

WEANING TIME IN CARDIAC SURGERY PATIENTS IN ASSOCIATION TO  
EXTRACORPOREAL CIRCULATION TIMEManthou Panagiota\*<sup>1</sup>, Lioliousis Georgios<sup>2</sup>, Pappa Despoina<sup>3</sup>, Bouziz Evangelos<sup>4</sup> and Manna Ibrahim<sup>5</sup><sup>1</sup>RN, MSc, PhDc, Deputy Coordinator of Intensive and Emergency Care Nursing Specialty, Department of Nursing, National and Kapodistrian University of Athens, Greece.<sup>2</sup>RN, MSc, Clinical Instructor in Nursing Specialty of Emergency and Intensive Care, General Thoracic Hospital "Sotiria", Athens, Greece.<sup>3</sup>RN, MSc, PhDc, Hygeia Hospital, Department of Nursing, University of West Attica, Greece.<sup>4</sup>MD, Deputy Administrator of Intensive Care Unit, Hygeia Hospital, Athens, Greece.<sup>5</sup>MD, 4th Cardiac Surgery Clinic, Hygeia Hospital, Athens, Greece.**\*Corresponding Author: Manthou Panagiota**

RN, MSc, PhDc, Deputy Coordinator of Intensive and Emergency Care Nursing Specialty, Department of Nursing, National and Kapodistrian University of Athens, Greece.

Article Received on 08/09/2021

Article Revised on 29/09/2021

Article Accepted on 19/10/2021

## ABSTRACT

**Introduction:** The increased morbidity of cardiovascular diseases has led to new cardiac surgery techniques to reduce complications and length of stay in the Intensive Care Unit (ICU). The time of the extracorporeal circulation and the complexity of the operation increase the complications and may delay weaning. **Aim & Methods:** The aim of this study was to investigate the weaning time in patients undergoing open heart surgery and the risk factors that may prolong the length of stay in the ICU. This was a randomized prospective study with the participation of 130 patients who had undergone cardiac surgery using cardiopulmonary bypass, under extracorporeal circulation. Length of stay in ICU, inotropic and antiarrhythmic medication use, anesthetic procedures were recorded. Statistical analysis was performed with SPSS version 19.0, using bivariate and multivariate linear progression. **Results:** The majority of patients (55.4%) underwent coronary artery bypass graft (GABG), while the rest of them had cardiac valve surgery. The most frequent co-morbidities were hypertension, chronic obstructive pulmonary disease and insulin-dependent diabetes mellitus. After one failed weaning attempt, the 5.4% received mannitol. The mean extracorporeal circulation time was 113.1 minutes and the average length of stay in the ICU was approximately 3 days. The extracorporeal circulation time was found to depend on the type of surgery ( $p < 0.001$ ). No correlation found between extracorporeal circulation time period with weaning efforts. Negative correlation was found between BMI ( $p = 0.019$ ), left ventricular ejection fraction ( $p = 0.034$ ) and the duration of mechanical support. Patients treated with mannitol had significantly longer mechanical support ( $p = 0.005$ ). **Conclusions:** In conclusion, the extracorporeal circulation does not seem to affect the extubation of patients. Further study, however, needs to be done in Greek hospitals to investigate the correlation of extracorporeal circulation with prolonged mechanical support.

## 1. INTRODUCTION

In recent decades the increasing morbidity of cardiovascular diseases has led to new practical methods in cardiac surgery with the aim of reducing the average length of stay in the Intensive Care Unit and postoperative complications. Today, coronary heart disease and its complications are treated surgically, such as acute myocardial infarction, mitral valve insufficiency, interventricular communication, aneurysms and cardiogenic shock.

Since 1953, the invention of the IVF machine has made it possible to bypass heart function and lung function, making cardiac surgery more effective and less dangerous.<sup>[1]</sup> Patients undergoing coronary artery bypass

graft surgery or mitral or aortic valve replacement undergo extracorporeal circulation. The length of stay in the extracorporeal circulation as well as the type of surgery has been found to affect the occurrence of complications. Despite the great improvement of the IVF technique, the conventional method still has side effects. Activation of the systemic inflammatory response (SIRS), coagulation disorders, haemorrhage, hemolysis, length of stay in ICU as well as the weaning time are some of them.<sup>[2]</sup>

## 1.1. After-extracorporeal circulation syndrome

After extracorporeal circulation, during the patient's stay in sedation, in the Intensive Care Unit, pulmonary and renal dysfunction, hemorrhagic tension, increased interstitial edema, fever, vasoconstriction and hemolysis

have been observed. This syndrome is referred to as "post-perfusion syndrome"<sup>[3,4,5,6,7,8]</sup>.

## 2. METHODS

### 2.1. Design and participants

The present study aimed to investigate the weaning time in cardiac surgery patients who have been in extracorporeal circulation. 130 patients were recorded with a mean age of 64,4 years old who had undergone cardiac surgery at specific cardiac surgery center in Greece. The registration form included demographic data such as gender and age, type of surgery, administered anesthesia, length of stay in extracorporeal circulation, length of stay in mechanical support. Also, length of stay in the ICU, inotropic and vasoconstrictive medication, antiarrhythmic drugs and total sedation time were recorded. At the same time, attempts for weaning were recorded too. All patients included in the study were asked for written consent preoperatively, adhering to the principles of ethics regarding the processing of personal and medical data.

### 2.2. Statistical analysis

Mean values, standard deviations (SD), median and interquartile range were used to describe the quantitative

variables. Absolute (N) and relative (%) frequencies were used to describe the qualitative variables. Pearson's  $\chi^2$  test or Fisher's exact test was used to compare ratios where necessary. Student's t-test or the non-parametric Mann-Whitney criterion was also used in this study. Significance levels were bilateral and the statistical significance was set at 0.05. The statistical program SPSS 19.0 was used for the analysis.

## 3. RESULTS

A percentage of 74.6 was of male patients. Also, the average BMI of the patients was 28.7 points. 45.3% of patients were overweight and 33.6% were obese. Of the 130 patients, as shown in *Table 1*, 72 (55.4%) underwent GABG surgery, 35 (26.9%) underwent AVR and 19 (14.6%) underwent MVR. A small number of patients had undergone a cardiac surgery in the past and only 3.8% of patients had a permanent pacemaker. The most common comorbidities were hypertension (72.3%), followed by COPD (38.5%) and insulin-dependent diabetes (30.8%).

**Table 1: Demographic data according to registration form.**

Demographic Data		Extracorporeal Time (min)		P Mann-Whitney test
		Mean(SD)	Median (QR)	
Gender	Male	112 (45,4)	104 (88 - 128)	0,355
	Female	116,1 (36,6)	112 (95 - 132)	
BMI	Underweight/Normal	117,4 (37,5)	105 (96 - 128)	0,300*
	Overweight	112,9 (38)	108,5 (90 - 140)	
	Obese	109,9 (53,7)	100 (84 - 120)	
Surgery	AVR	113,2 (32,7)	107 (93 - 121)	<0,001*
	GABG	99,1 (32,7)	96 (84 - 111)	
	MVR	134,5 (29,7)	142 (109 - 155)	
	other	113,3 (48,9)	106,5 (79,5 - 151,5)	
	Combined	157,8 (72,4)	131 (124 - 181)	
Vasoactive Drugs	No	113,7 (41,5)	106 (88,5 - 139,5)	0,749
	Yes	113,1 (44,7)	105 (90 - 128)	
Antiarrhythmic Drugs	No	112,1 (45)	103 (88 - 131)	0,102
	Yes	122,2 (28,1)	119,5 (104 - 143)	
Mannitol	No	112,8 (42,9)	104,5 (89 - 132)	0,406
	Yes	122,9 (52,3)	118 (87 - 180)	
Comorbidities	No	128,1 (93,8)	89 (84 - 180)	0,569
	Yes	111,6 (35,8)	105 (90 - 132)	
Surgery in the past	No	113,2 (44,7)	105 (88 - 137)	0,779
	Yes	111,9 (30,2)	105 (95 - 127)	
Bleeding	No	111,3 (43)	103 (89 - 126)	0,082
	Yes	130,6 (43,9)	127,5 (98,5 - 175,5)	

\*Kruskal-Wallis test

Almost all patients received vasoactive drugs for hemodynamic stability and improvement of cardiac function. In 99.2% inotropic drugs were administered such as dopamine, adrenaline, dobutamine, milrinone and levosimendan, 59.7% took vasoactivedrugs such as

norepinephrine and phenylephrine, and in 12.4% antiarrhythmics such as amiodarone and esmolole were used. 5% tried nitrate such as glycerol trinitrate. 5.4% of patients took mannitol after one failed weaning. The mean left ventricular ejection fraction in all patients was

47.4% (SD = 9.6%) which is lower than the mean normal values of 60-70%.

Also, the mean length of stay in the extracorporeal circulation was estimated to 113.1 minutes (SD = 43.2 minutes). The mean length of stay in the ICU was 3.1 days (SD = 2.6 days) and the median duration of mechanical support was 14 hours in range (8 - 21 hours). In addition, it was recorded that in 9.2% of patients, hemorrhage was treated with coagulation factors as well as blood transfusions and its agents (fresh frozen plasma and platelets). Some of these patients, however, were reopened in the operating room to control bleeding. Also, in 2.3% was used intra-aortic pump due to low cardiac output. The extracorporeal time was found to differ significantly only between the types of surgery. Specifically, after the Bonferroni correction, it was found that patients who underwent multiple surgery had significantly higher extracorporeal time compared to those who underwent only AVR ( $p = 0.005$ ) or only GABG ( $p < 0.001$ ). Also, patients who underwent only MVR had significantly higher extracorporeal time compared to those who underwent only GABG ( $p < 0.001$ ).

There was a significant positive correlation, as it is shown in *Table 2*, between the time of extracorporeal and the length of stay in the ICU. So, the longer they stayed in extracorporeal the longer they stayed in the ICU. In fact, extracorporeal time was not found to be significantly associated with the patient's clinical profile (ejection fraction, BMI, concomitant diseases).

**Table 2: Correlation between clinical parameters.**

		<b>Extracorporeal Time</b>
<b>Ejection Fraction (%)</b>	r	0,03
	p	0,724
<b>Stay in ICU(days)</b>	r	0,22
	p	<b>0,011</b>
<b>BMI</b>	r	-0,09
	p	0,312
<b>Commorbidities</b>	r	0,05
	p	0,554

A multifactorial linear regression was then performed with mechanical support duration as a dependent variable. The use of vasoactive drugs, antiarrhythmics, mannitol and BMI were found to be independently related to the duration of mechanical support.

Specifically:

- Patients taking these drugs had significantly longer duration of mechanical support than patients who did not receive them.
- Patients taking antiarrhythmics had significantly longer duration of mechanical support than the other patients.

- Patients taking mannitol had significantly longer duration of mechanical support than patients not taking.
- As patients' BMI increases, the duration of mechanical support decreases.

#### 4. DISCUSSION

In the current research, we aimed to evaluate whether the length of stay in the extracorporeal circulation ultimately affects patient's weaning. The results of the study showed that extracorporeal circulation time was not related to the patient's stay in ICU. An important role for the weaning process seemed to play the administered drugs, the general postoperative condition of the patient such as the left ventricular ejection fraction and any complications such as bleeding after surgery.

The average extracorporeal circulation time was related to the type of heart surgery and its complexity. In similar studies it was shown that the total time of the operation affects the awakening of the patients. In particular, Immer et al.<sup>[9]</sup> compared the postoperative course of patients who underwent coronary artery bypass grafting with the conventional extracorporeal circulation method and patients who underwent a new method. It was found that the shorter the stay in the extracorporeal circulation, the lower the total time of the surgery and consequently the stay of the patients in mechanical ventilation. While in research of Suematsu et al.<sup>[10]</sup> found that longer surgery times often indicate technical difficulties with intraoperative complications.

Totonchi et al. in a prospective study of 743 patients showed that 6.1% had prolonged wake-up time and extubation which was associated with increased surgery time ( $p < 0.001$ ) and number of transfusions during surgery ( $p = 0.017$ ). Furthermore, it was found that patients who experienced bleeding in the first 24 hours in the ICU and received inotropic support had a longer stay in mechanical ventilation ( $p < 0.001$ ).<sup>[11]</sup>

In the majority of studies, the age of patients seemed to play an important role for intubation, where in the present study it was not a risk factor. Specifically, in a study by Giakoumidakis et al.<sup>[12]</sup>, but also in a study by Prapas et al.<sup>[13]</sup> where the Greek population was studied in cardiac surgery centers, it appeared that the advanced age of patients is related to the delay of extubation.

Wong et al.<sup>[14]</sup> showed that the use of an intra-aortic pump, the use of inotropic drugs and the appearance of arrhythmias after surgery were risk factors for delayed weaning of patients. Intraoperative blood transfusion in combination with a smaller ejection fraction ( $< 30\%$ ), prolonged surgical time mechanical support for more than 12 hours, were studied by Cislighi et al.<sup>[15]</sup>

Regarding the correlation of BMI and delayed extubation of patients in our study, it was found that patients with increased BMI remained less in mechanical ventilation.

In the prospective study by Saleh *et al.*<sup>[16]</sup> among 10,977 patients it was found that the combination of all the above risk factors together with BMI > 35 kg / m<sup>2</sup> was associated with prolonged use of mechanical ventilation for up to 72 hours. Of course, this contradicted the research of Branca *et al.*<sup>[17]</sup> where they demonstrated that BMI is not related to patient awakening.

## 5. CONCLUSIONS

In conclusion, the length of stay in extracorporeal circulation does not seem to unilaterally affect the length of stay in mechanical support and consequently in the intensive care unit. The weaning procedure depends on a number of factors such as the general clinical condition of the patient (low ejection fraction, comorbidities, BMI), the amount of drugs administered (inotropes, vasoconstrictors, antiarrhythmics and sedatives) and the postoperative condition. As there are limited scientific studies on the correlation of extracorporeal circulation with prolonged mechanical support, further research is suggested in order to adequately highlight the risk factors.

## REFERENCES

- Anastasiadis K, Asteriou C, Deliopoulos A, Argiriadou H, Karapanagiotidis G, Antonitsis P, Grosomanidis V, Misias G, Papakonstantinou C. Haematological effects of minimized compared to conventional extracorporeal circulation after coronary revascularization procedures. *Perfusion*, 2010; 25: 197-203.
- McMurray J, Adamopoulos S, Anker S, Auricchio A. *et al.* ESC Guidelines for the diagnosis and treatment. *European Heart Journal*, 2012; 33: 1787-1847.
- Runge TM, Runge MS. Limiting brain and lung damage after coronary artery bypass grafting: an alternative to conventional coronary artery bypass graft. *Clin Cardiol*, 2004; 27: 594-598.
- Samankatiwat P, Samartzis I, Lertsithichai P, *et al.* Leucocyte depletion in cardiopulmonary bypass: a comparison of four strategies. *Perfusion*, 2003; 18: 95-105.
- Rodrigus IE, Amsel BJ, Conraads V, *et al.* Emergency ventricular assist device: better survival rates in non-post cardiectomy-related cardiogenic shock. *Acta Chir Belg*, 2001; 101: 226-231.
- Levy JH, Tanaka KA. Inflammatory response to cardiopulmonary bypass. *Ann Thorac Surg*, 2003; 75: 715-720.
- Liebold A, Khosravi A, Westphal B, *et al.* Effect of closed minimized cardiopulmonary bypass on cerebral tissue oxygenation and microembolization. *J Thorac Cardiovascular Surg*, 2006; 131: 268-276.
- Westerberg M, Bengtsson A, Jeppsson A. Coronary surgery without cardiectomy suction and autotransfusion reduces the postoperative systemic inflammatory response. *Ann Thorac Surg*, 2004; 78: 54-59.
- Immer FF, Ackermann A, Gygax E, Stalder M, Englberger L, Eckstein FS, Tevaearai HT, Schmidli J, Carrel TP. Minimal extracorporeal circulation is a promising technique for coronary artery bypass grafting. *Ann Thorac Surg*, 2007; 84: 1515-20.
- Suematsu Y, Sato H, Ohtsuka T, Kotsuka Y, Araki S, Takamoto S. Predictive risk factors for delayed extubation in patients undergoing coronary artery bypass grafting. *Heart Vessels*, 2000; 15: 214-20.
- Totonchi Z, Baazm F, Chitsazan M, Seifi S, Chitsazan M. Predictors of prolonged mechanical ventilation after open heart surgery. *J Cardiovasc Thorac Res.*, 2014; 6: 211-6.
- Giakoumidakis K, Baltopoulos GI, Charitos C, Patelarou E, Galanis P, Brokalaki H. Risk factors for prolonged stay in cardiac surgery intensive care units. *Nurs Crit Care*, 2011; 16: 243-51.
- Prapas SN, Panagiotopoulos IA, Hamed Abdelsalam A, Kotsis VN, Protogeros DA, Linardakis IN, *et al.* Predictors of prolonged mechanical ventilation following aorta no-touch off-pump coronary artery bypass surgery. *Eur J Cardiothorac Surg*, 2007; 32: 488-92.
- Wong DT, Cheng DC, Kustra R, Tibshirani R, Karski J, Carroll-Munro J, Sandler A. Risk factors of delayed extubation, prolonged length of stay in the intensive care unit, and mortality in patients undergoing coronary artery bypass graft with fast-track cardiac anesthesia: a new cardiac risk score. *Anesthesiology*, 1999; 91: 936-44.
- Cislaghi F, Condemi AM, Corona A. Predictors of prolonged mechanical ventilation in a cohort of 3,269 CABG patients. *Minerva Anestesiol*, 2007; 73: 615-21.
- Saleh HZ, Shaw M, Al-Rawi O, Yates J, Pullan DM, Chalmers JA, Fabri BM. Outcomes and predictors of prolonged ventilation in patients undergoing elective coronary surgery. *Interact Cardiovasc Thorac Surg*, 2012; 15: 51-6.
- Branca P, McGaw P, Light R. Factors associated with prolonged mechanical ventilation following coronary artery bypass surgery. *Chest.*, 2001; 119: 537-46.