was conducted only on patients that had undergone CABG operations at one healthcare center and by one surgeon and one nursing and anesthetic team to control intervening factors, it is suggested that it should be repeated to include other open-heart surgery techniques so that the results can be generalized.

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