RETROSPECTIVE STUDY ON PREDICTION OF MORTALITY OUTCOME USING POST CARDIAC SURGERY PROGNOSTIC SCALE (POCAS) AMONG PATIENT UNDERWENT CARDIAC SURGERY AT HOSPITAL UNIVERSITI SAINS MALAYSIA KELANTAN

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ABSTRAK

Latar belakang kajian: Keperluan bagi pembedahan jantung semakin meningkat sejak 2 dekad yang lalu disebabkan oleh penambahbaikan perkhidmatan kesihatan di seluruh dunia menyebabkan peningkatan dari sudut umur pesakit dan cakupan perkhidmatan kesihatan ke seluruh negara. Kami menjalankan kajian untuk mengkaji hubungan antara prognosis pesakit selepas 90 hari pembedahan jantung berkaitan dengan skala POCAS dan EuROSCORE II di mana kedua-dua ini adalah skala prognosis bagi pesakit yang menjalani pembedahan jantung bagi meningkatkan kualiti penjagaan pesakit di institusi kami.

Kaedah kajian: Ini adalah kajian rekod secara retrospektif bagi pesakit dewasa yang menjalani pembedahan jantung di unit Pembedahan Kardiothorasik, Hospital Universiti Sains Malaysia, Kelantan bermula dari 1 Januari 2012 sehingga 31 Disember 2018. Data diperoleh daripada rekod perubatan pesakit dan rekod pembedahan jantung. Pembedahan jantung termasuk dalam kajian adalah pembedahan pintasan jantung, pembedahan mengganti injap jantung, pembedahan kombinasi pintasan jantung dan penggantian injap jantung, pembedahan merawat jantung berlubang.

Keputusan: Sebanyak 158 orang pesakit telah menjalani pembedahan jantung termasuk dalam data kajian kami. Sebanyak 133 kes pesakit hidup selepas pembedahan jantung dan 33 kes pesakit meninggal dunia dalam masa 90 hari selepas pembedahan. Berdasarkan skala POCAS, kami menganalisis dan menjumpai kaitan ketara antara skala POCAS dan kadar kematian selepas pembedahan. Melalui analisis *regression* kami mendapati bahawa setiap satu markah kenaikan skala POCAS, terdapat kenaikan pada skala kematian (AOR; 1.286, 95% CI; 1.172 – 1.410, p =<0.001). Tambahan juga, kajian *regression* kami mendapati skala EuroSCORE II

juga mempunyai kaitan yang kuat dengan skala kemation selepas pembedahan. Dengan setiap kenaikan satu markah pada skala EuroSCORE II, terdapat kebarangkalian yang jelas untuk kematian 90 hari selepas pembedahan jantung (AOR 2.875, 95% CI; 1.923 – 4.298, p =<0.001).

Kesimpulan: Terdapat kaitan yang jelas dan penting antara skala POCAS dan kadar kemation 90 hari selepas pembedahan jantung, di mana skala POCAS adalah berdasarkan faktor keputusan makmal dan fungsi sistem jantung selepas pembedahan. Terdapat kaitan yang penting juga antara skala EuroSCORE II dengan kadar kematian yang dilihat selepas pembedahan jantung. Ramalan kadar kes kematian selepas pembedahan jantung adalah penting untuk merancang strategi rawatan pesakit di unit rawatan rapi selepas pembedahan jantung.

ABSTRACT

Background: Demand for cardiothoracic surgery is increasing in recent decades from better health service improvement throughout the world resulting in higher life expectancies and better health care coverage. We study association between outcome of 90 days mortality post cardiac surgery in Cardiothoracic Unit, HUSM and prognostic scale; Post- operative Cardiac Surgery Score (POCAS) and EuroSCORE II in order to improve post-operative care of cardiac surgery patient in our center.

Methods: This is a retrospective record review study of adult patient who underwent cardiac surgery in Cardiothoracic Unit, Hospital Universiti Sains Malaysia, Kelantan from 1st January 2012 until 31st December 2018. Data was collected from medical records and post-operation registration database. Cardiac surgery included are isolated coronary artery bypass surgery (CABG), valve replacement or repair surgery, combined operation of CABG and valve surgery and congenital heart septal closure surgery.

Results: A total of 158 patients who underwent cardiac surgery were included in this study. We found 133 survivors and 25 cases of mortality within 90 days after cardiac surgery throughout the period of study. Based on POCAS score, we found there is association of this scale with mortality cases. By regression analysis, we found that when there is an increase of 1 score of POCAS, there is 1.286 times increment of odds for 90 days post-operative mortality (AOR; 1.286, 95% CI; 1.172 – 1.410, p =<0.001). Furthermore, we study on regression analysis and found there is significant association as well between mortality cases with EuroSCORE II scale. When adjusted for 90 days post-operative mortality, we found that with an increase of 1

score of EuroSCORE II scale, patient has 2.875 times the odds to have mortality 90 days post cardiac surgery in HUSM population (AOR 2.875, 95% CI; 1.923 – 4.298, p =<0.001).

Conclusion: There is significant association between POCAS score which is post-operative biochemical and hemodynamics parameters scale with 90 days post-operative mortality. There is significant association between mortality prediction of EuroSCORE II and mortality observed cases as well. Prediction of mortality after cardiac surgery may enlighten clinicians to lay down strategy of intensive care in complex cardiac surgery cases.

1. INTRODUCTION

1.1 Introduction

Measuring health service quality using clinical outcome is becoming a more significant task for healthcare providers. Analyzing in-hospital mortality, widely used as a quality indicator, gained momentum in 1986 when the US Healthcare Financing Administration published hospital mortality data. Since then, in hospital mortality has been used as a healthcare quality indicator, despite complexity of adjusting rates to enable hospital or regional comparisons. Health service quality has been used as a reflection of economics and social growth of a country (1).

Fatality following cardiac surgeries often raised inquiries and hesitation among patient and family members upon planning for cardiac surgery. Studies have reported that the morbidity followed by mortality of cardiac surgery is high, ranges from 2.94% to 10.5% according to different nature of procedures and population (2). In order to forecast outcome after cardiac surgery, various cardiothoracic institutions have tried to establish a risk stratification for post-operative mortality prediction which specifically tailored for patients undergoing cardiac surgery.

The lack of standardized criteria for comparing outcome of cardiac surgery has leads to development of different clinical prediction scores throughout different cardiothoracic centres. General severity systems that are established in intensive care units such as Acute Physiology score and Chronic Health (APACHE II) , Simplified Acute Physiology Score (SAPS II) and Sequential Organ Failure Assessment (SOFA), when applied to heart surgery patients, do not

work well in predicting in hospital mortality and their precision is less accurate compared to observed mortality rate mostly because they are based on preoperative parameters (3).

This study is aimed to see association of 90 days mortality after adult cardiac surgery with prognostic score specifically tailored to risk stratify patients going for cardiac surgery; POCAS and EuroSCORE II score. Besides that, we also analyse demographic and clinical characteristics of mortality cases post cardiac surgery in order to improve outcome of cardiac surgery in east coast cardiac centre in Malaysia.

1.2 Literature Review

In-hospital mortality after cardiac surgery has been used as an outcome indicator in many studies. A study conducted by Tamayo *et al* conducted in 2013 carried out between January 2009 and January 2011 among patients underwent cardiac surgery with cardiopulmonary bypass in Hospital Clinico Universitario, Valladolid (Spain) found that in-hospital 90 days mortality was ranging from 3.5% to 9.9% from total operated patients. Various predictive scales have different weightage on observed and predictive accuracy depend on parameters included in each scale.

By using Post-Operative Cardiac Surgery Score (POCAS), it shows highest predictive ability compared to other predictive scales (4).This study was based on four independent factors which was recorded on admission of patient to intensive care unit after surgery which are mean arterial pressure, bicarbonate ratio, lactate ratio and the INR. The POCAS scale was compared with four other risk scores in the validation series. Discriminatory power of accuracy was defined with a receiver-operating characteristics (ROC) analysis. The best accuracy in predicting in-hospital mortality over 90 days was achieved by POCAS score followed by Simplified Acute Physiology Score (SAP II), Sepsis related organ failure assessment (SOFA), Acute physiology and chronic health evaluation (APACHE II), logistic EuroSCORE and ACEF score (2).

A single tertiary center retrospective study conducted by Chang *et al* (2017) in Taiwan to predict mortality risk among patient went undergoing coronary artery bypass surgery aimed to validate usage of common general severity scoring system that routinely used in intensive care setting found that in-hospital mortality (30 days) is 9.9%. This was conducted among 483

patients, single center with mean age of 62.9 years old (5,6). Mortality risk scales used was sepsis related organ failure assessment (SOFA) and acute physiology and chronic health evaluation (APACHE II), found these scales are significantly effective in predicting mortality index post coronary artery bypass surgery. However, parameters are taken using preoperative data on admission before surgery. In this study, mortality group was older, more likely to have end stage renal disease and more likely on ventilatory support before surgery. It is also found that higher creatinine level, lower albumin, lower hemoglobin level and poorer preoperative heart conditions such as more requirement preoperative intra-aortic balloon pumping (IABP) usage and more recent myocardial infarction had association with higher mortality scores (6,7).

1.3 Rationale of Study

In clinical practice, the scale that are available are not all that could be desired for predicting the mortality risk after cardiac surgery. A hypothesis was made that specific risk score needed to be developed for cardiac surgery on the basis that performance status upon admission to intensive care unit would have better predictive index than the existing scales based on preoperative parameters. The functionality parameters on admission to intensive care unit among cardiac surgery patients reflects changes that have occurred during the surgical procedure and should allow more precise postoperative surgical risks score compared to preoperative parameters (3,8). Therefore, specific prognostic scoring system for patient undergoing for cardiac surgery is needed.

Post-operative cardiac surgery prognostic score (POCAS) was developed based on four high impacts variables on predicting post-operative cardiac surgery mortality which are mean arterial pressure, serum lactate level, bicarbonate level and coagulation profile (Internationalized normalize ratio). Cardiovascular parameters reflected in mean arterial pressure has been used in most organ failure assessment score in general intensive care unit to prognosticate outcome. Thomas *et al* reported in his study for predictors of outcome of cardiac surgery patients with prolonged intensive care stay that requirement of inotropic support to maintain mean arterial pressure for hypotensive patient were associated with excess hospital mortality. This study conducted retrospectively in 1997, recruiting 490 cardiac patients which showed 141 patients succumbed within 14 days post operatively in ICU and 74 patients succumbed within 28 days post operatively in ICU. Organ failure score (OFS) were recorded at day 14 and day 28 of ICU stay (9,10).

Excess lactate accumulation in blood may occur as result of anaerobic metabolism that occur during physiological oxidative stress during operative period or post-operative recovery period. Hyperlactatemia may occur in 10 to 20% patients following cardiac surgery. Clinically, elevated serum lactic acid may reflect severity of tissue hypoxia as lactic acid is a waste product of glycolysis to produce energy during anaerobic metabolism. It is released from skeletal muscle during stress period and involved in *Cori cycle* to produce ATP for cell energy. Under aerobic condition, there will be reuptake of lactate to be removed by body by oxidation. According to Maillet *et al* who studied prospectively outcome of hyperlactatemia in patient after cardiac surgery, there are increased in subsequent morbidity in patient recorded with excess of serum lactate upon and during stay in ICU. This study was conducted in single cardiothoracic intensive care unit which 325 patients was observed during period of study (11,12).

Acid-base disturbance commonly encountered in patient after major surgery, trauma and severe sepsis. It is a result of metabolic acidosis which occur by imbalance of oxidative phosphorylation of tissue cell. Base deficit and bicarbonate level frequently monitored in critically ill patient to guide for medical therapy management. Martin *et al* studied 22091 non trauma surgical ICU patients for 8 years form 1996 until 2004 reported that serum bicarbonate and base deficit value showed significant value in prediction of morbidity and mortality in 174 patients who died during study period (13).

Defects in coagulation factors in critically ill patient has been frequently observed in close monitoring care environment. Derangement of coagulation may range from asymptomatic thrombocytopenia or generalized prolongation of coagulation factors that might be manifested as bleeding tendency during critically ill period. Walsh *et al* has reported in his

study regarding prevalence and outcome of patient with prolonged coagulation profile in general intensive care units in United Kingdom, among 1923 admission into ICU during study period, 30% developed abnormal prolongation of coagulation time. 70% if then has internationalized normalization ratio (INR) between 1.7 to 2.5. 33% of them was managed with transfusion of fresh frozen plasma for various reasons (6,14).

2. BODY CONTENT

2.1 Introduction

Measuring health service quality using clinical outcome is becoming a more significant task for healthcare providers. Analyzing in-hospital mortality, widely used as a quality indicator, gained momentum in 1986 when the US Healthcare Financing Administration published hospital mortality data. Since then, in hospital mortality has been used as a healthcare quality indicator, despite complexity of adjusting rates to enable hospital or regional comparisons. Health service quality has been used as a reflection of economics and social growth of a country (1).

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This study is aimed to see association of 90 days mortality after adult cardiac surgery with prognostic score specifically tailored to risk stratify patients going for cardiac surgery; The Post-operative Cardiac Surgery Score and European System for Cardiac Operative Risk Evaluation II, hereafter will be referred to in this study as POCAS score and EuroSCORE II score. Besides that, we also analyzed demographic and clinical characteristics of mortality cases post cardiac surgery in order to improve outcome of cardiac surgery in east coast cardiac center in Malaysia.

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2.2 Methodology

Study design

This is a retrospective study among patients underwent cardiac surgeries in Cardiothoracic unit HUSM Kelantan. Cardiac surgeries involve coronary artery bypass surgery and valve replacement surgeries including mitral valve replacement, tricuspid valve replacement and aortic valve replacement. Duration of study involved from 1st January 2012 until 31st December 2018. The data of these patients will be retrieved from Record unit HUSM and operation theatre. Data will be collected based on preoperative, intraoperative and post-operative values as well as specific data that included into POCAS criteria scales. Outcome of study variables was 90 days in-hospital mortality. All patients will be divided into survivors and mortality group then mortality risk index from POCAS and EuroSCORE II score will be assessed. Descriptive analysis will be performed for survivor and mortality group based on preoperative, intraoperative and postoperative biochemical and hemodynamic parameters.

Patient who fulfilled inclusion and exclusion criteria were recruited into this study.

Inclusion Criteria:

a) Patient underwent cardiac surgeries in HUSM Kelantan from 1st January 2012 until 31st December 2018 either elective or emergency operations.
b) Adult patients who are 18 years old and above
c) Patient underwent cardiac surgeries in HUSM Kelantan that has mortality within 90 days post operatively.

Exclusion criteria:

a) Patient who had passed away intra operatively
b) Patient passed away after 90 days post cardiac surgery
c) Incomplete documentation of medical records

d) Patient age under 18 years old

Subjects will be recruited by convenient sampling method in divided 2 groups:

a) Patient that underwent cardiac surgery at Cardiothoracic Unit HUSM Kelantan from 1st January 2012 until 31st December 2018 that passed away after cardiac surgeries within 90 days.
b) Patient that underwent cardiac surgery in Cardiothoracic Unit HUSM Kelantan from 1st January 2012 until 31st December 2018 serve as sampling frame

Statistical analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 24. Data were entered in proforma and transferred to Microsoft excel for electronic software data. Then, data were checked and cleaned for error and missing values. Baseline demographic, biochemical and hemodynamic parameters were described, categorical variables were presented as frequencies (percentage) and continuous variables were presented as mean and standard deviation (SD). Data were put into tables based on preoperative, operative and post-operative clinical and laboratory characteristics.

Data were divided into 2 groups; survivor and mortality. Univariable analysis using Pearson's Chi-square test or Fischer's exact test for categorical variables and independent samples T-test for continuous variables were used to assess the dissimilarity in the characteristics between survivor and mortality groups. Data were divided into 3 sets of periods from before operation, data related during operation and post-operative data.

Binary logistic regression analysis was used to determine the adjusted odds ratio (AOR) of POCAS and EuroSCORE II in association with the studied data. Multiple logistic regression was modelled for POCAS score and each parameter of POCAS; mean arterial pressure, serum

lactate, Internationalized normal ratio (INR) and serum bicarbonate. The forward and backward stepwise likelihood ratio (LR) method was used to determine AOR of factors that increase in POCAS score. Multicollinearity and 2-way interactions between variables were checked. Hosmer and Lemeshow test, the area under the receiver operating characteristics (ROC) curve and Classification tables were used for goodness of fit. AOR with 95% confidence interval (CI) and corresponding p-values were obtained. P-value of less than 0.005 accepted as statistically significant.

2.3 Results

Descriptive Analysis

A total of 158 adult patients who cardiac surgery performed at Cardiothoracic Unit Hospital Universiti Sains Malaysia Kelantan from first January 2012 until 31st December 2018 were included in this study. During this study period, total identified numbers of patient operated were 720 patients. After screening based on inclusion and exclusion criteria, 528 adult patient population fulfilled the criteria of study population. From this sample population, 180 patients recruited into the study based on convenient sampling method of subject selection. However, 22 patients further excluded from sampling frame for multiple factors during data collection process, mostly due to lack of medical records documentations during postoperative period, loss of follow up records hence unable to detect 90 days progression of patient and no personal identification data to contact patients or family to get progress upon 90 days post-operative period.

Major cardiac surgery included which are isolated CABG, isolated valve replacement or repair surgery (MVR, TAP, AVR), combined procedure of CABG and valve surgery and cardiac septal congenital defect closure (ASD and VSD closure). Based on convenient sampling method, 25 patients have mortality within 90 days post-operation and 133 adult patients recovered well after cardiac surgery. Based on type of surgery distribution, 127 (80.4%) patients had isolated CABG performed as being the major heart disease presentation in cardiothoracic health care clinics, 10 (6.3%) patients had valve replacement or repair surgery, 12 (7.6%) patients underwent combined CABG and valve replacement or repair surgery whereas 9 (5.7%) patients had been performed congenital septal defect closure which includes ASD or VSD.

According to gender, 123 (77.8%) patients are male and 35 (22.2%) are female patients. Mean age of patients is 54.91 (SD 12.39) years old. The majority of patients have body mass index (BMI) of 25.2 (SD 4.25), with 78 (49.4%) patient have BMI more than 25 considered as overweight and obese, whereas 80 (50.6%) patient have normal BMI less than 25. Most of the patients have multiple metabolic comorbidities, 128 (81.0%) patient have background of hypertension, 86 (54.4%) have diabetes mellitus, 51 (32.3%) patients have underlying atrial fibrillation, 41 (25.9%) patient have underlying chronic obstructive respiratory disease, 37 (23.4%) patient have chronic kidney failures of variable stages. More than half percentage of patient are smokers making up to 99 (62.7%) from total patients. The majority of cardiac surgery is under elective setting, 132 (83.5%) whereas emergency surgery account for only 25 (15.8%) of all cases.

Table 1: Preoperative demographic data and clinical characteristics of survival and mortality groups. [Expressed as Mean (Standard deviation)]

Preoperative factors	Survival (n = 133)	Mortality (n = 25)	*p*-value
Age	54.4 (12.36)	56.9 (12.58)	0.388[a]
Gender			0.808[b]
Male	104 (78.2%)	19 (76%)	
Female	29 (21.8%)	6 (24%)	
Weight, kg	66.98 (12.49)	67.40 (14.53)	0.884[a]
Height, cm	163.10 (7.71)	162.44 (6.77)	0.689[a]
BMI	25.32 (4.42)	24.03 (4.52)	0.183[a]
BMI >25, Overweight and obese	68 (51.1%)	10 (40.0%)	0.307[b]
Co-morbidities			
Diabetes mellitus	72 (54.1%)	14 (56.0%)	0.902[b]
Hypertension	108 (81.2%)	20 (80.0%)	0.889[b]
Atrial fibrillation	43 (32.3%)	8 (32.0%)	0.908[b]
COPD	35 (26.3%)	6 (24.0%)	0.809[b]
Smoking	85 (63.9%)	14 (56.0%)	0.453[b]
CKD/ESRF	30 (22.6%)	7 (28.0%)	0.773[b]
Type of Cardiac Surgery			0.159[b]
CABG	103 (77.4%)	24 (96%)	
Valve Replacement/Repair	10 (7.5%)	0	
CABG and Valve Surgery	12 (9.0%)	0	
ASD/VSD	8 (6.0%)	1 (4.0%)	
NYHA Classification			0.421[b]
I	7 (5.3%)	0 (0%)	
II	18 (13.5%)	4 (16%)	
III	89 (66.9%)	15 (60.0%)	
IV	19 (14.3%)	6 (24.0%)	
Left ventricular ejection fraction	56.62 (12.55)	53.24 (12.22)	0.217[a]

[a] Independent-Samples T-test applied, [b] Pearson Chi-Square test applied, [c] Fischer's exact test applied, BMI; body mass index, COPD; chronic obstructive pulmonary disease, CKD; chronic kidney disease, ESRF; end-stage renal failure, CABG; coronary artery bypass graft surgery, ASD; atrial septal defect, VSD; ventricular septal defect, NYHA; New York Heart Association Classification

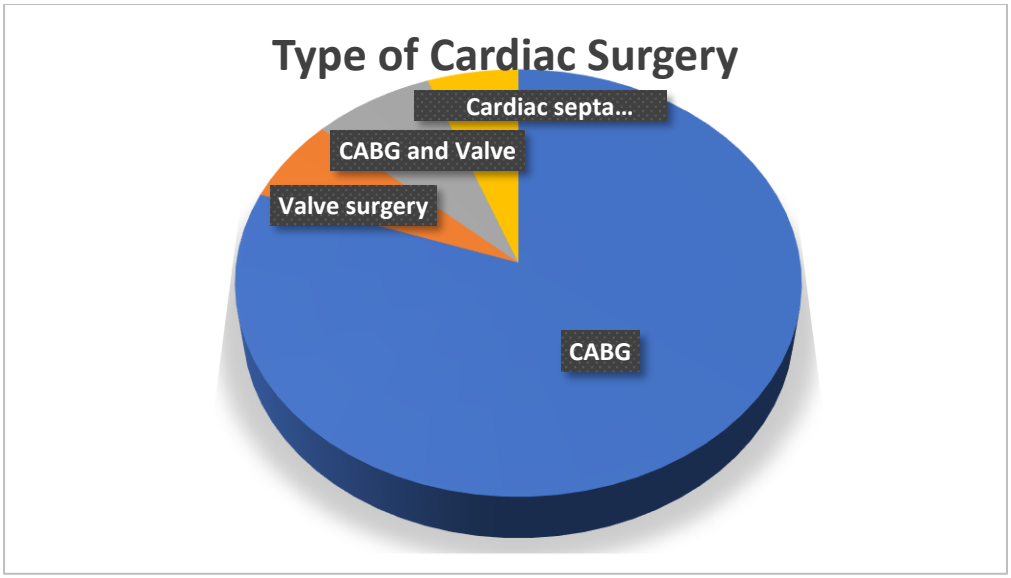

Figure 1: Pie chart distribution of type of cardiac surgery involved in the study.

Comparing the survival and mortality groups (Table 1), patients who has mortality 90 days after cardiac surgery are older (survival vs. mortality, 54.4 vs. 56.9 years old, p = 0.388). Majority of survival are male patients compared to female gender (104 vs. 29 patients, p =0.808). Higher body mass index found in survivor group compared to mortality group (25.32 vs. 24.03, p= 0.183) and higher percentage of overweight and obese patients defined as BMI more than 25 for overweight and more than 30 for obese found in survival group (51.1% vs. 40.0%, p= 0.307). There is no significant different in medical co-morbidities between survival and mortality groups, almost half of patient percentage in both arms have hypertension (survival 81.2% vs. mortality 80.0%, p =0.889) and diabetes mellitus (survival 54% vs. mortality 56%, p =0.902). Higher percentage of patient with chronic kidney disease and end-stage renal failure in mortality arm compared to survivor (22.6% vs. 28.0%, p =0.773). Data also show most of heart disease patients are smokers, both in survivor and mortality arms (63.9% vs 56.0%).

In terms of cardiac functional status, based on NYHA classification, the patients whom end up with poor outcome post-surgery has lower cardiac performance compared to survivor (Class IV NYHA, 14.3% vs. 24.0%, p =0.421). Lower percentage left ventricular ejection fraction seen in mortality group (56.62 vs. 53.24, p =0.217). More mortality cases observed in emergency surgery compare to survival (15.0% vs. 20.0%, p =0.553). No significant different of 90-days mortality outcome in elective surgery (84.2% vs. 80.0%, p =0.756)

According to univariate analysis (Table 2), longer duration of preoperative admission found in mortality arm compared to survivor (1.53 vs. 1.84, p =0.006), longer cardiac intensive care unit stay after operation (2.56 vs. 5.60, p =0.002) however shorter post-operative stay in cardiac rehabilitation ward after surgery (10.14 vs. 7.24, p =0.019).

Table 2: Operative characteristics of post cardiac surgery survival and mortality [Expressed as mean (SD)]

Operative factors	Survival (n = 133)	Mortality (n = 25)	*p*-value
Operative Status			
Previous cardiac surgery	3 (2.3%)	1 (4.0%)	0.801[b]
Emergent surgery	20 (15.0%)	5 (20.0%)	0.553[c]
Elective surgery	112 (84.2%)	20 (80.0%)	0.756[b]
Hospital Stay, days			
Preoperative hospitalization	2.32 (1.52)	3.28 (1.84)	0.006[a]
CICU stay	2.56 (1.02)	5.60 (4.47)	0.002[a]
Post-operative hospitalization	10.14 (3.26)	7.24 (5.63)	0.019[a]
Cardiopulmonary bypass			
Total CPB time, min	112.41 (25.22)	112.84 (20.91)	0.936[a]
Aortic cross-clamp time, min	83.13 (18.51)	82.36 (18.32)	0.849[a]
Duration of mechanical ventilation, days	1.62 (0.77)	3.36 (1.99)	0.230[a]
Post-operative Morbidity			
Reintubation	6 (4.5%)	15 (60.0%)	<0.001[b]
Multiple transfusion	106 (79.7%)	25 (100%)	0.106[b]
Acute renal failure	58 (43.6%)	21 (84%)	<0.001[b]
Pneumonia	16 (12.0%)	6 (24.0%)	0.122[c]
Surgical site infections	23 (17.3%)	6 (24.0%)	0.672[b]

[a] Independent-Samples T-test applied, [b] Pearson Chi-Square test applied, [c] Fischer's exact test applied, CICU; cardiac intensive care unit, CPB; cardiopulmonary bypass time.

According to univariate analysis, no significant difference found in cardiopulmonary bypass and aortic cross clamping time among both arm of survival and mortality group (CPB time 112.42 vs. 112.84, p =0.936), (Aortic cross clamp time (83.13 vs. 82.36, p =0.849). Post-operative morbidity is higher in mortality group which are incident of reintubation in CICU higher compared to survival arm (4.5% vs. 60.0%, p =<0.001), multiple transfusion post-operatively are higher (79.7% vs 100%, p =0.106), acute renal failure (43.6% vs. 84%, p =<0.001), hospital acquired pneumonia (12.0% vs. 24.0%, p =0.122), surgical site infections (17.3% vs. 24.0%, p =0.672).

Table 3: Post-operative laboratory characteristics of post cardiac surgery survival and mortality group. [Expressed as mean (SD)].

Parameters on CICU admission	Survival (n = 133)	Mortality (n = 25)	*p*-value
Laboratory Parameters			
Blood gas PH	7.36 (0.06)	7.22 (0.11)	<0.001[a]
Bicarbonate level, mEq/L	21.27 (2.27)	15.78 (2.17)	<0.001[a]
PCO_2, mmHg	36.74 (6.21)	40.23 (6.63)	0.012[a]
PaO_2/FiO_2 ratio	369.54 (139.83)	302.85 (106.27)	0.025[a]
Leucocyte count, cells/mm^3	13.21 (4.03)	16.02 (4.15)	0.002[a]
Lactate, mmol/L	1.83 (0.98)	5.41 (3.56)	<0.001[a]
Glucose, mmol/L	7.89 (1.78)	8.03 (1.96)	0.765[a]
Creatinine, mg/dL	122.31 (48.44)	242.96 (125.31)	<0.001[a]
Hematocrit, %	30.91 (3.53)	28.76 (3.37)	0.006[a]
Na, mmol/L	140.08 (5.27)	144.72 (8.15)	0.011[a]
K, mmol/L	4.42 (0.60)	4.82 (0.82)	0.005[a]
INR, range	1.23 (0.35)	1.95 (0.40)	<0.001[a]
APTT, range	37.87 (6.53)	50.04 (7.25)	<0.001[a]
Platelet count, cells/mm^3	171.76 (60.16)	109.80 (45.14)	<0.001[a]
Vital Signs			
Heart rate, beats/min	81.24 (14.13)	73.60 (15.98)	0.016[a]
Core temperature, ^oC	36.01 (0.74)	35.81 (0.90)	0.246[a]
Mean arterial pressure (MAP), mmHg	84.74 (12.02)	62.16 (6.90)	<0.001[a]

[a] Independent-Samples T-test applied, [b] Pearson Chi-Square test applied, [c] Fischer's exact test applied, PCO_2; Partial pressure of carbon dioxide, PaO_2/FiO_2; Arterial partial pressure of oxygen to fraction of inspired oxygen, Na; Sodium level, K; potassium, INR; international normalized ratio, APTT; activated partial thromboplastin time, MAP; mean arterial pressure.

Biochemical parameters upon admission to CICU varies between survival and mortality group (Table 3). Arterial blood gas show PH more acidosis in mortality arm (7.36 vs. 7.22, p =<0.001), bicarbonate level higher in survival group (21.27 vs. 15.78, p =<0.001), partial carbon dioxide pressure, PCO_2 (36.74 vs. 40.23, p =0.012), arterial partial pressure of oxygen to fraction of inspired air, PaO_2/FiO_2 (369.54 vs. 302.85, p =0.025), lactate level (1.83 vs. 5.41, p=<0.001). Full blood count cell distribution also show difference between survival and mortality arms, leucocyte count (13.21 vs. 16.02, p =0.002), hematocrit level (30.91 vs. 28.76, p =0.006), platelet count (171.76 vs. 109.80, p =<0.001). Coagulation function prolongation seen in mortality group; international normalized ratio, INR (1.23 vs. 1.95, p =<0.001), activated partial thromboplastin time, APTT (37.87 vs. 50.04, p =<0.001). Renal function test; Sodium level, Na (140.08 vs. 144.72, p =0.011), potassium level, K (4.42 vs. 4.82, p =0.005), creatinine level (122.31 vs. 242.96, p =<0.001). Hemodynamics in circulation show lower mean arterial pressure (MAP) and heart rate values in mortality arm upon admission in CICU, MAP (84.74 vs. 62.16, p =<0.001), heart rate (81.24 vs. 73.60, p =0.016). No difference in core temperature in CICU observation (36.01 vs. 35.81, p =0.246).

Non-linear Regression Analysis

Using multiple logistic regression analysis, the risk-adjusted probability of survival and mortality cases post cardiac surgery using POCAS score was modelled (Table 4). When adjusted for 90 days post-operative mortality, we found that with an increase in 1 score of POCAS scale, patient has 1.286 times the odds to have mortality 90 days post cardiac surgery (95% confidence interval [CI]; 1.172 – 1.410, p =<0;001). When each parameters in POCAS scale adjusted for 90 days post-operative mortality (Table 5); we found that with an increase in 1 score of Lactate parameter in POCAS scale, patient has 1.863 times the odds to have mortality

(95% Confidence interval [CI]; 1.084 – 3.201, p =0.024), with an increase in 1 score of mean arterial pressure (MAP) score in POCAS scale, patient has 1.181 odds to have mortality (95% CI; 0.992 – 1.407, p =0.024), with an increase in 1 score of international normalized ratio (INR) in POCAS scale, patient has 1.517 times the odds to have mortality (95% CI; 0.849 – 2.709, p =0.995) .

Table 4: Multiple logistic regression analysis of survivors and mortality cases post cardiac surgery using POCAS score

Adjusted odd ratio (AOR) of survivor and mortality cases post cardiac surgery using POCAS score					
Variable	B	Wald	AOR	95% CI	p-value
Constant	-22.749	31.453	<0.001		<0.001
POCAS score	0.251	28.314	1.286	1.172 – 1.410	<0.001
* Forward and backward stepwise likelihood ratio (LR) methods was applied					
* No multicollinearity and no interaction were found					
* Hosmer Lemeshow test [Pearson Chi-Square test(7) = 23.724, p =0.001]					
* Classification table 97.5% correctly classified					
* Area under Receiver Operating Characteristics (ROC) curve was 0.955					

Table 5: Multiple logistic regression analysis of survivors and mortality cases post cardiac surgery using POCAS score parameters

Adjusted odd ratio (AOR) of survivor and mortality cases using POCAS score parameters					
Variable	B	Wald	AOR	95% CI	p-value
Constant	-109.900	<0.001	<0.001		0.994
Lactate	0.622	5.072	1.863	1.084 – 3.201	0.024
MAP	0.166	3.482	1.181	0.992 – 1.407	0.062
INR	0.417	1.983	1.517	0.849 – 2.709	0.159
Bicarbonate	4.161	<0.001	64.165		0.995
* Forward and backward stepwise likelihood ratio (LR) methods was applied					
* No multicollinearity and no interaction were found					
* Hosmer Lemeshow test [Pearson Chi-Square test (8) = 0.526, p =1.000]					
* Classification table 98.1% correctly classified					

Figure 1: Pie chart distribution of type of cardiac surgery involved in the study.**Error! Bookmark not defined.**

Table 6: Multiple logistic regression analysis of survivor and mortality cases post cardiac surgery using EuroSCORE II score

Adjusted odd ratio (AOR) of survivor and mortality cases post cardiac surgery using EuroSCORE II					
Variable	B	Wald	AOR	95% CI	p-value
Constant	-6.800	34.161	0.001		<0.001
EuroSCORE II	1.056	26.504	2.875	1.923 – 4.298	<0.001

* Forward and backward stepwise likelihood ratio (LR) methods was applied
* No multicollinearity and no interaction were found
* Hosmer Lemeshow test [Pearson Chi-Square test (8) = 7.719, p =0.461]
* Classification table 94.3% correctly classified
* Area under Receiver Operating Characteristics (ROC) curve was 0.980

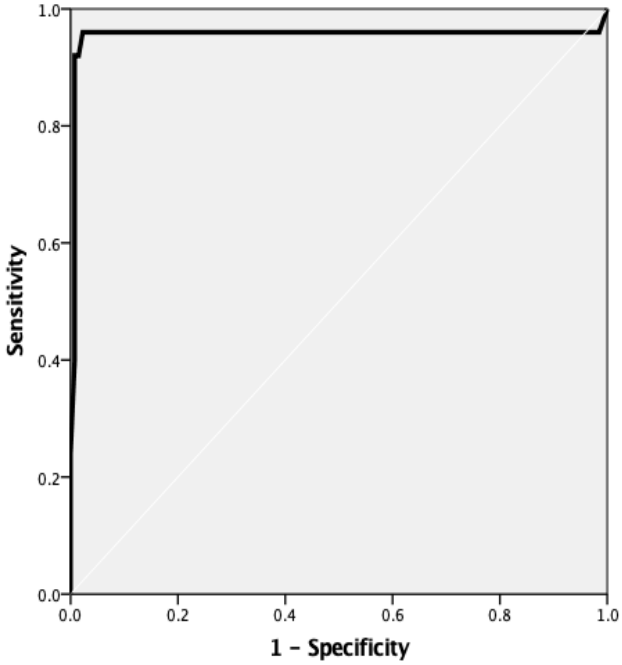

Figure 2: Receiver Operating Curve showing AUC for POCAS Score