STS (Society of Thoracic Surgeon) Score as a Predictor for Major Adverse Cardiovascular Events in Patients Undergone Coronary Artery Bypass Surgery During Admission in Haji Adam Malik General Hospital Medan

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Abstract:-
Background: Coronary heart disease ranks first as the leading cause of death in the world, an estimated 17.9 million people die every year. Coronary artery bypass surgery (CABG) is one of the management interventions for CHD patients, but the high mortality rate after CABG and other risks is still high. The STS score is one of two types of scores currently used to predict the incidence of mortality in patients undergoing cardiac surgery.

Objective: To determine the role of STS scores in predicting Major Adverse Cardiovascular Events (MACE) in patients undergone coronary artery bypass surgery during admission in Haji Adam Malik General Hospital Medan.

Methods: This study is a retrospective cohort study of 75 CHD patients who undergone CABG at Haji Adam Malik Hospital Medan from June 2019 to June 2020. Each patient who undergone CABG was calculated using the STS calculator to assess the risk of post-CABG outcome. There are nine risks that are assessed and then the relationship will be assessed with the incidence of MACE in CABG patients. Statistical analysis was performed to assess the role of the STS outcome score in predicting MACE.

Results: From 75 patients undergoing CABG, 12 patients (16.0%) experienced major cardiovascular events (MACE). Acute heart failure was the highest MACE during hospitalization, around 33,3%. The STS risk score for prolonged ventilation and risk of major morbidity/mortality were predictor factors that were statistically significant, respectively with OR 0.061 and p value = 0037; and OR 5.667 and p value = 0.017, with constant being -36.794. The ROC analysis obtained a cut-off point of the STS score for the risk of prolonged ventilation against the incidence of MACE, namely at a score of 6,36% (AUC:0,868; sens 83,3%; spes 81,0%;p<0,001) and the cut-off point STS score for the risk of major morbidity/mortality to the incidence of MACE at a score of 10.355% (AUC: 0,852; sens 83,3%; spes;74,6%; p<0,001).

Conclusion: STS score can be used as predictor of MACE in patients undergoing coronary artery bypass surgery.

Keywords:- STS score, MACE, CABG.

I. INTRODUCTION

Cardiovascular disease ranks first as the leading cause of death in the world, an estimated 17.9 million people die every year, and 75% of all cases occur in developing countries, especially in the middle to lower economic class.1 WHO also estimates that deaths from CHD in the world will increase from 7.2 million from 2002 to 11.1 million in 2020.

Coronary artery bypass surgery (CABG) is an invasive therapies in the management of coronary heart disease.[2] Data from the STS (Society of Thoracic Surgeons) through a meta-analysis study revealed that from 800 websites collected, every year there are about 270,000 patients undergoing CABG. CABG is an operation that requires intensive observation due to its several post-surgical complications that can occur both acutely and chronically.[3]

The STS score is a complex scoring model consisting of 50 demographic and operative variables with continuous improvement, it is not only used to predict the mortality rate, but also the morbidity rate of patients undergoing cardiac surgery. This score is considered more consistent in assessing risk factors associated with cardiac surgery patients than EURO SCORE.[4,5]

Although the role of STS score has been widely studied and is the most frequently used model in predicting mortality rates in patients undergoing cardiac surgery procedures, its role in predicting CABG is rarely studied, especially in Indonesia. In addition, some studies have only conducted studies on mortality rates, for the assessment of Major Adverse Cardiovascular Events (MACE), while other outcomes have been rarely studied.

In this study, the author aimed to determine the role of STS score as a predictor in predicting MACE during hospitalization in patients undergoing CABG, thus could be a consideration in determining prognosis in patients undergoing CABG.

II. METHODS

A. Study population

The data of this study were taken from CHD patients who were going to undergo a coronary artery bypass procedure at RSUP HAM from June 2019 to June 2020 using the consecutive sampling method. The study involved 75 CHD patients at Haji Adam Malik General Hospital Medan, who were willing to become research subjects. Patients with CHD who already have a history of previous coronary artery bypass surgery, undergoing heart valve surgery, and incomplete data at the time of sampling were excluded from the study subjects.

B. STS score evaluation

This study is a retrospective cohort study. The diagnosis of SKA and CHD is based on the guidelines from ESC and PERKI. For patients treated before study time, clinical course during admission and MACE were viewed through medical record data. For patients treated during the study, observations were made during treatment and accompanied by MACE that occurred until the patient was discharged or died. All data obtained from the history, physical examination and support (criteria according to the STS score variable) were inputted to the online STS score calculator via the Society of Thoracic Surgeon website.

C. Statistical analysis

The data were analyzed using the SPSS program. Bivariate analysis for comparison between the two groups on numerical independent variables and categorical dependent variables is using the T-independent test (T-test). If the conditions for the Independent T-test are not met, the Mann Whitney test is used. Multivariate analysis of independent variables with categorical dependent variables was tested by logistic regression to determine the STS score as a predictor of MACE. The variables found to have a significance value of $p < 0.05$ in the multivariate analysis are shown in the form of odds ratios (OR) with 95% confidence interval (CI). The variable is considered significant if the p value < 0.05.

III. RESULTS

75 patients with CHD who undergone BPAK at Haji Adam Malik General Hospital Medan had met the inclusion and exclusion criteria, consisting of 69 patients (92%) male and 6 patients (8%) female with a mean age of 56 years. A total of 12 patients (16.0%) experienced Major Adverse Cardiovascular Event (MACE) and 63 other patients (84.0%) did not experience Major Adverse Cardiovascular Event (MACE). Acute heart failure was the highest MACE during hospitalization with 4 events (33.3%), followed by 3 deaths (25%), 3 cardiogenic shock events (25%), and 2 malignant arrhythmias (16.7%). The characteristics and basic data parameters of the results of the examination of patients undergoing BPAK are presented in table 1.

Table 1. Baseline Characteristics

Parameter	MACE		Total	p values
	Yes (n=12)	No (n=63)		
Age, years	61,25±4,88	54,61±5,08	55,68±5,58	<0,001
Sex				
Male	12 (17,4)	57 (82,6)	69 (92,0)	0,581
Female	0 (0,0)	6 (100,0)	6 (8,0)	
SBP	130 (100-140)	130 (100-150)	130 (100-150)	0,668
DBP	80 (60-80)	70 (60-90)	80 (60-90)	0,459
HR	72 (67-90)	74 (56-94)	72 (56-94)	0,514
RR	20 (20-24)	20 (20-24)	20 (20-24)	0,058
Hb	13,0±1,95	13,57±1,75	13,48±1,78	0,312
Ht	39,12±6,11	40,41±5,43	40,20±5,516	0,463
Leucocyte	9890 (7430-13760)	8410 (5370-14560)	8640 (5370-14560)	0,048
Thrombocyte	270750 ±99929	250841±67628	254026 ±73282	0,392
Ureum	38,85(21-92)	28(11-89)	30 (11-92)	0,032
Creatinine	1,58±0,40	1,19±0,39	1,25±0,422	0,003
CrCl	44,5 (32-75)	62 (32-264)	58 (32-264)	<0,001
Natrium	138,91±7,02	138,55±4,78	138,61±5,15	0,826
Kalium	4,6 (3,5-5,1)	4,1 (3,5-5,6)	4,1 (3,5-5,6)	0,029
Chloride	107,08±9,18	106,22±6,77	106,36±7,14	0,705
NYHA class				
I	0 (0,0)	7 (100,0)	7 (9,3)	<0,001
II	3 (6,3)	45 (93,8)	48 (64,0)	
III	8 (42,1)	11 (57,9)	19 (25,3)	
IV	1 (100,0)	0 (0,0)	1 (1,3)	
Recent MI				
Yes	11 (36,7)	19 (63,3)	30 (40,0)	<0,001
No	1 (2,2)	44 (97,8)	45 (60,0)	

LV Function	41,66±10,07	54,49±11,81	52,44±12,42	0,001
LM	54,5 (0,0-90)	30,0 (0,0-99,0)	40,0 (0,0-99,0)	0,151
LAD	94,5 (0,0-100,0)	90,0 (0,0-100,0)	90,0 (0,0-100)	0,302
LCx	90 (0,0-100)	90 (0,0-100)	90,0 (0,0-100)	0,883
RCA	100 (80-100)	90 (0,0-100)	90,0 (0,0-100)	0,006
CTR	59 (48-100)	55 (0,0-100)	57 (0,0-100,0)	0,101
Weight of isolation				
Isolated CABG	11 (15,1)	62 (84,9)	73 (97,3)	0,296
2 Procedures	1 (50,0)	1 (50,0)	2 (2,7)	
MACE, Yes				
Acute heart failure	4 (33,3)	0 (0,0)	4 (33,3)	-
Cardiogenic shock	3 (25,0)	0 (0,0)	3 (25,0)	-
Mortality	3 (25,0)	0 (0,0)	3 (25,0)	-
Malignant arrhythmia	2 (16,7)	0 (0,0)	2 (16,7)	-
Stroke	0 (0,0)	0 (0,0)	0 (0,0)	-
Amount of graft	3,5 (2-4)	3 (2-6)	3 (2-6)	0,542

In the risk scoring system calculator with an STS score, there are nine risk endpoints that may be experienced by patients with CABG, the difference in the scoring of each STS risk score in patients who have MACE and those who did not experience MACE are presented in table 2. The analysis found that there was a statistically significant difference in each endpoint of the STS risk score between CABG patients who experienced MACE and those who did not experience MACE.

The STS score for the risk of operative mortality in patients who experienced MACE was greater (1.71%) compared to those who did not experience MACE (0.75%). Of the nine STS risk score endpoints, two STS risk scores that had a greater percentage score were found in patients who did not experience MACE, namely the STS risk score for deep sternal wound infection and the STS risk score for short length of hospitalization. The STS risk score for deep sternal wound infection in patients who experienced MACE was greater (0.26%) compared to those who experienced no MACE (0.15%). The STS score for the risk of short length of hospitalization in patients who did not experience MACE was greater (6.94%) compared to those who experienced MACE (2.88%).

Table 2. Nine Endpoints of Risk Scoring System with STS Score in Patients Undergone CABG

Endpoint STS Score	MACE		Total	p value
	Yes (n=12)	No (n=63)		
Operative mortality	1,71 (0,78-5,49)	0,75 (0,33-3,47)	0,82 (0,33-5,49)	<0,001
Permanent stroke	1,77 (0,87-5,04)	0,82 (0,39-5,57)	0,92 (0,39-5,57)	<0,001
Acute kidney injury	2,92 (0,60-13,45)	0,81 (0,25-11,39)	0,88 (0,25-13,45)	0,001
Prolonged ventilation	8,37 (5,05-40,95)	4,40 (2,16-18,24)	4,74 (2,16-40,95)	<0,001
Deep sternal wound infection	0,26 (0,18-0,49)	0,15 (0,06-167,0)	0,17 (0,06-167)	0,001
Recurrent operations	3,03±0,44	2,57±0,57	2,69±0,50	0,011
Major morbidity/mortality	14,81 (8,25-54,9)	7,08 (3,88-26,68)	8,12 (3,88-54,9)	<0,001
Prolonged hospitalization (>14 days)	38,90 (15,36-50,30)	57,24 (28,90-73,28)	55,52 (15,36-73,28)	<0,001
Short length of hospitalization (<6 days)	6,94 (3,43-23,02)	2,88 (1,23-10,74)	3,10 (1,23-23,02)	<0,001

Multivariate analysis was used to determine which factors predicted the incidence of MACE in patients undergoing CABG (table 3). The bivariate analysis result variable with p value < 0.25 was included in the logistic regression analysis on the incidence of MACE, it was then calculated until the last stage in step 4, the STS score variable (renal failure, permanent stroke, prolonged ventilation, morbidity / mortality, short length of hospitalization [<6 days], and prolonged hospitalization [> 14 days]). STS risk score for prolonged ventilation (OR 0.061 and p value = 0037) and the STS risk score for major morbidity / mortality were predictor factors that were statistically significant (OR 5,667 and p value = 0.017; constant -36,794).
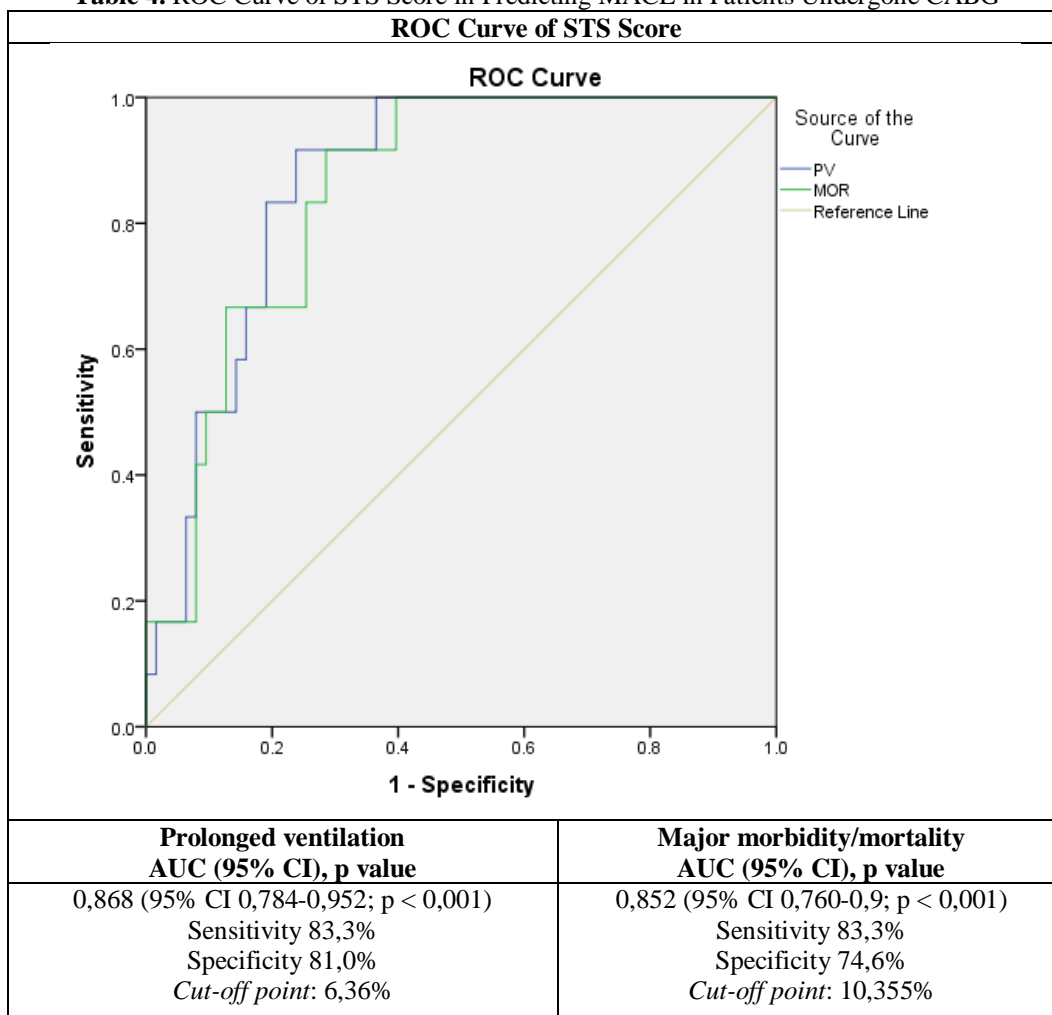
Table 3. Multivariate Analysis of STS Risk Scoring in Predicting MACE in Patients who Undergone CABG

Variable	Coefficient	p value	OR	95% CI (Min-max)	
Step 4:					
Acute kidney failure	-2,387	0,091	0,092	0,006	1,468
Permanent stroke	5,459	0,135	243,831	0,182	3031,513
Prolonged ventilation	-2,794	0,037	0,061	0,004	0,843
Major morbidity/mortality	1,735	0,017	5,667	1,831	38,633
Short length of hospitalization (<6 days)	0,381	0,124	1,463	0,901	2,375
Prolonged hospitalization (>14 days)	2,993	0,051	19,938	0,986	403,294
Constant	-36,794				

The cut-off point percentage of the STS score that predicted the incidence of MACE in patients undergoing CABG was subjected to ROC analysis (table 4). The STS score for the risk of prolonged ventilation had a very strong association strength (AUC 0.868) and is statistically significant (p < 0.001). The STS score of risk for morbidity and major mortality had a very strong relationship strength (AUC 0.852) and was statistically significant (p < 0.001).

Table 4. ROC Curve of STS Score in Predicting MACE in Patients Undergone CABG

| Prolonged ventilation AUC (95% CI), p value	Major morbidity/mortality AUC (95% CI), p value
0,868 (95% CI 0,784-0,952; p < 0,001) Sensitivity 83,3% Specificity 81,0% *Cut-off point*: 6,36%	0,852 (95% CI 0,760-0,9; p < 0,001) Sensitivity 83,3% Specificity 74,6% *Cut-off point*: 10,355%

Visualization to determine the STS score cut-off point for the incidence of MACE in patients with CABG is presented in figure 1 and 2. The intersection of the curve of 83.3% sensitivity and specificity of 81% obtained a cut-off point of the STS score for the risk of prolonged ventilation for the incidence of MACE of 6,36%. Thus patients with STS risk score for prolonged ventilation of ≥6.36% were more likely to experience a Major Adverse Cardiovascular Event (MACE).

The intersection of the curve of the sensitivity of 83.3% and specificity of 74.6% obtained a cut-off point of the STS score for the risk of major morbidity/mortality for the incidence of MACE 10.355%. Patients with a major

morbidity/mortality STS risk score of ≥10.355% may have a Major Adverse Cardiovascular Event (MACE) after CABG.
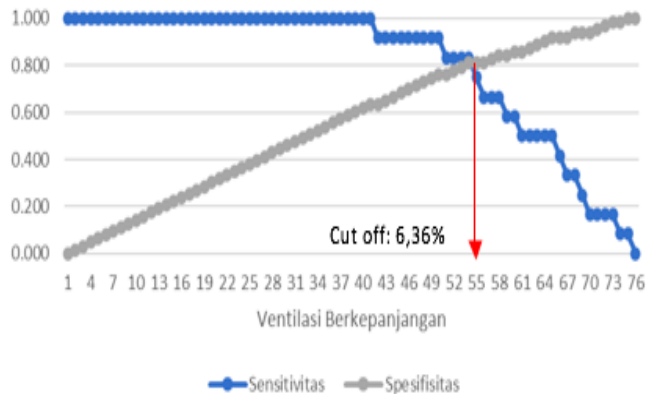
Fig 1. *Cut-off point* of STS score of prolonged ventilation risk for the incidence of MACE in patients with CABG
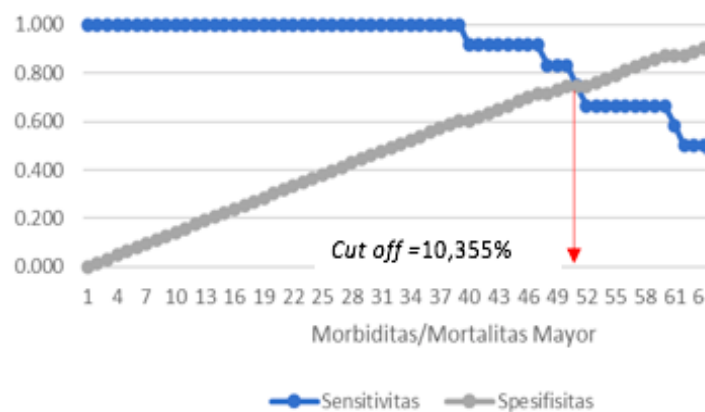
Fig 2. *Cut-off point* of the STS score of major morbidity/mortality risk for the incidence of MACE in patients with CABG

IV. DISCUSSION

It was found that the predictive value of the components of "prolonged ventilation" (>24 hours) and "major morbidity and mortality" significantly predicted the occurrence of MACE in patients after CABG. The result of STS scoring for "prolonged ventilation" that can predict the incidence of MACE is if the score is greater than 6,36%, while the component of "major morbidity and mortality" can predict MACE if the score is greater than 10.355%.

Factors associated with mortality after cardiac surgery are sepsis, renal failure, myocardial infarction, stroke, and cardiac arrest.[6,7] A study by LaPar et al. reported that in ICU postoperative cardiac surgery patients, among the postoperative complications, cardiac arrest, prolonged ventilation (> 48 hours) and stroke were the strongest predictors of mortality (p <0.001).[8]

Although mechanical ventilation is important in maintaining vital functions, it has side effects. However, the side effects mentioned will only cause symptoms when it is used for a prolonged period.[9] Metnitz et al. analyzed risk

factors for mortality in the hospital and found that the risk was increased (OR 1.18) if the patient required mechanical ventilation during ICU admission.[10]

In patients with acute respiratory failure, mortality was significantly affected by the duration of the invasive procedure itself. In intubated patients, the incidence of pneumonia was approximately 6 and 21 times higher, and the risk increased by 1% and 3% for each additional day of patients with endotracheal intubation, and mechanical ventilation, respectively. Apart from an increased risk of nosocomial infection, invasive ventilation also causes direct lung tissue damage.[11]

Hessels et al. in his study established a predictive score that identifies patients at high risk of prolonged (> 24 hours) mechanical ventilation after cardiac surgery. Their data analysis reported that preoperative patient-related factors (such as anemia, infection, congestive heart failure, disease severity or organ dysfunction) were not associated as a component of the predictive score.[12]

In this study, it was observed that major morbidity is also a predictor of mortality in post-cardiac surgery patients. Major morbidities include permanent stroke, renal dysfunction or renal failure requiring dialysis, cardiac reoperation, prolonged ventilation of more than 48 hours, and deep sternal wound infection. It was found that this major morbidity is one of the predictors of the incidence of MACE, one of which is mortality.

V. CONCLUSION

STS score can be used as a predictor of MACE in patients undergoing CABG. The components of STS scoring that can predict MACE in patients after CABG are the end points of "prolonged ventilation" and "major morbidity and mortality" with cut-off points of 6.36% and 10.355%, respectively.

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