DOI: https://doi.org/10.54393/pjhs.v4i04.646

PAKISTAN JOURNAL OF HEALTH SCIENCES

https://thejas.com.pk/index.php/pjhs

Volume 4, Issue 4 (April 2023)

Original Article

Role of Troponin-I in Predicting Length of ICU Stay in Post-Cardiac Surgery Patients

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ARTICLE INFO

Key Words:
Post-Operative Troponin Levels, Cardiac Surgery, ICU Stay, Troponin I

How to Cite:
Saleem, W. ., Hassan, I. ., Iqbal, F. ., & Saleem, F. . (2023). Role of Troponin-I in Predicting Length of ICU Stay in Post-Cardiac Surgery Patients: Role of Troponin-I in Predicting Length of ICU Stay. Pakistan Journal of Health Sciences, 4(04). https://doi.org/10.54393/pjhs.v4i04.646

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Received Date: 18th March, 2023
Acceptance Date: 17th April, 2023
Published Date: 30th April, 2023

ABSTRACT

The cardiac surgery procedures are associated with a release of enzyme troponin from the heart muscles. These troponin levels can be used to predict the post-operative outcomes. **Objective:** To find out the relationship between troponin I levels and length of ICU stay after open heart surgery. **Methods:** A total of 200 patients' data were collected from January to August 2022 at the cardiac surgery department of National Institute of Cardiovascular Diseases, Karachi. The study was conducted after the approval of Ethical Research Committee. Demographic characteristics of patients, procedure details and post-operative course was taken into account for this study. The troponin I levels were sent 12 hours after the surgery and their effect on ICU stay was studied. **Results:** The post-operative troponin levels were divided into different sets. There were 61% patients with troponin- I levels less than 9 ng/ml, 28% patients with troponin-I levels between 9 – 18 ng/ml and 11% patients with troponin-I levels of more than 18ng/ml. There was no difference in ICU stay between patients having troponin levels < 18ng/ml. They were all stable and their ICU stay comprised of 24 hours only. Whereas, in the group of patients having troponin levels > 18 ng/ml, the ICU stay was prolonged, extending to 48 - 72 hours. **Conclusions:** Serum Troponin levels can be used to predict the length of ICU stay. Higher Troponin levels > 18 ng/ml are associated with a prolonged ICU stay of more than 24 hours.

INTRODUCTION

Troponin is a protein found in the heart muscles. As the heart muscle is damaged, troponin is released into the blood. Therefore, greater the amount of damage higher the troponin levels will appear in the blood [1]. There is a rise in troponin levels after every cardiac operation. The type of operation, duration of cross-clamp time, type of cardioplegia, route of delivery and renal function tests all affect the post-operative troponin levels. Higher troponin levels signify the perioperative myocardial injury and are associated with major adverse cardiovascular events [2]. A cut off level of 0.8ng/ml has been roughly estimated to predict the adverse outcomes [3]. However, an exact value of post-operative troponin level to determine major adverse cardiovascular events has not been established yet. Recent studies and data calculate a higher threshold of post-cardiac surgery troponin levels. Devereaux *et al.*, studied the data of 13, 862 patients and concluded that estimated threshold value of cardiac sensitive troponin is 12, 981 ng/l (499 times the upper limit) within one day after surgery and 2503 ng/l (96 times the upper limit) two or three days after surgery [4]. Open Heart Surgery comprises different types of procedures. Most commonly done procedures in our setup include CABG and valvular surgeries. The serum Troponin I is sent 12 hours after every open-heart surgery as a part of other baseline investigations. The role of Troponins in patients with chest

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pain has a very diagnostic significance. However, in post-cardiac surgery patients, their role gets a bit different because some amount of troponin leak is common as heart undergoes various sorts of injuries during arrest, cross-clamping and manipulation. Troponin has a predictive role in determining repeat revascularization and major adverse cardiovascular events post-cardiac surgery [5]. In this study, we studied the role of post-operative troponin levels in predicting the length of ICU stay in patients in our hospital.

METHODS

The data were collected at National Institute of Cardiovascular Diseases, Karachi. All the post-operative open-heart surgery patients were included from the period of January, 2022- August 2022. A sample size of 200 was obtained from sample-size calculator with the population proportion kept at 39%, population size of 438 and a confidence interval of <5%. A sample of post-cardiac surgery patients was collected whose troponin levels post-operatively were sent after 12 hours. All the details were noted and they were followed up for a period of ICU stay. The study design used was Cross-Sectional Study. Non-probability, consecutive sampling technique was applied. Inclusion criteria stated : Either gender, Open heart surgery and Troponin levels done 12 hours after surgery. We excluded patients having closed heart surgery, Off-pump CABG, surgeries on Deep Hypothermic Circulatory Arrest and patients having pre-operatively deranged renal function tests. Two patients were excluded from the study. One was a DVR patient who had a post-operative depressed RV (TAPSE; 10mm and Serum Bilirubin: 5mg/dl. Post-operative troponin level was 8 ng/ml but the prolonged stay of 48 hours was to follow the trend of LFTs. Another patient of AVR (post-operative troponin: 21ng/ml) was excluded from data as he stayed 72 hours in ICU and the reason of prolonged stay was that he developed peritonitis and laparotomy was performed on the patient. These patients were excluded to remove the bias and the sample of 200 patients do not include the above-mentioned cases. Informed verbal consent was taken from patients. We categorized them on the basis of cardioplegia use as well. Their post-operative troponin levels were noted and the data were stratified into different groups. 1st group: Troponin levels < 9ng/ml (122), 2nd group: Troponin levels 9 – 18 ng/ml (56) and 3rd group (22) with Troponin levels > 18ng/ml. We measured the troponin I levels in our study. The troponin test was sent as a part of our routine tests in the hospital laboratory. Troponins are labelled as more significant markers of myocardial injury than LDH and AST [6], according to 'The Levels of Critical Care' [7]. Our definition of ICU Stay consists of "level 3 and level 2 critical care patients". Level 1 critical care patients are transferred to HDU and level 0 patients are kept in ward. Level 3 critical care includes patients requiring two organ support and level 2 includes critical patients requiring support for a single organ system. It is necessary to mention here that for now, our ICU set-up is having level 3 and 2 patients at same place, different from the standard which state that level 2 patients should be in HDU. Our HDU is getting equipped and soon level 2 patients will be in HDU. So, in this study, ICU patients and stay is based on both the level 3 and level 2 critical care patients. The data were collected and analyzed via SPSS version 23 (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp). Frequency was calculated by standard methods. Mean ± standard deviation was obtained for quantitative variables like age (years), Ejection Fraction (%), preoperative troponin levels (ng/ml), CPB time (minutes), cross-clamp time (minutes), and RFT's (mg/dl). Frequencies and percentages were calculated for categorical variables like types of operation and total number of conduits grafted. The independent sample t-test is applied to the measurement data. Statistical significance is kept at p<-0.05.

RESULTS

The study included 200 open-heart patients. The average age of patients was 52.35 ± 10.3 years. All the open-heart procedures were included: 80% CABG and 20% valvular operations (Table 1). 2 patients of CABG were reopened on the 0 post-operative day due to bleeding. IABP use was in 2 patients due to depressed ventricular function and poor targets. IABP was introduced after coming off bypass when the patient got hemodynamically compromised and inotropic support increased. The patient characteristics are discussed in Table 1.

Table 1: Patients Demographics

Variable	N = 200
Age	52.35 ± 10.3 years
Ejection Fraction	51.9 ± 10.5 %
Pre-op troponin levels	0.1 ± 0.2 ng/ml
Operation type	CABG: 80% (160)
	MVR: 10% (20)
	AVR: 5% (10)
	DVR: 5% (10)
Grafts	5 grafts: 10% (20)
	4 grafts: 30% (60)
	3 grafts 65% (130)
	2 grafts: 5 % (10)
Cardioplegia type	Saint Thomas: 85% (170)
	Delnido:15% (30)
Bypass time	147.96 ± 47.3 mins
Cross -clamp time	97.7 ± 38 mins
Renal Function tests (Serum Creatinine levels)	1.1 ± 0.7

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The serum troponin I levels were divided into different sets for easy analysis of data (Table 2).

Table 2: Troponin levels and length of ICU stay

Trop Levels	<9 ng/ml	9 – 18 ng/ml	> 18 ng/ml
%	61% (122)	28%(56)	11%(22)
Length of Stay	24 hours	24 hours	48 – 72 hours

There was no difference in length of ICU stay in patients whose troponin leak was less 18. However, the length of stay increased as the troponin level raised more than 18ng/ml (Figure 1).

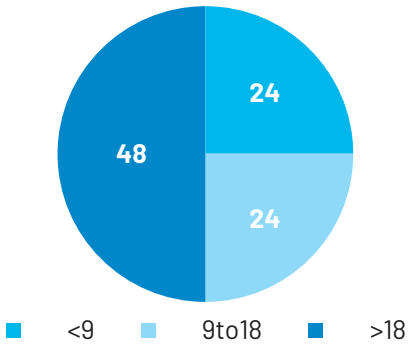

Figure 1: Troponin levels and length of ICU stay

The independent sample t-test is applied in Table 3 to find the significance value. The data shows that age, ejection fraction, pre-operative troponin, type of cardioplegia and serum creatinine play no role in determining the ICU stay. Postoperative serum troponin levels and aortic cross-clamp time played a significant role in predicting the length of ICU stay. Patients whose cross-clamp times were higher than 100 minutes had significantly higher chances of increased length of ICU stay. The aortic cross-clamp times less than 100 minutes played no role in lengthening the ICU stay.

Table 3: Demographic and preoperative clinical assessments of patients stratified by postoperative survival status

Patients	ICU Stay > 24 hours		p-value
	No	Yes	
Age	52.09 ± 10 years	53.90 ± 12 years	0.07
EF	51.7% (171)	53.2% (29%)	0.3
Total Bypass minutes	142 ± 39	182 ± 70	<0.001
Aortic cross clamp time	92 ± 33 mins	128 ± 50 mins	0.001
Renal Function Test	1.1 ± 0.16 mg/dl	1.0 ± 0.22 mg/dl	0.2
Cardioplegia	0.85 ± 0.3	0.83 ± 0.3	0.4
Post-Operative troponin	6.8 ± 4.6 ng/ml	19.54 ± 2.5/ml	<0.001

DISCUSSION

Our levels of serum troponin were higher than the range of the laboratory values. However, similar studies have reported that the cut off levels of troponin was several times higher than specified in the test kits because of unavoidable surgery related troponin release [8]. Omran *et al.*, in their study concluded that serum Troponin I levels sent earlier before 6 – 12 hours has poor prognostic value and a higher threshold of about 8000ng/l was associated with repeat revascularization within 48 hours after surgery. They recommended to use a higher threshold for serum troponin after the cardiac operation [9]. We tried to rule out the peri-operative Myocardial Infarction. The definition of perioperative MI includes either "autopsy findings of acute MI or an elevated level of a cardiac biomarker or enzyme and at least 1 of the following defining features: ischemic symptoms, development of pathologic Q waves, ischemic changes on electrocardiography, coronary artery intervention, or cardiac imaging evidence of MI" [10]. So, our patients had elevated cardiac biomarkers post-operatively but none of them developed any ECG changes or deteriorating clinical findings so chances of major peri-operative MI were ruled out. A study was conducted to determine the causes for post-operative troponin levels. It was concluded that age, previous cardiac surgery, pre-operative renal dysfunction, isolated CABG were independently associated with late elevations of cardiac troponin levels whereas isolated valvular procedures and cross-clamp time was associated with an early elevation of troponin levels. Complications like perioperative myocardial infarction, resuscitation, stoke, death and renal insufficiency was associated with both early and late rise of cardiac troponin levels [11]. Post-operative raised trop I levels 8 hours after surgery indicates post-operative hypoperfusion injury [12]. Al-Sarraf *et al.*, concluded by multiple logistic regression that cross-clamp time of more than 60 minutes is associated with increased post-operative low cardiac output, prolonged ventilation, blood transfusion, mortality and increased hospital stay [13]. OPCAB is associated with lower cardiac troponin levels than CCB irrespective of the stats of elective or urgent surgery [14]. Lehrke *et al.*, presented a series of 204 patients and reported that serum levels of 0.46ng/l after 48 hours of surgery are associated with a 4.9 fold increase in long-term death [15]. Another recent study on 11,847 patients received in emergency room found that reduced eGFR was a bigger predictor of elevated troponin level [16]. Lim *et al.*, in their study concluded that elevated troponin level without ECG changes was not independently predictive of ICU or hospital stay [17]. A research conducted on 48,629 patients concluded that increased BNP levels and cardiac troponin levels were associated with a prolonged length of hospital stay [18]. Retrospective data collection of 240 critically ill patients was performed and troponin levels were stratified into low <0.1ng/ml and intermediate levels of 0.1 ng/ml to 1.49 ng/ml and concluded that even borderline elevations are associated with increased length of ICU stay and mortality. However, they didn't associate elevated troponin levels with length of hospital stay [19]. Another study concluded that troponin levels alone can be used to predict outcomes after cardiac

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surgery [20]. All these studies from the literature complement our findings that cross-clamp times > 100 minutes are linked with a longer ICU stay and troponin levels > 18ng/ml are associated with a longer ICU stay.

CONCLUSIONS

Our study concludes that patients whose post-operative troponin was more than 18ng/ml had a longer ICU stay mainly because of inotropes needed to support the patient hemodynamically. Those having troponin levels of less than 18ng/ml and were in varying ranges did not determine a long ICU Stay. A patient having a troponin of 5ng/ml or 17 ng/ml behaved similarly in terms of length of ICU stay so it can be derived that troponin level of < 18 ng/ml does not predict a prolong ICU stay.

Authors Contribution

Conceptualization: WS
Methodology: WS
Formal analysis: IH, FI
Writing-review and editing: FS, WS

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

Source of Funding

The authors received no financial support for the research, authorship and/or publication of this article.

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