



Development of Isolated Coronary Artery Bypass Grafting (CABG) Mortality Risk Stratification Model: An Initiative Model for South Asian Countries and its Comparison with International Risk Stratification Models

Imran Ali ¹, Ahson Memon ¹, Ghufran Ullah Khan ¹, Khalid Rasheed ¹, Hafeez Ullah ^{*1}, Shafqat Hasan ¹, Junaid Alam Ansari ¹, Bashir Hanif ¹, Mehreen Aziz ¹, Syeda Nida ¹

1. Department of Cardiothoracic Surgery, Tabba Heart Institute, Karachi, Pakistan.

***Correspondence to: Dr.** Hafeez Ullah, Department of Cardiothoracic Surgery, Tabba Heart Institute, Karachi, Pakistan.

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Received: 30 January 2026

Published: 01 February 2026

DOI: <https://doi.org/10.5281/zenodo.18453950>

Abstract

Background: Risk models of isolated coronary artery bypass grafting (CABG) have been reported from several series, in Western countries. The Society of Thoracic Surgeons (STS) National Adult Cardiac Database (NCD) and European System for Cardiac Operative Risk Evaluation (EuroSCORE) have contributed much to this field. To develop mortality Risk stratification models of isolated coronary artery bypass grafting (CABG) using a structured prospective database in order to assess and improve the quality of cardiac surgical care. Data was extracted from the Tabba Heart Institute (THI) Cardiac Surgery registry database, to develop a South Asian risk stratification model for expected mortality of isolated CABG procedure, and compared it with international risk stratification models.

Methods: The study population consisted of 5324 adult patients who have undergone isolated CABG procedure between January 1, 2011, and June 30, 2016 at Tabba Heart Institute (THI). The structured database was then divided into developmental and validation subsets. Model developmental dataset consisted of 4793 patients and was used for the construction of the risk model whereas the validation dataset consisted of 531 patients and was used for testing and validation of the risk model. A number of factors associated with mortality suggested by the panel of cardiac surgeons and biostatisticians were taken into account in logistic regression analysis. The outcome of the risk model was mortality. Model discrimination ability was tested using the area under the receiver operating characteristic curve (C index). Model calibration was tested by the Hosmer-Lemeshow test.

Results: Of 4793 subjects, the mean age was 57.7 ± 8.8 years, with 17.5% females, 54.2% had diabetes mellitus, and the mean preoperative creatinine was 1.09 ± 0.45 (mg/dl), whereas for New York Heart Association class II, III and IV were 21.1%, 23.2% and 2.7% respectively, with 31.5% urgent and 2.6% emergent and salvage. The observed mortality rate was 2.4% in the model development dataset. Logistic regression analysis revealed that the influential risk factor that were found to statistically significant were Age (OR 1.054; CI, = 1.017-1.093; $p < 0.0043$), CCS Class IV (OR 1.809; CI, = 1.101-2.972; $p 0.0193$), creatinine clearance < 50 (ml/min) (OR 2.343; CI, = 1.272-4.315; $p 0.0063$), critical preoperative state (OR = 6.223; CI= 3.557-10.886; $p < 0.0001$) and emergent or salvage procedure status (OR 2.167; CI, = 0.996-4.712; $p 0.0511$).

The validation dataset had Hosmer-Lemeshow Chi Square = 13.36 (p 0.100) and discriminating area under the ROC curve = 0.7588 (CI= 0.735-0.836), that was satisfactory.

We compared the performances of the scores developed at (Tabba Heart Institute THI) with EuroSCOREII and the Society of Thoracic Surgeons' STS risk prediction algorithm. These models applied to 531 patients, operated at the same institute between January 1, 2016, and June 30, 2016. The actual mortality was 2.8%. The mean STS score of all patients was 1.17%, the mean EuroScoreII was 2.44% and the mean THI score was also 2.44%. The Hosmer-Lemeshow goodness-of-fit test gave a P-value of 0.328 for STS, 0.093 for EuroScoreII and 0.163 for THI score. The area under the receiver operating characteristic curve was 0.728 for STS, 0.770 for EuroScoreII and 0.756 for THI score.

Conclusions: *THI Score is a simple and soundly based on the South Asian population, and for the South Asian population. The results obtained here were at least as good as those reported elsewhere. The performance of our risk model also matched with those of the Society of Thoracic Surgeons National Adult Cardiac Database and the European Society Database. It is proposed to use it for the future expected mortality risk stratification of isolated CABG.*

Introduction

Ischemic heart disease was the leading cause of CVD health lost globally, as well as in each world region, followed by stroke. Globally absolute number of Cardiovascular disease (CVD) death rate is increasing due to the growth of the population and aging, as well as to important lifestyle and food-system changes (1). In 2015, there were an estimated 422.7 million cases of CVD and 17.59 to 18.28 million CVD deaths respectively (2). According to the WHO 2012 report, 17.5 million people die each year from Cardiovascular Disease CVD, an estimated 31% of all deaths worldwide, >75% of CVD deaths occur in low-income and middle-income countries and 80% of all CVD deaths are due to heart attacks and strokes (3). According to the WHO global health observed data repository 2012, In Pakistan, the Estimated Total Deaths (ETD) per 100,000 persons, due to coronary disease, was 274.2 while that in males was 256.4 and in females, it was 293.6, an estimated 42% of all deaths in Pakistan (4).

Today coronary revascularization, comprising coronary artery bypass graft (CABG) surgery and percutaneous coronary intervention (PCI), is among the most common and most costly major medical procedures provided by the US healthcare system, with more than 1 million procedures performed annually (5).

Mortality, morbidity, and the patient's comfort are the most valuable parameters in evaluating the results and success rate of the surgical procedure (6). In cardiac surgery, operative or hospital mortality has long been accepted as an indicator of the quality of care. Health authorities, health service purchasers, and providers demand the highest quality of care (7). Therefore, analysis of patient outcome is gaining increasing importance, as institutions, health care providers, and patients' satisfaction, whom desire is statistically sound data on risk and prognosis and cost-effectiveness of treatment strategies for assessing the quality of care provided (8). However, crude operative mortality fails as a measure of quality only when there are major variations in case mix (9).

Risk stratification distinguishes subpopulations within a cohort that have different risks of a particular outcome. The ability to compare outcome at different times and at different institutions is a major advantage of risk stratification (10). Therefore it becomes an important tool in assessing the quality of surgical care with major risk factors like increasing age, disease severity, and comorbidity in patients undergoing cardiac surgery. The knowledge of these factors to determine individual risk is also essential to the attending physician in evaluating correctly the appropriateness of the therapy. It also helps the patient as well as the family to weigh their risks and benefits, so as to clarify expectations (12).

It is essential that the risk stratification system is objective and resistant to manipulation. This is achieved by the selection of real, measurable and easily available risk factors. The selection of risk factors in a model is a necessary compromise between what is practical and what is feasible. (13)

The European system for cardiac operative risk evaluation (EuroSCORE) team introduced EuroSCORE II after collecting prospective risk and outcome data on 22 381 consecutive patients undergoing major cardiac surgery in 154 hospitals in 43 countries. EuroSCORE II risk calculator incorporates 18 risk factors, including 10 patient related factors, 5 cardiac and 3 operation-related factors (14).

The Society of Thoracic Surgeons (STS) database is now, without doubt, the largest of its kind in the medical world having nearly 90% of the cardiac surgery providers in the United States on board and a

total tally of 950 participants, with data on more than 3.6 million procedures. (15). STS began building risk models in 1994, starting with isolated CABG mortality . The latest models, the “2008 Models” were developed using data collected during 2002 to 2006 and comprise 27 models, including nine end points (16,17).

Japanese have built their own database system “the Japan Adult Cardiovascular Surgery Database (JACVSD)”, rather than borrow from other systems such as the STS NCD or the EuroSCORE system. They collected prospective risk and outcome data on 7133 consecutive patients undergoing Isolated CABG surgery from 97 participating hospitals throughout Japan during 2000 and 2005. Three different risk models were developed, and odds ratios (OR) resulting from the final logistic models were identified. (18,).

In 2012, extensive work was carried out for risk stratification in Cardiac Surgery in Pakistan. The sample size was 3064 consecutive patients who underwent myocardial revascularization between 2006 and 2010. They reported odds ratios (OR) of nine mortality predictors; patient-related variables were six and intra-operative were three. It was reported that STS risk prediction algorithm is more effective model for risk assessment as compared to EuroSCORE II models in Pakistani population. They also emphasized the need for developing national clinical databases in Pakistan, and to conduct studies for evaluating various risk stratification methods best suited for Pakistani patients.(19,)

The South Asian ethnicity was an independent predictor of a poorer outcome after coronary artery bypass grafting and suggested that ethnicity is a cardiovascular risk factor that should be considered when assessing clinical outcomes preoperatively before coronary artery bypass grafting or other interventional revascularization procedures. (20)

There are demographic and clinical differences between the white patients and south Asian patients. Compared with white patients, south Asian patients tended to be younger, male, non-obese, non-smokers, and more educated with lower household incomes. Additionally co-morbid like diabetes, adverse lipoprotein profile, severe angina or atypical chest pain, and triple vessel or left main stem disease detected on angiography were also more common in south Asian patients. (21, 22)

A higher proportion of Indo-Asian patients underwent coronary revascularization on a non-elective basis as compared with white Chinese Canadian patients, had a higher prevalence of diabetes, a lower

prevalence of smoking and a lower rate of previous myocardial infarction. Although there was a trend towards a very high in-hospital (30 day) mortality. (23) South Asians (South Asian includes patients of Pakistani, Indian, Bangladeshi, or Sri Lankan ethnic origin) were younger more burdened by cardiovascular risk factors, particularly diabetes mellitus and more likely to have the multivessel coronary disease than Caucasians. (24) Chinese patients presented with AMI at older ages, whereas South Asian patients were younger than white patients. Both Chinese and South Asian patients were more likely to reside in the low-income neighborhoods and to have diabetes mellitus, hypertension, congestive heart failure, and renal disease compared with white patients. (25) Malaysian National Cardiovascular Disease (NCVD) database registry results showed that there is a significant difference in Socio-demographic characteristics and risk factors of cardiac patients, within the Asian continent. Indian had the biggest waist circumference, the highest rate of DM and family history of premature CAD as compared to other ethnic groups ($p = <0.0001$). Despite having the lowest BMI, Chinese had the highest rate of hypertension and dyslipidemia ($p = <0.0001$) (26). Indians and Malays have a higher risk of developing AKI after cardiac surgery than Chinese in a South East Asian population. Ethnicity was shown to be an independent predictor of AKI after cardiac surgery. (27)

So, as we have defined above, the Asian population is different from the Western population in terms of Lifestyle, daily diet, ethnicity, literacy, medical facilities and social system, as which may also affect their postoperative mortality after coronary artery bypass grafting (CABG) surgery. Unlike Western countries, no such risk-evaluating model has been derived to date in Pakistan. Our aim is to construct a model that could be applied later on at large and that could be incorporated into local data collection and management systems. Therefore, the aim of our study is to develop an initiative short term / in hospital mortality risk stratification model of isolated coronary artery bypass grafting (CABG) for South Asian countries, and its comparison with international risk stratification models

Methods

Study setting and duration:

The study will be based on retrospective data derived from Cardiothoracic Surgery Registry (CTSR) at THI. Cardiothoracic Surgery (CTS) Department of Tappa Heart Institute (THI) has been maintaining a

computerized CardioThoracic Surgery Registry (CTSR) for all the patients undergoing cardiac surgery since 2011. The structured format has been designed for CTSR. Data is being collected into a dedicated data collection form with predefined variables. All cases of intra-operative and post-operative events (morbidity and mortality) being reviewed and discussed by surgeons on weekly basis. Furthermore, quality of the data has been checked by a team comprising of cardiothoracic surgeons, quality assurance department and anesthesia department, of randomly selected clinical records (5% of the recruited sample) by a comparison of the entered data with patient's clinical record data.

Inclusion and Exclusion Criteria

All consecutive cases from January 2011 till December 2015 will be assessed for inclusion in the analysis. Only CABG cases, (First time CABG and Redo CABG) will be included in analysis. Valve and Combined cases will be excluded from the analysis.

Anthropometric variables

The anthropometric variables were measured by standard methods such as height and weight and were measured preoperatively. The clinical history was taken by using the standard questionnaire. Body mass index (BMI) was calculated using the formula $BMI = \text{weight (kg)} / \text{height}^2 \text{ (m}^2\text{)}$. CC as an estimate of glomerular filtration rate was calculated using the Cockcroft–Gault formula:

$$CC \text{ (ml/min)} = \frac{(140 - \text{age (years)}) \times \text{weight (kg)} \times 0.85 \text{ (if female)}}{72 \times \text{serum creatinine (mg/dL)}}$$

Development of risk score:

Retrospective data will be extracted from the prospectively collected CTSR for model development, having preoperative, intraoperative and postoperative variables, for consecutive patients who underwent Isolated Coronary Artery Bypass Grafting (CABG) surgery between 2011 and 2015. After that, logical checks will be carried out on the whole dataset to check the inconsistency (if any), for assurance of the data quality and accuracy. Major variables are patient age in years, gender, preoperative creatinine mg/dl, myocardial infarction, Ejection fraction and status of procedure.

An expert panel of cardiothoracic surgeons and biostatisticians will review the whole process of data analysis. From the collected data, patient demographics will be presented as percentages for categorical variables, and mean \pm standard deviation (S.D.) for continuous variables. Initially, a series of univariate logistic regression models will be fitted to the dataset in order to identify the potential predictors of mortality. Akaike's information criterion (AIC) assesses the fit of the model; lower values indicate better fit. AICs are only comparable if models use the same data, i.e. the same cases. For model significance; P-values will determine statistically significant at $P < 0.05$ from likelihood ratio tests.

Significant univariate predictors will be used for the multivariate logistic model; for which panel will review the selected variables and will make modifications if needed. The final model will be chosen on the basis of clinical face validity (reflecting current knowledge in the field of cardiac surgery) and predictive accuracy (maintaining the area under the ROC curve at around 80% or more).

The performance of the model will be evaluated in terms of their discrimination and calibration. Discriminatory power will be assessed using the area under the Receiver Operating Characteristic (ROC) curve with 95% CI; an area of 0.5 indicates no predictive ability, whereas an area of 1.0 represents perfect discrimination. To evaluate model calibration, the Hosmer-Lemeshow (H-L) test for the lack of "goodness of fit" will be applied. Hosmer-Lemeshow p-values above 0.05 indicate a well-calibrated model for the study population in question (28).

Validation of risk score

The final model will then be tested on the validation dataset (consecutive patients who underwent Isolated Coronary Artery Bypass Grafting (CABG) surgery between January and June 2016). THI score will be calculated by applying the derived regression coefficients. The EuroSCOREII and STS risk scores will be calculated by their published regression coefficients. The performance of the THI, EuroSCOREII and STS risk scores will be assessed in terms of their discrimination and calibration as discussed above.

Software used for analysis.

SPSS 19.0 and SAS 9.4 university edition will be used for data analysis.

Results:

A set of variables used for model development is described in Table 1. Such as patient related factors age, height, diabetes, pulmonary disease, smoking and creatinine level etc, another variables are cardiac related for example CCS, LV function, systolic pressure etc. The critical preoperative variables were also noted in the development of the score such as resuscitation, pre op VT/VF and ventilation. The most important variable was creatinine clearance respectively.

| |
|--|
| Patient-related factors |
| Age and Gender |
| Height and Weight |
| Pulmonary Disease |
| Diabetes Status |
| Cerebrovascular disease |
| Tobacco Usage |
| On Dialysis |
| Last Serum Creatinine |
| Cardiac-related factors |
| Symptomatic status |
| NYHA |
| CCS |
| LV Function |
| Recent last myocardial infarct |
| Systolic PA pressure |
| Previous cardiac surgery |
| Critical preoperative state |
| PreOP Carcinogenic Shock or on Inotropes |
| Resuscitation |
| Pre-op VT/VF or aborted sudden death |
| Pre-op ventilation |
| Pre-op intra-aortic balloon pump IABP |
| Operation-related factors |
| Status (elective, urgent, emergent, salvage) |

Table 1 Initial List of Variables

The patient demographic characteristics and comorbidities were described in Table 2. A total of 4,793 patients were included in the model development. The mean age was up at 57.7 with 17.5% females, 54% had diabetes out of those 27% was insulin dependent. Average BMI was 26.8 ± 4.3 . The pulmonary and cerebrovascular disease patients were only 2.3% respectively. Most of the patients 41.7% were tobacco users. The few of one 0.3% were already on dialysis. The mean last creatinine level was estimated 1.1 respectively. The CC 50 – 80 was among 49.4% of the patients. Along with Cardiac Risk Factor and Urgency of Procedure were shown in Table 3. When we reviewed the cardiac risk factor in model development data set there were 44.3% patients had NYHA class II-III, Average Left Ventricular Ejection Fraction was 45.7 ± 12.2 , 15% patients has $EF \leq 30\%$, around 50% had recent myocardial infarct. 5% patients had history of PCI, Among the cardiac related factors LV Function > 30 was among 84.5% patients followed by recent last myocardial infarct patient ratio found 48.2%. The least prevalent cardiac related factor was Systolic PA pressure > 55 0.6% correspondingly. Among the critical cardiac preoperative states the pre-op intra-aortic balloon pump IABP was applied on 3.1% patients and the resuscitation was needed only 0.6% patients. Urgency Status of the patient showed that 66.1% were elective and 31.5% were operative on urgent basis.

| Patient-related factors | Frequencies (%) or mean (SD) [range] |
|---------------------------------------|--------------------------------------|
| Age in years | 57.7 (8.8) [58.0] |
| Gender Male | 3953 (82.5) |
| Female | 840 (17.5) |
| Height | 163.1 (8.7) [164.0] |
| Weight | 71.3 (12.6) [70.0] |
| BMI (calculated) (kg/m ²) | 26.8 (4.3) [26.3] |
| Body surface area (calculated) | 1.8 (0.2) [1.8] |
| Diabetes | 2598 (54.2) |
| Diabetes on Insulin | 713 (27.4) |
| Diabetes non Insulin | 1860 (71.6) |
| Hypertension | 3631 (75.8) |
| Pulmonary Disease | 111 (2.3) |
| Cerebrovascular disease | 112 (2.3) |
| Tobacco Usage | 1998 (41.7) |
| On Dialysis | 16 (0.3) |
| Last Serum Creatinine (mg/dl) | 1.1 (0.3) [1.0] |
| CC (calculated) | 79.9 (29.7) [77.1] |
| CC >85 | 1812 (37.8) |
| CC 50-85 | 2368 (49.4) |
| CC <50 | 597 (12.5) |

Table 2 : Demographics and Comorbidity

| Cardiac-related factors | Frequencies (%) or mean (SD) [range] |
|--|--------------------------------------|
| NYHA Class II-III | 2122 (44.3) |
| NYHA Class IV | 130 (2.7) |
| CCS Class 4 | 625 (13.0) |
| LV Function Ejection Fraction EF | 45.7 (12.2) [45] |
| LV Function > 30 | 4051 (84.5) |
| LV Function 20-30 | 533 (11.1) |
| LV Function < 20 | 209 (4.4) |
| Recent last myocardial infarct | 2310 (48.2) |
| Systolic PA pressure 31-55 | 625 (13.0) |
| Systolic PA pressure > 55 | 30 (0.6) |
| Previous PCI | 237 (4.9) |
| Previous cardiac surgery | 47 (1.0) |
| Critical preoperative state | |
| PreOP Carcinogenic Shock or on Inotropes | 57 (1.2) |
| Resuscitation | 31 (0.6) |
| Pre-op VT/VF or aborted sudden death | 43 (0.9) |
| Pre-op ventilation | 51 (1.1) |
| Pre-op intra-aortic balloon pump IABP | 148 (3.1) |
| Urgency Status | |
| Elective | 3169 (66.1) |
| Urgent | 1511 (31.5) |
| Emergent | 105 (2.2) |
| Salvage | 17 (0.4) |

Table 3 : Cardiac Risk Factor and Urgency of Procedure

Variables associated with mortality were described in Table 4, the age was significantly associated with mortality followed by weight and body surface area. In alignment with CC clearance >85 and <50 were also have positive significance with mortality. It was also noted that urgency and emergent/salvage procedures were significantly associated with the risk of mortality. The other mentioned factors were found non-significantly associated with the mortality.

| Variable | Univariable logistic model coefficients | AIC | P-value | |
|--|---|----------|----------|----------|
| Age in years | 0.0994 | 1032.742 | < 0.0001 | |
| Gender Female (Ref: Male) | 0.1935 | 1073.539 | 0.4178 | |
| Height | -0.0124 | 1066.627 | 0.2514 | |
| Weight | -0.0171 | 1062.407 | 0.0287 | |
| BMI (calculated) (kg/m ²) | -0.0398 | 1066.255 | 0.0796 | |
| Body surface area (calculated) | -1.1864 | 1070.499 | 0.0232 | |
| Diabetes on Insulin (Ref: non insulin) | 0.0265 | 1074.318 | 0.9208 | |
| Hypertension | 0.0191 | 1073.948 | 0.931 | |
| Pulmonary Disease | 0.5493 | 1074.973 | 0.2995 | |
| Cerebrovascular disease | 0.636 | 1075.283 | 0.2942 | |
| Tobacco Usage | 0.0531 | 1073.599 | 0.782 | |
| On Dialysis | 1.3807 | 1076.159 | 0.1788 | |
| Last Serum Creatinine (mg/dl) | 1.3734 | 993.979 | < 0.0001 | |
| CC (calculated) | -0.0279 | 1013.72 | < 0.0001 | |
| CC >85 | Baseline | 1018.695 | < 0.0001 | |
| CC 50-85 | 0.5075 | | | |
| CC <50 | 1.833 | | | |
| Cardiac-related factors | | | | |
| NYHA Class II-III | 0.4366 | 1060.736 | 0.001 | |
| NYHA Class IV | 1.4342 | | | |
| CCS Class 4 | 0.6605 | 1067.046 | 0.0066 | |
| EF | LV Function Ejection Fraction | -0.0415 | 1036.488 | < 0.0001 |
| | LV Function > 30 | Baseline | 1045.426 | <.0001 |
| | LV Function 20-30 | 0.8856 | | |
| | LV Function < 20 | 1.5025 | | |
| | Recent last myocardial infarct | 0.7372 | 1059.094 | 0.0001 |
| | Systolic PA pressure 31-55 | 0.8886 | 1056.908 | <.0001 |
| | Systolic PA pressure > 55 | 1.8334 | | |
| | Previous PCI | -0.4368 | 1074.026 | 0.255 |
| | Previous cardiac surgery | 0.8173 | 1075.66 | 0.266 |
| | Critical preoperative state | 2.7851 | 940.005 | <.0001 |
| Urgency | Elective | Baseline | 988.707 | <.0001 |
| | Urgent | 0.9125 | | |
| | Emergent / Salvage | 2.9501 | | |

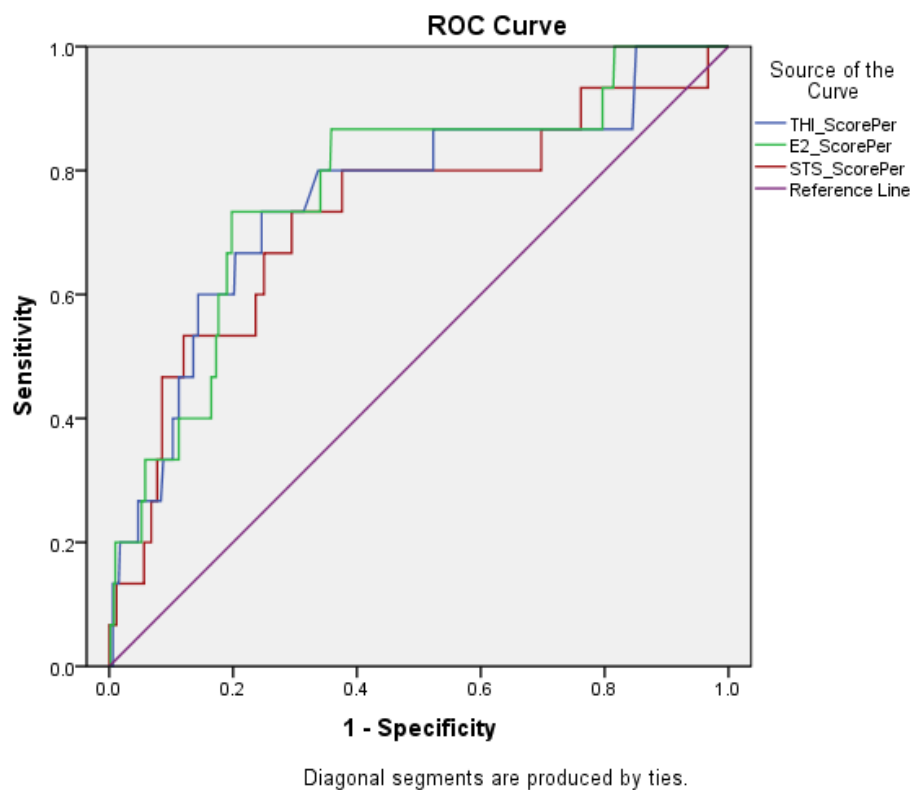
Table 4 : Variables associated with mortality

The risk factors by multivariate regression for the model were accessed in Table 5. The age, CC<50, critical preoperative state and emergent/salvage status found significant risk factors associated with the complications of the cardiac surgery. The critical preoperative coefficient was very high 1.8585 as compared to other identified variables. The least coefficient value was observed related to the age 0.0493 respectively.

| Risk Factor | Coefficient | Standard error | P-value | [95% confidence interval] |
|--------------------------------|-------------|----------------|---------|---------------------------|
| Intercept | -5.5463 | 0.3385 | <.0001 | - |
| Age in years | 0.0493 | 0.0184 | 0.0075 | 1.013, 1.089 |
| NYHA | | | | |
| Class II-III | 0.3768 | 0.2067 | 0.0682 | 0.972, 2.186 |
| Class IV | 0.2988 | 0.4312 | 0.4884 | 0.579, 3.139 |
| CCS Class 4 | 0.6004 | 0.2528 | 0.0175 | 1.111, 2.992 |
| Renal dysfunction | | | | |
| CC 50-85 | 0.256 | 0.2651 | 0.3342 | 0.768, 2.172 |
| CC <50 | 0.9033 | 0.3095 | 0.0035 | 1.345, 4.527 |
| Critical preoperative state | 1.8585 | 0.2845 | <.0001 | 3.672, 11.202 |
| LV function | | | | |
| EF 20-30 | 0.1972 | 0.2721 | 0.4686 | 0.715, 2.076 |
| EF < 20 | 0.2255 | 0.3372 | 0.5036 | 0.647, 2.426 |
| Recent last myocardial infarct | 0.1602 | 0.2202 | 0.467 | 0.762, 1.807 |
| Systolic PA pressure | | | | |
| PA pressure 31-55 | 0.3766 | 0.2382 | 0.1139 | 0.914, 2.324 |
| PA pressure > 55 | 1.029 | 0.6808 | 0.1307 | 0.737, 10.627 |
| Urgency | | | | |
| Urgent | 0.2668 | 0.2389 | 0.2641 | 0.818, 2.086 |
| Emergent / Salvage | 0.9314 | 0.3837 | 0.0152 | 1.196, 5.384 |

Table 5 : Final risk factors by multivariate regression for the model

We compared the performances of the scores developed at (Tabba Heart Institute THI) with EuroSCOREII and the Society of Thoracic Surgeons' STS risk prediction algorithm. These models applied to 531 patients, operated at the same institute between January 1, 2016, and June 30, 2016. The actual mortality was 2.8%. The mean STS score of all patients was 1.17%, the mean EuroScoreII was 2.44% and the mean THI score was also 2.44%. The Hosmer–Lemeshow goodness-of-fit test gave a P-value of 0.328 for STS, 0.093 for EuroScoreII and 0.163 for THI score. The area under the receiver operating characteristic curve was 0.728 for STS, 0.770 for EuroScoreII and 0.756 for THI score.



Discussion

The number of cardiac surgery cases has increased globally and over the last decades the number of cardiac surgery systems has increased, the available scoring systems are near about 20 in current adult cardiac surgery (29). One common factor among the scoring systems is that most of them were proposed from Europe or North America (30). For our best knowledge there is not any specific scoring system for south asians patients undergoing cardiac surgery. The present study was established to purpose the scoring system THI for South Asian population, along with the validity of the THI score was also compared with the EuroSCOREII and STS risk scores. Similar study was done by Ad N (2016), in this study EuroSCORE II, original EuroSCORE, and the STS risk score of cardiac surgery patients was compared (31). The widely used scoring system is EuroSCORE II but when it was tested on the Pakistani population by Khan S (2018) the risk prediction of EuroSCORE II was best suited for low and medium risk group but it was not applicable on high risk patients (32). Our findings suggested that THI score will be applicable on low medium and high risk patients. The local score development is needed for the system. Mark (2017) applied the euro (AC) score on the Kenyan population; it suggested that this score is not applicable on the Kenyan population and the need of the local scoring is essential to evaluate the cardiac surgery patients at risk (33).

In a study Kar (2017) noted the predicted mortality 5.7% of the Euro SCORE II among the population of India (34). These findings were also higher as compared to our study values, it can be due to the severity of the related risk factors. In a study of Nežić (2019) the hospital mortality was 3.86% which is higher than our study results and the mean predicted mortality by the EuroSCORE II was 3.61% respectively (35). Similar to our study, Xiue conducted the comparative study among the Chinese population the predictive mortality of SinoSCORE, EuroSCORE II and STS risk evaluation system were 1.35%, 1.74% and 1.05%, respectively (40).

In our study findings the critical preoperative state got the highest risk score OR = 6.223 which has ability to cause morbidity and mortality among the cardiac surgery patients. It might be due to the fact that most of our study population was suffering with diabetes and age was more than 50+.

We found the mean age 57.7 ± 8.8 years of the patient which was found to have an influential risk factor statistically significant with OR 1.054; CI, = 1.017-1.093; $p < 0.0043$) respectively.

Almost similar findings were noted by Ramponi (2018) in the study by using the EuroSCORE II in which the higher age was also classified as the risk factor of the cardiac surgery mortality (36). The age could be increased the risk of the cardiac surgery due to the aging factors. In align with our study results Vikholm (2017) Swedish cardiac surgery registry found that CCS-IV angina and poor mobility were considered with low risk score (37). The considerable element of these patients usually used the preventive medication which potentially reduces the risk during the cardiac surgical procedures. The creatinine level which is the most important investigation before cardiac surgery to evaluate the patient. In our findings the creatinine clearance is considered as moderate risk OR 2.343 for the patients underwent the cardiac surgery. In a study of Cooper (2006) similarly low creatinine clearance was one of the most powerful predictors of operative mortality and morbidities (38).

We compared the performances of the THI risk predictor algorithm with EuroSCOREII and STS risk prediction algorithm. Similar study was established by Wang (2016) for the comparison of the Cardiac Surgery algorithm (44). Comparatively, our centre THI score was 2.44% which was similar to EuroScoreII was 2.44%, whereas mean STS score was low 1.17% respectively. It presented that THI score implication in our study population is the same as the EuroScore II score. The Ad (2016) noted the discriminated risk scores of STS, EuroSCORE II, and EuroSCORE I which was 2.7%, 3.3%, and 7.8% these scores were different from the same population (40). The reason is that the applicability power of the risk scores is not the same around the globe; it varies according to population. Which reflected the importance of the local score system development.

When we compared the validity of THI score with STS and EuroSCORE the results were comparatively the same, the area under the receiver operating characteristic curve was 0.728 for STS, 0.770 for EuroScoreII and 0.756 for THI score. The THI score validation in our population is almost the same as STS and EuroSCORE II. Similarly validation was noted Nashef (2002) Discrimination was good for the population and area under the receiver operating characteristic curve was between STS 0.75 and EuroSCORE II 0.78 respectively (39). Likewise among the Chinese population SinoSCORE was in a similar area under curve value 0.888, to STS 0.844 and EuroSCORE II 0.814 respectively (40). Among the Greek cardiac surgical population Area under the ROC curve for EuroSCORE II was 0.85 (95% CI: 0.75-0.94), suggesting very good correct classification of the patients (41). In an other comparative single centre study by using the area under curve the validation was accessed of EuroSCORE II (AUC of 0.83 followed by STS IE (AUC of 0.75), PALSUSE (AUC of 0.74) and modified AEPEI (AUC of

0.68) respectively (36). The ROC score of the EuroSCOREII was 0.7 to 0.8 for all the surgeries (42). The validation power of the different risk score differs due to the population mapping and severity of the disease.

In our study The Hosmer–Lemeshow goodness-of-fit test gave a P-value of 0.328 for STS, 0.093 for EuroScoreII and 0.163 for THI score. Similar to our study the study of Brizido (2016) also applied Hosmer-Leme which showed good calibration for EuroSCORE II ($p=0.08$) and STS risk score for IE ($p=0.03$) but not for PALSUSE ($p=0.65$), modified AEPEI ($p=0.12$), These findings are align to our study findings the THI score have good calibration power of the risk among the cardiac surgery patients (43). The same application value in our population no risk score can accurately predict events in an individual patient. Because all databases for modelling of the score systems have some limitations, differences in definitions and variables between the risk scores can affect performance when they are applied to different populations. But the scoring systems also can be used as a guide; therefore, it is essential to choose an appropriate treatment for the patients in the next step. After comparison with two commonly used risk scoring systems we must acknowledge that THI score can effectively be used for the population of the Pakistan as well as south asians.

Our conclusions are limited by the scope of this single-centre retrospective study. Although a single-centre study enables more strict adherence to protocol and better standardization of treatment, a multicentre study enrolling an even larger number of participants will be required to validate our results in a more diverse population and more diverse range of clinical practices.

Conclusion

It is concluded that THI Score has similar applicability as EuroSCORE and STS, it can effectively evaluate the risk among both high risk and low risk patients. It is very simple to applicable in any cardiothoracic surgical settings and soundly based on the population of Pakistan. Population. The results obtained here were at least as good as those reported elsewhere. It is proposed to use it for the future expected mortality risk stratification of isolated CABG. Further multical and big data base study is needed to further refine the application of THI score.

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