

Comparison of The HARKIT Score with The STS Score in Predicting Mortality Rates Post Valve Surgery

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Abstract

Background: Valvular heart disease is a major contributor to increased mortality. The HARKIT score has been validated to predict mortality after specific valve surgery and the STS score to predict mortality rates in patients after cardiac surgery. Haji Adam Malik General Hospital Medan has never used the HARKIT score and the STS score to predict mortality in patients with post-valve surgery.

Methods: A cross-sectional study from January 2022-April 2023 at Haji Adam Malik General Hospital Medan. The data is obtained from patient medical records who had heart valve surgery. The data were analyzed with descriptive statistics and presented the form of frequency distribution. A comparison of the HARKIT score with the STS score to predict mortality rates was analyzed using chi-square test.

Results: Among 63 patients who underwent valve surgery, 8 patients died after surgery. The HARKIT score system has good analytical power and very strong discriminant (H-L test $P=0.646$; AUC=0.916; 95% CI=0.794-1.000), while the STS score has poor analytical power (H-L test $P=0.002$) but has moderate discriminant (AUC=0.798; 95% CI=0.632-0.964).

Conclusions: The HARKIT score is more accurate than the STS score in predicting the mortality rate of post-valve surgery patients at Haji Adam Malik General Hospital Medan.

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Introduction

Valvular heart disease is a condition in which the heart valves do not operate normally, resulting in disruption of blood circulation through the valves. Manifestations can be stenosis (narrowing) or regurgitation (leakage) which can result in reduced quality of life and increased mortality rates.¹

The mortality rate for rheumatic heart disease in Indonesia reached 4.8% per 100,000, populations while aortic stenosis severity was recorded at RSUP Prof. Dr. I.G.N.G Ngoerah Denpasar in 2018-2023 was 55.8%, impacting mortality.³ Harapan Kita Heart and Blood Vessel Hospital (RSJPDHK) is a referral center in Indonesia regarding heart problems, handles 400-550 heart valve surgeries yearly in 2019-2020, but factors like economic status, education, and limited healthcare facilities often cause delays in intervention for valvular heart disease.⁴

Various scoring systems like EuroSCORE II and STS Mortality Risk Score help estimate mortality and morbidity rates after cardiac surgeries. However, a newer predictive tool, the Harapan Kita score (HARKIT), introduced in 2021 by Soesanto et al., is validated for assessing mortality and morbidity in specifically evaluates mortality and morbidity rates in patients with heart valve abnormalities, considering variables like NYHA Class 3-4, hypertension, history of heart surgery, CCT < 50 ml/hour, TAPSE < 1.6 cm, history of emergency surgery, history of CABG and history of TVR.²

Saputri et al., have compared these scoring systems in different settings, with research at RSUP Dr. Hasan Sadikin Bandung showing equivalent predictive abilities of STS and EuroSCORE II in determining mortality rates during coronary artery surgery. finding that patients aged > 65 years, male gender, overweight BMI, history of hypertension, ejection fraction 21-30% and creatinine clearance value < 50 mL/min had higher mortality.⁸ However, while EuroSCORE's validity in predicting mortality rates was established across hospitals, the HARKIT score was mainly validated within RSJPDHK.² This study aims to determine the comparison of the HARKIT score with the STS score in predicting mortality rates in patients after heart valve surgery at Haji Adam Malik General Hospital Medan.

Methods

Study Design

We performed a cross-sectional study to determine the comparison of the HARKIT score with the STS score in predicting the mortality rate of patients after heart valve surgery. This research was carried out at Haji Adam Malik General Hospital Medan on 63 patients with a history of post-valve surgery at Haji Adam Malik General Hospital Medan for the period January 2022–April 2023. This research was approved by Ethics Committee Approval for Conducting Health Research No:631/KEPK/USU/2023.

Subjects

We included all adult patients using consecutive sampling from patient medical record with inclusion mitral valve (stenosis or regurgitation) or aortic valve (stenosis or regurgitation) or combination of both valves, who had underwent heart valve surgery. The exclusion criteria were patients with congenital heart disease, history of other surgery. The HARKIT score < 5 is categorized as low risk of mortality and > 5 high risk of mortality, while the STS score if < 8% is categorized as low risk and > 8 high risk of mortality.

Data collections and Outcome

The instrument of this research is medical record data of patients with a history of post-valve surgery at Haji Adam Malik General Hospital Medan in January 2022 - April 2023 in the form of age, gender, weight and height, history of current illness and history of comorbidities in post-valve surgery patients at Haji Adam Malik General Hospital Medan in January 2022 – April 2023.

Data Analysis

All data were analyzed using IBM SPSS statistics. Categorical scale presented in frequency distribution, while numerical scale was presented in mean ± SD. The Chi-square test was employed in a bivariate analysis to assess the relationship between the HARKIT score and the mortality rate and the relationship between the STS score and the mortality rate for patients after

valve surgery. Furthermore, a prognostic assessment was performed utilizing the Receiver Operating Characteristic (ROC) curve to determine the cut-off point, sensitivity, specificity, and Area Under the Curve (AUC). The optimum cut-off point for the HARKIT score and STS score for predicting death was calculated based on the Youden index.

Results

Based on the results of data collection, 63 samples were obtained that met the inclusion criteria through the medical records at Haji Adam Malik General Hospital Medan for the period January 2022 – April 2023.

Table 1. shows that the proportion of genders undergoing surgery is almost equal, namely 55.6% of female patients. The age was dominated by those aged > 25 years as many as 54 patients (85.7%). Around 88.9% of patients had a BMI >18.5 kg/m² and risk factors for heart disease such as diabetes mellitus were 27%, and 22.2% were hypertension. 9.5% of patients underwent surgery in active infective endocarditis and 27% of patients were anemic. NYHA FC was slightly equal by NYHA FC Class 3-4 with 30 patients (47.6%). All patients before surgery were in stable condition and no patient had a history of heart surgery before. From echocardiography examination, the majority of patients had good LVEF of 95.2%, right ventricular dysfunction (TAPSE) of 49.2% and 74.6% of patients had TVG > 46 mmHg. The mortality rate at Haji Adam Malik General Hospital Medan from the period January 2022 – April 2023 after surgery was 12.7% or 8 patients.

Table 2. provides the majority of patients showed abnormalities in the mitral valve 69.8% and abnormalities in the aortic valve 9.5% of patients. A total of 20.6% of patients showed abnormalities in both valves. The type of valve abnormality shows that mitral stenosis dominates, namely 60.3% of patients. Aortic stenosis occurred in 11.1% of patients, and aortic regurgitation occurred in only 3.2% of patients, while another 3.2% showed more than one type of significant abnormality. Heart valve surgery was dominated by mitral valve surgery in 45 patients (71.4%), followed by 12 patients (19.1%) in mitral and aortic valve surgery, while aortic valve surgery was 19.1% or 6 patients. Rheumatic heart disease is the most common etiology

of heart valve disease, accounting for 73%.

Based on Table 3, it is known that by using the HARKIT score for patients who experienced mortality, an average score of 6.71 was obtained with a median of 7. Meanwhile, the STS score obtained an average score for patients who experienced mortality of 3.79% with a median of 2, 6%.

Based on the results of the bivariate test, the HARKIT score and STS score have a relationship with mortality.

Figure 1. shows that the ROC curve is generated from various cut-off point values. It can be seen that the ROC curve is above the reference line. The resulting AUC value is 0.916, so based on this AUC value the level of accuracy of the HARKIT Score prediction in classification is very good.

Figure 2 shows that the ROC curve is generated from various cut-off point values. It can be seen that the ROC curve is above the reference line. The resulting AUC value is 0.798, so based on this AUC value the level of accuracy of the STS Score prediction is in the medium classification.

Discussion

The HARKIT and STS scores assess mortality risk post-heart valve surgery, considering various factors like age, sex, NYHA fc, BMI, DM, hypertension, history of stroke, atrial fibrillation/flutter, active infective endocarditis, history of heart surgery, preoperative conditions, CCT, Hb levels, rheumatic heart disease, LVEF, TAPSE, TVG, operation timing, number of valve operations, concomitant CABG, and concomitant TVR. Patients undergoing surgery are mostly over 25 years old, aligning with prior studies by Melati & Sofia (2019) suggesting surgery is cautioned for elderly patients due to higher mortality risks even with corrected factors. In addition, patients over 65 years of age have less good results than younger people, this is related to decreased heart function, complications such as heart failure, pulmonary edema, and other incidents that can have adverse effects after surgery.⁹ In this study, both women and men who underwent heart valve surgery had relatively equal numbers, namely 55.6% vs 44.4%. In this study, it was found that 9.5% of patients who died were female. This is in line with research by Rosengrena

Table 1. Baseline Characteristic Subjects.

Variable	n	Percentage (%)
Demographic Characteristic		
Age < 25 years	9	14.3
Age > 25 years	54	85.7
Woman	35	55.6
Man	28	44.4
BMI < 18.5 kg/m ²	56	88.9
BMI > 18.5 kg/m ²	7	11.1
Clinical Parameter		
Diabetes Mellitus	17	27.0
Hypertension	14	22.2
Stroke History	2	3.2
Atrial Fibrillation History	28	44.4
Active IE	6	9.5
Previous Surgery	0	0
Emergency Surgery	0	0
Unstable Preoperative Condition	0	0
Functional Class 3-4	30	47.6
Laboratorium		
Hb < 12 gr/dL	17	27.0
Hb > 12 gr/dL	46	73.0
CCT < 50 ml/min	12	19.0
CCT > 50 ml/min	51	81.0
Echocardiography Parameter		
LVEF < 40%	3	4.8
LVEF > 40%	60	95.2
TAPSE < 1.6 cm	31	49.2
TAPSE > 1.6 cm	32	50.8
TVG < 46 mmHg	16	25.4
TVG > 46 mmHg	47	74.6
Concomitant CABG	0	0
Concomitant TVR	42	66.7
Mortality		
Life	55	87.3
Die	8	66.7
HARKIT Score		
High Risk	12	19%
Low Risk	51	81%
STS Score		
High Risk	4	6.3%
Low Risk	59	93.7%

Table 2. Characteristics of Heart Valve Disorders and Surgery.

Variable	n	Percentage (%)
Number of Valve Operations		
Single valve operation	56	88.9
Double valve operation	7	11.1
Mitral and Aortic Valve Disorders		
Mitral valve only	44	69.8
Aortic valve only	6	9.5
Mitral and aortic valves	13	20.6
Types of Valve Abnormalities		
Predominant mitral stenosis	38	60.3
Predominant mitral regurgitation	14	22.2
Predominant aortic stenosis	7	11.1
Dominant aortic regurgitation	2	3.2
More than 1 is significant	2	3.2
Valve Surgery		
Mitral valve surgery	45	71.4
Aortic valve surgery	6	9.5
Mitral and aortic valve surgery	12	19.1
Valve Disease Etiology		
Rheumatic Heart Disease	46	73.0
Non-Rheumatic Heart Disease	17	27.0

et al. (2019) that the death rate for women is 6.4 times greater than for men. However, bivariate analysis in this study did not establish a direct link between gender and post-surgery mortality.¹⁰

Rheumatic heart disease was the primary cause of valve disease in 73% of cases. Around 9.5% underwent surgery during active endocarditis. Most patients (88.9%) had a BMI > 18.5 kg/m², consistent with Tjeertes et al. (2015) previously stated that the average BMI of patients undergoing surgery was overweight.¹¹ Obesity has a significant relationship with death after heart valve surgery,¹² while in several other studies, it was stated that obesity raises the STS scoring value, elevating the risk of in-hospital death.⁸

In a covariate study no disparity was observed in postoperative mortality based on BMI.¹³ However, obesity might heighten early postoperative complications. Preoperative BMI screening for valve surgery patients is deemed essential. Contrary to expectations, this study revealed higher mortality rates among patients with overweight BMI, potentially attributed to the majority

of surgery candidates falling into this category due to stringent preoperative screening protocols for heart valve surgery eligibility.

Patients with hypertension accounted for 22.2%, and notably, 7.9% of post-valve surgery mortalities were in this group. Research shows that 27.0% of patients undergoing heart valve surgery have a history of diabetes mellitus. Rosengrena et al. (2019) stated that 26 - 34% of patients undergoing heart valve surgery have a history of diabetes mellitus. In this study, the majority of patients who died with comorbid diabetes mellitus was 1.6%. The overall characteristics of surgery in this study were elective procedures, stable preoperative condition and no history of heart surgery. Single valve surgery dominates heart valve surgery at 88.9% with mitral stenosis valve abnormalities at 60.3%.¹⁰

Based on echocardiography results, the majority of patients undergoing heart valve surgery have a left ventricular ejection fraction > 40%. Patients with low ejection fraction have worse survival rates compared to patients with normal ejection fraction (Saputri et al,

Table 3. Statistical Distribution of HARKIT and STS Score.

Variables	Mortality	Mean ± SD (N=63)	Median
HARKIT score	No	2,98 ± 1,43	3
	Yes	6,71 ± 1,25	7
STS score	No	19,03 ± 130,62	1,67
	Yes	3,79 ± 3,30	2,6

Table 4. Bivariate test on HARKIT scores and STS scores.

Variables	Mortality		Mortality	Mortality	95% Confidence Interval	
	No	Yes			Min	Max
	N (%)	N (%)				
HARKIT score						
High Risk	4 (6,3)	8 (12,7)	<0,001	0,333	0,150	0,742
Low Risk	51 (81)	0				
STS score						
High Risk	1 (1,6)	3 (4,8)	0,005	0,031	0,003	0,355
Low Risk	54 (85,7)	5 (7,9)				

2022). The findings of this study indicate that a high ejection fraction is associated with a low mortality rate after heart valve surgery.

Based on laboratory test results, most patients exhibited hemoglobin levels above 12 gr/dL (73%), while hematocrit levels were notably low at 65.1%. Platelet counts were within the normal range for 79.4% of patients. Leukocyte counts were normal for 68.3%, but approximately 31.7% showed elevated levels. Creatinine levels were normal for 57.1%, while 22.2% had low levels and 20.6% had high levels. Pre-surgery laboratory assessments, as highlighted by Kumar & Srivastava (2011), play a pivotal role in comprehending patient conditions and aiding risk assessment and postoperative care preparation.¹⁴

Most patients (69.8%) exhibited mitral valve abnormalities, with 20.6% having issues in both mitral and aortic valves. Predominantly, mitral stenosis was observed in 60.3% of patients, followed by mitral regurgitation in 22.2%. Aortic stenosis was present in 11.1%, aortic regurgitation in 3.2%, while another 3.2% showed more than one type of significant abnormality. Mitral valve surgeries prevailed (71.4%), followed by combined mitral and aortic surgeries

(19.1%), and aortic valve surgeries (19.1%). This data delineates the spectrum of heart valve abnormalities and the corresponding surgical interventions within the patient sample.

The study's bivariate analysis revealed associations between patient mortality, both the HARKIT score ($p < 0.001$, OR = 0.333, CI 95% = 0.150-0.742) and the STS score ($p = 0.005$, OR = 0.031, CI 95% = 0.003-0.355). Based on the results of scoring with the HARKIT score, it was found that 8 patients were in the high-risk category and in this study, it was found that a 100% mortality rate was predicted to experience mortality. This is in line with the results of previous research by Soesanto et al. (2021) that based on the HARKIT score it was able to predict mortality well, namely that a mortality rate of 8.6% was obtained from the 11.9% of patient deaths predicted after heart valve surgery.² Meanwhile, based on the STS score, 2 patients were found to be in the high-risk category, and 61 patients were in the low category, based on the mortality experienced by the patients, it was found that 6 out of 8 patients who experienced mortality were from patients in the low category. Balan et al. (2017) revealed that the STS score is less suitable in predicting mortality risk

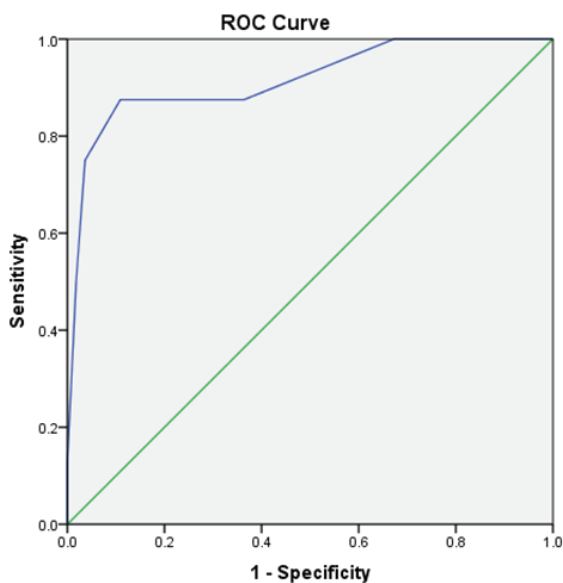


Figure 1. AUC Curve for the HARKIT Score Mortality Scoring System.

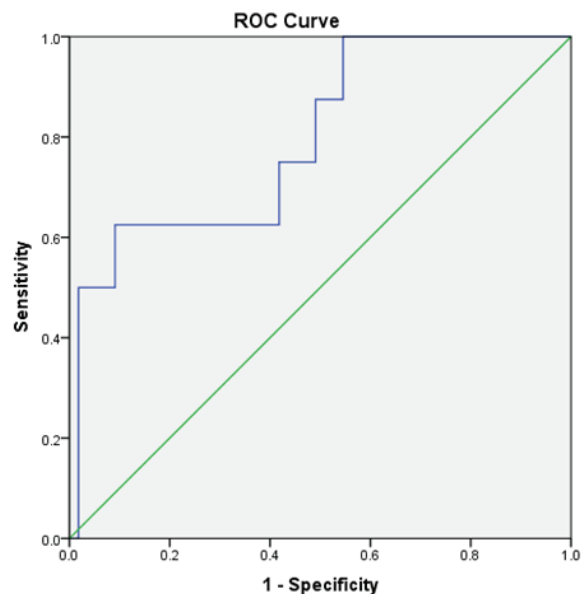


Figure 2. AUC Curve for the STS Mortality Score System.

well.¹⁵

The logistic regression analysis using the H-L test showed that the p-value was 0.646, which means there is no significant difference between the model and the data, indicating the HARKIT score's ability to effectively predict observed outcomes. Seeing that the H-L test results are positive, the relationship between the HARKIT scores is unidirectional, that the higher the HARKIT score obtained, the worse the patient's outcome is after valve surgery mortality. Similar results were obtained from research by Soesanto et al. (2021) which states that the HARKIT score can be used to predict mortality after valve surgery. This suggests that the HARKIT score is useful in evaluating patients after valve surgery.²

The ROC graph shows that HARKIT has a very good performance for predicting patient mortality post-valve surgery with an AUC value of 0.916. Conversely, STS displayed a moderate performance, depicted by its AUC value of 0.798 (95% CI = 0.632 - 0.964) with a p-value of 0.002, indicating its inability to predict the observed value. These results align with Melyana's (2020) findings, supporting HARKIT's superior predictive capacity compared to other scores.¹⁶ The results of this research are also supported by the findings of Soesanto et al. (2021), affirming the HARKIT score's efficacy in

analyzing the risk of post-valve surgery mortality.²

Conclusion

The HARKIT score is more accurate than the STS score in predicting the mortality rate of patients after valve surgery at Haji Adam Malik Hospital, Medan. In addition, based on the OR value, the HARKIT score was more accurate in predicting the incidence of mortality after valve surgery compared to the STS score.

List Of Abbreviations

AUC	Area Under the Curve
BMI	Body Mass Index
CABG	Coronary Artery Bypass Grafting
DM	Diabetes Mellitus
HARKIT	Harapan Kita
Hb	Hemoglobin
LVEF	Left Ventricular Ejection Fraction
ROC	Receiver Operating Characteristic
STS	Society of Thoracic Surgeons
TAPSE	Tricuspid Annular Plane Systolic Excursion
TVG	Tricuspid Valve Gradient
TVR	Tricuspid Valve Repair

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