

Does Parsonnet scoring model predict mortality following adult cardiac surgery in India?

Moningi Srilata, Narmada Padhy, Durga Padmaja, Ramachandran Gopinath

Department of Anaesthesiology and Critical Care, Nizam's Institute of Medical Sciences, Hyderabad, Andhra Pradesh, India

ABSTRACT

Aims and Objectives: To validate the Parsonnet scoring model to predict mortality following adult cardiac surgery in Indian scenario. **Materials and Methods:** A total of 889 consecutive patients undergoing adult cardiac surgery between January 2010 and April 2011 were included in the study. The Parsonnet score was determined for each patient and its predictive ability for in-hospital mortality was evaluated. The validation of Parsonnet score was performed for the total data and separately for the sub-groups coronary artery bypass grafting (CABG), valve surgery and combined procedures (CABG with valve surgery). The model calibration was performed using Hosmer–Lemeshow goodness of fit test and receiver operating characteristics (ROC) analysis for discrimination. Independent predictors of mortality were assessed from the variables used in the Parsonnet score by multivariate regression analysis. **Results:** The overall mortality was 6.3% (56 patients), 7.1% (34 patients) for CABG, 4.3% (16 patients) for valve surgery and 16.2% (6 patients) for combined procedures. The Hosmer–Lemeshow statistic was <0.05 for the total data and also within the sub-groups suggesting that the predicted outcome using Parsonnet score did not match the observed outcome. The area under the ROC curve for the total data was 0.699 (95% confidence interval 0.62–0.77) and when tested separately, it was 0.73 (0.64–0.81) for CABG, 0.79 (0.63–0.92) for valve surgery (good discriminatory ability) and only 0.55 (0.26–0.83) for combined procedures. The independent predictors of mortality determined for the total data were low ejection fraction (odds ratio [OR] - 1.7), preoperative intra-aortic balloon pump (OR - 10.7), combined procedures (OR - 5.1), dialysis dependency (OR - 23.4), and re-operation (OR - 9.4). **Conclusions:** The Parsonnet score yielded a good predictive value for valve surgeries, moderate predictive value for the total data and for CABG and poor predictive value for combined procedures.

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Key words: Cardiac surgery; heart disease; mortality; postoperative complications; risk stratification in cardiac surgery

INTRODUCTION

Data on risk, prognosis, and performance of specific procedures, particularly for resource-intensive operations such as coronary artery bypass graft (CABG) and heart valve surgery generates meaningful information on outcome performance of a center for a particular disease. This has led to an increased importance of patient outcome analysis.^[1] It is vital to define the preoperative risk parameters to improve the planning of the necessary resources and the final cost of

hospitalization, especially for organizations that financially support the procedures.^[2] Comparison of patient outcome with predicted outcome following adult cardiac surgery with the use of validated risk stratification models is the most preferred method to evaluate the quality of health care.^[3] Various mortality prediction models have been developed to correct for differences in the patient population and allow comparison of the actual outcome to expected outcome in cardiac surgery.^[4,5] The differences in the incidence of risk factors could affect the performance of risk

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Address for correspondence: Dr. Moningi Srilata, Flat No. G-3, Sujatha Sterling Homes, H. No. 8-2-403/A, Road No: 4, Banjara Hills, Hyderabad - 500 034, Andhra Pradesh, India. E-mail: srlatanims@gmail.com

stratification models applied to different geographical and ethnic populations.^[6] Different scoring systems with their revised models have come up with time to predict the short term outcome following cardiac surgery on the basis of preoperative characteristics. These include Parsonnet score,^[5] Euro additive model,^[7] and the Society of Thoracic Surgeons database score,^[8] etc., Most of them were designed to assess CABG patients, but they have been widely applied to patients undergoing heart valve surgeries also. The Parsonnet score, developed in the USA in 1989 is one of the most widely used methods of “stratifying open heart operations into levels of predicted operative mortality.”^[9] Parsonnet model is popular for its simplicity and easy application.^[10,11] Improvements in the diagnostic and therapeutic methods in the last two decades have led to a significant change in the profile of patients undergoing cardiac surgery. Several authors have modified the Parsonnet score and validated their modifications.^[5] These modifications are based on their data from local cardiac surgery management strategies and developments. These risk predicting scores need to be revalidated in different centers and scenarios at regular intervals. Moreover, very little Indian patient population based risk stratification models are available for regional application. Therefore, before applying the risk stratification models and their modifications to local population, their applicability, predictability, and accuracy need to be verified. The objective of our study was to validate the original Parsonnet risk scoring model to predict mortality following adult cardiac surgery in a tertiary referral hospital in India and to modify the model to suit the regional data.

MATERIALS AND METHODS

The study was conducted in a tertiary referral center in India. After obtaining IRB approval, patients undergoing elective or emergency adult cardiac surgery between January 2010 and April 2011 (15 months) were included in this study. Data from consecutive patients was collected prospectively after obtaining informed consent. All the variables in the Parsonnet scoring system were collected and entered into a computerized database to determine the Parsonnet score. Patients who were undergoing heart or heart-lung transplantation; and combined vascular and cardiac procedures, carotid endarterectomy, and aorto-femoral bypass were excluded from the study.

The Parsonnet risk model includes gender, age, diabetes, hypertension, type of valve surgery, ejection

fraction (EF), concomitant CABG surgery, obesity, preoperative intra-aortic balloon pump (IABP), surgery following cardiac catheterization, re-operation, dialysis dependent, other circumstances like severe asthma, paraplegia, pacemaker dependency, congenital heart disease in adult or other conditions, etc., and catastrophic states such as acute structural defect, cardiogenic shock, acute renal failure or other conditions, etc., Risk factors were recorded according to agreed definitions [Appendix 1].^[9,12] The primary outcome of this study was in-hospital mortality, which was defined as “mortality within the same hospital admission as operation, regardless of the cause.”

A Parsonnet score was derived for each patient and its predictive ability was studied. The data was divided into three sub-groups CABG, valvular surgery and combined procedures (CABG and valve surgery).

Statistical analysis

The data were presented as absolute numbers and percentages and mean \pm standard deviation or percentages. Data analysis was performed using the SPSS software package, version 17.0 (SPSS Inc. Released 2008. SPSS statistics for Windows, version 17.0. Chicago.SPSS Inc.). The Parsonnet score was derived for each patient. The predictive ability of the Parsonnet score was tested for the entire data and also for the sub-groups, CABG surgery, valve surgery and combined procedures. They were divided into five risk categories according to the Parsonnet score, good (0–4%), fair (5–9%), poor (10–14%), high (15–19%) and extremely high (>20%).^[9] The observed mortality in each of these categories were compared with the predicted mortality as per Parsonnet scoring system using Hosmer and Lemeshow's Chi-square statistic. $P < 0.05$ rejects the null hypothesis of no difference between observed and predicted deaths.

The total data were re-analyzed to assess the association between the parameters included in the Parsonnet score and postoperative mortality. The variables found to have a significant association with the outcome on univariate analysis ($P < 0.05$) were entered into multivariate regression analysis to identify independent predictors of mortality.

Comparison of categorical data between survivors and nonsurvivors was performed using Chi-square test and comparison of continuous data using independent sample *t*-test. All clinical variables with a $P < 0.05$ in the initial univariate analysis were considered potential

predictors of mortality. Independent predictors of mortality were determined using multivariate logistic regression analysis using forward conditional method. The R^2 of the model, change in R^2 obtained by addition of the variable, and the partial coefficients of each variable at each stage at which the variable is added to the equation were determined. The variable was retained if it contributed to a significant change in the R^2 (0.5 or more). The independent predictors of mortality were obtained using the variables with statistically significant contributions ($P < 0.05$) and no association between the variables.

RESULTS

A total of 889 adults underwent cardiac surgery during the specified period and were included in the study. The overall hospital mortality was 6.3% (56 out of 889 cases). Totally 482 patients underwent CABG and in-hospital mortality was 7.1% (34 out of 482 cases), mortality occurred in 16 of 370 patients (4.3%) for heart valve surgeries and 6 out of 37 patients (16.2%) had mortality in combined procedures. The prevalence of risk factors with mortality among the total study population and the sub-groups CABG, valve surgery and combined procedures is summarized in Tables 1-4.

The predicted and observed mortality for the described risk categories for the total data and the sub-groups CABG, valve surgery and combined procedures is shown in Table 5. The Hosmer–Lemeshow test statistic for model calibration showed $P < 0.01$ for the total data as well as the sub-groups CABG and valve surgery and $P < 0.05$ for combined [Table 5] rejecting the null hypothesis of no difference between observed and predicted deaths.

Figure 1 shows the receiver operating characteristics (ROC) curve for the total data of adult cardiac surgeries. Area under the ROC curve was found to be 0.699 (95% confidence interval: 0.62–0.77), which represents moderate discriminative ability. Figures 2-4 represent the ROC curves for CABG, heart valve surgeries and combined procedures, respectively. Area under ROC was found to be 0.73 (0.64–0.81) for CABG surgery, 0.79 (0.63–0.92) for valve surgery and 0.55 (0.26–0.83) for combined CABG and valve surgery. Parsonnet score was found to have a good discriminative ability for valve surgeries, moderate for CABG surgeries and poor for combined procedures.

Table 1: Prevalence of risk factors among the study population for overall cardiac surgery

Parameters	n=889	Mortality	P
Age			
<70	841	49 (5.8)	0.03*
71-74	35	6 (17.1)	
>74	13	1 (7.7)	
Female gender	301	21 (7)	0.32
Diabetes	354	24 (6.8)	0.36
Hypertension	426	33 (7.7)	0.06*
Obesity			
Nonobese	851	54 (6.3)	0.56
Obese	38	2 (5.3)	
PA pressure			
Normal	560	39 (7)	0.26
<60 mm Hg	199	13 (6.5)	
>60 mm Hg	130	4 (3.1)	
Aortic gradient			
Normal	745	49 (6.6)	0.36
<120 mm Hg	112	4 (3.6)	
>120 mm Hg	32	3 (9.4)	
EF			
Good	608	23 (3.8)	<0.001*
Fair	222	24 (10.8)	
Poor	55	8 (14.5)	
Preoperative-IABP	51	17 (33.3)	<0.001*
Left ventricular aneurysm	4	1 (25)	0.23
Valve+CABG	37	6 (16.2)	0.01*
Dialysis dependency	9	7 (77.8)	<0.001*
Emergency surgery following PTCA or catheterization complications	8	1 (12.5)	0.4
Catastrophic states (acute structural defect, cardiogenic shock, acute renal failure)	13	4 (30.8)	0.007*
Re-operation			
No	863	50 (5.8)	0.004*
1 st	26	6 (23.1)	
2 nd	0		
Type of surgery			
CABG	482	34 (7.1)	0.01*
Valve	370	16 (4.3)	
CABG+valve	37	6 (16.2)	
Other rare circumstances	35	3 (8.6)	0.38

IABP: Intra-aortic balloon pump, CABG: Coronary artery bypass grafting, PTCA: Percutaneous transluminal coronary angioplasty, EF: Ejection fraction, PA: Pulmonary artery, *: $P < 0.05$

In view of the poor calibration and moderate discriminatory ability of the Parsonnet score for the overall data, the total data were re-analyzed to identify independent risk factors of mortality from the variables included in the Parsonnet score. Fair EF, preoperative IABP, combined coronary artery bypass (CAB) and valve surgery, dialysis dependency and re-operation were identified as independent predictors of mortality on multivariate analysis. The odds ratio (OR) for mortality of these variables is shown in Table 6.

Table 2: Prevalence of risk factors among the study population for CABG surgery

Parameters	(n=482)	Mortality	P
Age			
<70	448	31 (6.9)	0.92
71-74	23	2 (8.7)	
>74	11	1 (9.1)	
Female gender	93	9 (9.7)	0.19
Diabetes	300	19 (6.3)	0.27
Hypertension	346	25 (7.2)	0.5
Obesity			
Nonobese	449	32 (7.1)	0.58
Obese	33	2 (6.1)	
PA pressure			
Normal	479	34 (7.1)	0.89
<60 mm Hg	1	0	
>60 mm Hg	2	0	
Aortic gradient			
Normal	482	34 (7.1)	-
<120 mm Hg	0	0	
>120 mm Hg	0	0	
EF			
Good	291	13 (4.5)	
Fair	147	16 (10.9)	0.02*
Poor	44	5 (11.4)	
Preoperative IABP	48	15 (31.3)	<0.001*
LV aneurysm	4	1 (25)	0.25
Valve+CABG	-	-	-
Dialysis dependency	6	5 (83.3)	<0.001*
Emergency surgery following PTCA or catheterization complications	8	1 (12.5)	0.445
Catastrophic states (acute structural defect, cardiogenic shock, acute renal failure)	12	4 (33.3)	0.007*
Re-operation			
No	479	33 (6.9)	0.19
1 st	3	1 (33.3)	
2 nd			
Other rare circumstances	15	2 (13.3)	0.29

IABP: Intra-aortic balloon pump, CABG: Coronary artery bypass grafting, PTCA: Percutaneous transluminal coronary angioplasty, EF: Ejection fraction, PA: Pulmonary artery, *: $P<0.05$

Table 3: Prevalence of risk factors among the study population for valve surgery

Parameters	n=370	Mortality	P
Age			
<70	361	13 (3.6)	0.001*
71-74	8	3 (37.5)	
>74	1	0	
Female gender	191	9 (4.7)	0.45
Diabetes	44	1 (2.3)	0.47
Hypertension	63	3 (4.8)	0.52
Obesity			
Nonobese	365	16 (4.4)	0.8
Obese	5	0	
PA pressure			
Normal	0		0.74
<60 mm Hg	249	12 (4.8)	
>60 mm Hg	121	4 (3.3)	
Aortic gradient			
Normal			0.79
<120 mm Hg	340	14 (4.1)	
>120 mm Hg	30	2 (6.7)	
EF			
Good	294	8 (2.7)	0.001*
Fair	65	5 (7.7)	
Poor	7	2 (28.6)	
Preoperative IABP	-	-	-
LV aneurysm	-	-	-
Valve+CABG	-	-	-
Dialysis dependency	3	2 (66.7)	0.005*
Emergency surgery following PTCA or catheterization complications	0	-	-
Catastrophic states (acute structural defect, cardiogenic shock, acute renal failure)	1	0	0.95
Re-operation			
1 st	23	5 (21.7)	0.002*
2 nd			

IABP: Intra-aortic balloon pump, CABG: Coronary artery bypass grafting, PTCA: Percutaneous transluminal coronary angioplasty, EF: Ejection fraction, LV: Left ventricular, PA: Pulmonary artery, *: $P<0.05$

DISCUSSION

Risk stratification model for prediction of mortality in cardiac surgery is important to health authorities, hospitals, medical practitioners, and patients. Preoperative risk scores are an essential tool for risk assessment, cost-benefit analysis, and to study therapy trends. Several different scoring systems have been developed to predict mortality after adult heart surgery, to correct for differences in patient population and to allow comparison of the actual outcome to predicted outcome.^[3,5] These models allow for an objective assessment of the indications for surgery in individual patients, by facilitating a more accurate balance of

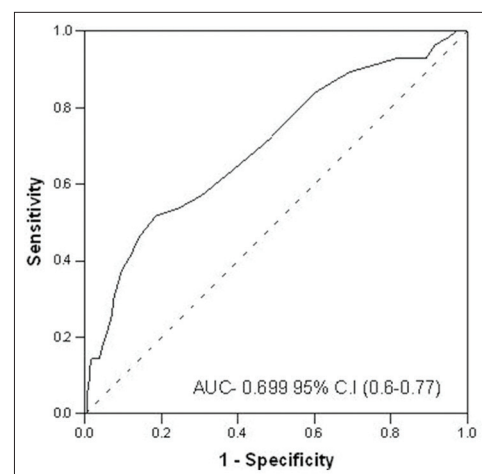


Figure 1: Receiver operating characteristics curve of the Parsonnet scores for the total number of adult cardiac surgeries. ROC: Receiver operating characteristics, AUC: Area under curve

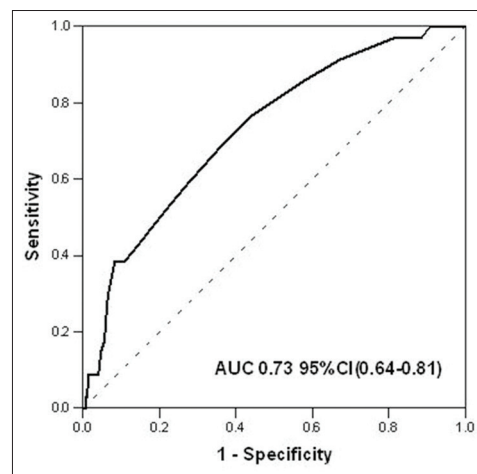
Table 4: Prevalence of risk factors among the study population for combined procedures

Parameters	n=37	Mortality (%)	P
Age			
<70	33	5 (15.2)	0.65
71-74	3	1 (33.3)	
>74	1	0	
Female gender	17	3 (17.6)	0.58
Diabetes	10	4 (40)	0.03*
Hypertension	17	5 (29.4)	0.06
Obesity			
Nonobese	37	6 (16.2)	-
Obese		0	
PA pressure			
Normal	9	1 (11.1)	0.29
<60 mm Hg	21	5 (23.8)	
>60 mm Hg	7	0	
Aortic gradient			
Normal	27	5 (18.5)	0.18
<120 mm Hg	8	0	
>120 mm Hg	2	1 (50)	
EF			
Good	23	2 (8.7)	0.27
Fair	10	3 (30)	
Poor	4	1 (25)	
Preoperative IABP	3	2 (66.7)	0.06
LV aneurysm	0	0	-
Dialysis dependency	0	0	-
Emergency surgery following PTCA or catheterization complications	0	0	-
Catastrophic states (acute structural defect, cardiogenic shock, acute renal failure)	0	0	-
Re-operation			
1 st	0	0	
2 nd			
Type of surgery			
CABG+MVR	27	5 (18.5)	0.05*
CABG+AVR	9	1 (11.1)	
CABG+DVR	1	0 (0)	

IABP: Intra-aortic balloon pump, CABG: Coronary artery bypass grafting, PTCA: Percutaneous transluminal coronary angioplasty, AVR: Aortic valve replacement, DVR: Double valve replacement, MVR: Mitral valve replacement, EF: Ejection fraction, LV: Left ventricular, PA: Pulmonary artery, *: $P < 0.05$

potential risks and benefits.^[2,13] Studies have shown that the risk stratification models may have reduced the applicability when used in patient populations different from the ones on which they were formulated.^[14] The application of newer techniques, drugs and modifications of the quality medical care and their effect on the outcome can be evaluated by such scoring models. Hence, risk stratification models need to be validated periodically and also in different populations.

The current study evaluated the validity of the Parsonnet score in a tertiary referral cardiac teaching hospital in India. The Parsonnet scoring had good

**Figure 2:** Receiver operating characteristics curve of the Parsonnet scores for coronary artery bypass surgery. ROC: Receiver operating characteristics; AUC: Area under curve; CABG: Coronary artery bypass surgery

discriminative ability for valve surgeries, moderate discriminating ability for CABG surgeries and for overall cardiac surgeries and poor discriminating ability for combined procedures. Among the parameters included in the Parsonnet score the risk factors, which were found to be significant predictors of mortality in the total data set were low EF (OR - 1.7), preoperative IABP (OR - 10.7), combined CAB and mitral valve surgery (OR - 5.1), dialysis dependency (OR - 23.4) and re-operation (OR - 9.4).

Ejection fraction <30% was found to be a significant predictor of mortality following cardiac surgery. Recent studies too have reported good correlation between low EF and poor outcome following cardiac surgery.^[15,16] As with Society of Thoracic Surgeons adult cardiac surgery database (The ASCERT study),^[8] and initial Parsonnet study,^[9] re-operation was found to be an independent predictor of mortality following cardiac surgery in our institute.

Perioperative catastrophes play a major role in determining the final outcome of cardiac surgical patients. Although a few recent studies have also shown a good outcome with preoperative use of IABP.^[17,18] IABP was found to be a significant predictor of hospital mortality with high OR. This may be attributed to other serious co-morbid events associated with patients requiring IABP.

Dialysis dependency carried a high OR in our current study and was significantly associated with mortality. Dialysis dependency patients carry a high risk and

Table 5: Comparison of predicted and observed mortality for overall cardiac surgery, and for sub-groups-CABG surgery, valve surgery and combined procedures

Comparison of predicted and observed mortality				
Risk group	Number of patients within the risk category	Predicted mortality within the risk category <i>n</i> (%)	Observed mortality within the risk category <i>n</i> (%)	Hosmer and Lemeshow goodness-of-fit test for model calibration
Overall (CABG+valve)				
Good	94	0.94 (1)	5 (5.3)	Hosmer–Lemeshow statistic-24.92, df-3, <i>P</i> <0.01
Fair	436	21.8 (5)	18 (4.1)	
Poor	238	21.42 (9)	13 (5.5)	
High	74	12.58 (17)	11 (14.9)	
Extremely high	47	14.1 (30)	9 (19.1)	
CABG surgery				
Good	52	0.52 (1)	2 (2.2)	Hosmer–Lemeshow statistic-14.99, df-3, <i>P</i> <0.01
Fair	249	12.5 (5)	9 (3.86)	
Poor	120	10.8 (9)	10 (10.1)	
High	35	5.9 (17)	9 (37.5)	
Extremely high	26	7.8 (30)	4 (11.4)	
Valvular surgery				
Good	3	0.03 (1)	0 (0)	Hosmer–Lemeshow statistic-9.616, df-3, <i>P</i> <0.01
Fair	183	9.15 (5)	2 (1.1)	
Poor	130	11.7 (9)	6 (4.6)	
High	45	7.65 (17)	6 (13.3)	
Extremely high	9	2.7 (30)	2 (22.2)	
Combined procedures				
Good	0	0	0	Hosmer–Lemeshow statistic-8.74, df-3, <i>P</i> <0.05
Fair	15	0.75 (5)	3 (20)	
Poor	14	1.26 (9)	1 (7.14)	
High	4	0.68 (17)	0	
Extremely high	4	1.2 (30)	2 (50)	

CABG: Coronary artery bypass grafting

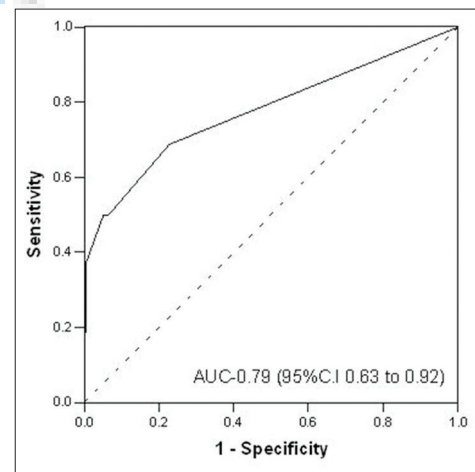
Table 6: Multivariate regression analysis to identify the independent predictors of mortality

Parameters	β coefficient	P	OR	Lower limit	Upper limit
Low EF	0.5	0.02	1.7	1.1	2.6
Preoperative IABP	2.4	0	10.7	5	22.8
Dialysis dependent	3.1	0	23.4	4	134.5
Combined procedures	1.6	0.01	5.1	1.9	13.9
Re-operation	2.2	0	9.4	3.2	27.9

OR: Odds ratio, IABP: Intra-aortic balloon pump

decreased survival following cardiac surgery. Though the risk has come down considerably, overall survival has not improved.^[19,20]

Left ventricular (LV) aneurysm, mitral and aortic valve involvement with significant high pulmonary artery pressures and increased aortic gradients did not have a significant association with hospital mortality following adult cardiac surgery. However, it was reported that LV aneurysm, when associated with advanced age, history of ventricular arrhythmia, three-vessel disease, poor LV function, and linear repair of the aneurysm were associated with poor survival.^[21]

**Figure 3:** Receiver operating characteristics curve of the Parsonnet scores for valve surgery. ROC- Receiver Operating Characteristics, AUC: Area under curve

Coronary artery bypass graft surgery at the same time as the valve surgery was also found to have a significant association with mortality following cardiac surgery. All the 37 patients who underwent combined CABG with valve surgery patients belonged to the CABG group and had primary coronary artery disease. The mortality in

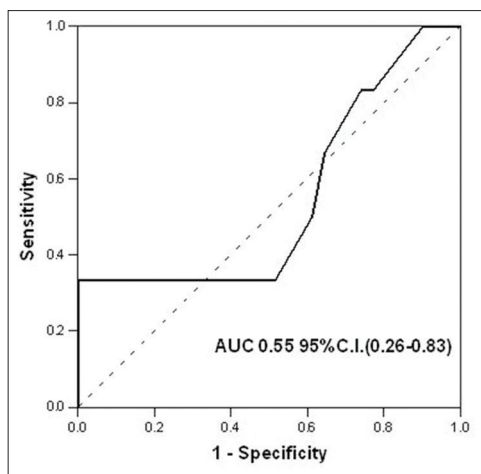


Figure 4: Receiver operating characteristics curve of the Parsonnet scores for combined procedures. ROC: Receiver Operating Characteristics, AUC: Area under curve

these patients was 16.2%. 27 patients had ischemic mitral regurgitation requiring mitral valve replacement (mortality of 18.5%). aortic valve replacement (AVR) was performed in nine patients (mortality of 11.1%) and double valve replacement in one patient. No patients with primary valvular disease underwent CABG in this set of patients. Our finding has shown Parsonnet score to have a poor discriminating ability for combined procedures compared to other sub-groups. The main limitation for this was the small sample size, hence may not be reliable. Researchers have reported that survival after mitral valve surgery and CABG is not only determined by the extent of coronary disease and ventricular dysfunction, but also by the success of the valve procedure.^[22] Combined AVR and CABG have shown to be markers for decreased survival. Preexisting factors such as diabetes, peripheral vascular disease and cerebrovascular disease, as well as poor preoperative New York Heart Association functional status have been reported to affect survival during AVR + CABG surgery.^[23] In Parsonnet risk scoring, the score given to CABG at the time of valve surgery compared to hypertension, obesity and diabetes is less. This could have also influenced the performance of the score.

Female gender has been found to be an independent predictor for mortality following CABG surgery in previous studies.^[24] Recent studies have shown that female gender associated with other preoperative risk factors and with increased age have shown a significant correlation with the postoperative mortality.^[24,25] However, in our study, neither female gender nor age were found to be significant predictors of mortality following cardiac surgery.

Other risk factors such as morbid obesity, diabetes and hypertension were also not significant predictors of mortality following CABG surgeries in the current study. We searched published reports of recent studies and found variable results regarding these predictors. Morbid obesity was not found to be a significant predictor of mortality following CABG surgery.^[26] There were conflicting results regarding diabetes as a predictor for the outcome following cardiac surgery.^[27,28] Hypertension *per se* was not an independent predictor of mortality following cardiac surgery. However, hypertension associated with other predictors like age, obesity and female gender, was associated with mortality following cardiac surgery.^[25] Factors like other rare circumstances (e.g., paraplegia, pacemaker dependency, congenital heart disease in adults, severe asthma) did not have any significant statistical association with mortality prediction in the study.

The emergency complications following catheterization were not found to be significant predictors of mortality. Seshadri *et al.* have reported that the major indications for emergency CABG following catheterization were found to be extensive dissection ($n = 61$, 54%), perforation/tamponade ($n = 23$, 20%), and recurrent acute closure of coronary artery ($n = 23$, 20%).^[29] Yang *et al.* reported that there has been a marked decrease in the prevalence of patients requiring emergency CABG following complications of cardiac catheterization. However the in-hospital mortality rate for their patients continued to be high.^[30] However, in our study, mortality with surgery following complicated catheterization was found to be comparable to those without such complications (1/8 cases [12.5%]). The use of drug eluting stents, improvised techniques for stenting, strict guidelines for practice of interventional procedures have resulted in a decrease of these complications. Surgery following catheterization carries 10 points. This may be crafted down for better validation in the current circumstances.

The Parsonnet score has been criticized for its overestimation of risk, moderate ability to predict mortality and better suitability for coronary surgeries.^[12] In contrast, the score seemed to perform better for valve surgeries when compared with CABG. Outcome prediction studies of valve surgery have been very few compared to those of coronary surgery. The risk factors associated with valve surgery are more ambiguous, and acceptable outcomes are more difficult to define.^[31]

Parsonnet score is known to omit some risk factors that are associated with mortality, such as urgency of surgery and include some factors that are not. The Parsonnet score has been modified by several researchers based on their local data. The original score was modified by including 30 risk factors used in the “SUMMIT” system. These 30 new risk factors replaced the two imprecise risk factors of the initial score, and this new score was referred to as the “modified Parsonnet score. However, studies have proved that the use of modified Parsonnet score is too complex, and many of its risk factors are subjective or not well defined.^[32] In 2000, an analysis of 10,703 patients from 10 centers in New Jersey (USA) gave rise to the 2000 Bernstein-Parsonnet score which is a simplified bedside version of the original but only fewer studies have reported good correlation between predicted and observed mortality in patients undergoing CABG or valve surgery.^[5,13] Risk stratification models for the immediate outcome in cardiac surgical patients in Indian population is sparsely reported. A recent study by Borde *et al.* from an Indian institution reported that Euroscore II and Society Thoracic Surgeons have shown poor discrimination.^[33] Parsonnet scoring is very easy to use and can be applied bedside and hence, is widely accepted by the cardiac centers. This scoring had got a good predictive value in studies conducted at various centers like Wythenshawe Hospital, Manchester,^[4] and Sarajevo Heart Centre.^[11] Objective variables rather than subjective variables with high validity are included in this model and clinicians are familiar with these conventional variables. Application of Parsonnet score to our data has shown moderate predictive ability for mortality with cardiac surgery.

CONCLUSION

The original Parsonnet risk scoring model to predict mortality following adult cardiac surgery and sub-groups CABG surgery, valve surgery and combined procedures was validated using the data from a tertiary referral center from India. Overall, the Parsonnet score generated a moderate predictive value for cardiac surgeries in Indian setup. The Parsonnet score yielded a good predictive value for valve surgeries and moderate predictive value for CABG surgery and poor predictive value for combined procedures. Re-analysis of the variables included in the Parsonnet score has shown that fair EF, preoperative IABP, combined CAB and valve surgery, dialysis dependency and re-operation were independent predictors of mortality.

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Appendix 1: Description of risk factors

Risk factors	Assigned weight
Female gender	1
Morbid obesity ($\geq 1.5 \times$ the ideal weight)	3
Diabetes	3
Hypertension (systolic blood pressure >140 mm Hg)	3
EF (%)	
Good ≥ 50	0
Fair 30-49	2
Poor <30	4
Age	
<70	7
71-74	12
≥ 75	20
Re-operation	
1 st	5
2 nd	10

Contd...

Appendix 1: Continued

Risk factors	Assigned weight
Preoperative IABP	20
LV aneurysm	5
Emergency surgery following PTCA or catheterization complications	10
Dialysis dependency (peritoneal or hemo-dialysis)	10
Catastrophic states (acute structural defect, cardiogenic shock, acute renal failure or similar conditions)	10-50
Other rare circumstances (paraplegia, pacemaker dependency, severe asthma, congenital heart disease in the adult)	2-10
Mitral surgery	5
Mitral surgery and PA pressure ≥ 60 mm Hg	8
Aortic surgery	5
Aortic surgery and aortic gradient ≥ 120 mm Hg	7
CABG at the time of valve surgery	2

IABP: Intra-aortic balloon pump, CABG: Coronary artery bypass grafting, PTCA: Percutaneous transluminal coronary angioplasty, LV: Left ventricular, EF: Ejection fraction, PA: Pulmonary artery