VALIDATION OF STS SCORE FOR EGYPTIAN CABG PATIENTS

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Abstract
Background: As the standard treatment of complex CAD, CABG was established. Medical recommendations have adopted prognostic models and are now broadly used to evaluate risk and guide treatment. We applied STS scoring system to patients undergoing CABG to evaluate their predictive performance of early mortality and morbidities.
Methods: In the period between septemper 2018 and June 2020, we evaluated 100 patients who underwent CABG at the Kasr AL Ainy hospitals. STS values were calculated for the patients who were fall in the isolated CABG model of the STS risk models using the STS calculator v2.9 available online
To represent the discriminative power of the scoring system, the area under the receiver operating characteristic (ROC) curve has been used and the Hosmer-Lemeshow statistics were used to evaluate calibration.
Results: STS model showed good discrimination power and good calibration in Hosmer and Lemeshow Test in predicting mortality, morbidity, renal failure, neurological complications, DSW infection and long length of stay. Also it showed bad calibration in predicting prolonged ventilation. However, it could not be assessed for reoperation and short length of stay because there were no events.
Conclusion: In the population studied subjected to CABG procedures, the STS scoring system has been well calibrated to be utilized, capable of detecting mortality and most of the results examined.
Keywords: (MACCE, STS, CABG, PCI, MI, and EF)

INTRODUCTION

Many prediction risk-stratification systems were developed with the main target of judging the risk of surgical mortality for patients experiencing cardiac surgery. In spite of their beneficial role, it continues to remain difficult to improve a risk model which precisely fulfils all subgroups of patients, especially high-risk patients referred for cardiac surgery **(Roques et al., 2003).**

Scoring risk models become important tools of cardiac surgical practice in nowadays for estimating operative morbidity and mortality. Continuous changes in cardiac surgery case complexity, clinical outcomes and advance in surgical techniques necessitate successive improvement and modification of presently accessible risk-stratification models. Both enhancements and modifications require additional validation testing for various patient groups. **(Stuart et al., 2013).**

Risk assessment is still a difficult issue in European patients, in spite of recently updated Euro SCORE II that is associated with improvements in comparison with the both additive and logistic Euro SCORE. The Society of Thoracic Surgeons (STS) score was shown to be better than the Euro SCORE, but in some patient subgroups, some studies have still documented poor model performance. Risk models were known to be poorly calibrated and to overestimate mortality, especially in high-risk patients. **(Chalmers et al., 2013).**

Many interacting factors result in suboptimal model performance. That may be due to the risk score omitting many risk factors that may as effective as conventional cardiovascular risk factors (e.g. renal failure, diabetes). Most risk models originate from standard statistical approaches, not taking into account associations with the risk factor or complexity unique to the procedure. A mismatch is often found among the model's original patient cohort and the patient populations with which it is used in practice; certain subgroups of patients are typically under-represented. **(Dewey et al., 2008).**

Aim of Work

This study is carried out to analyze patients' data in prospective design to evaluate the predictive perormance of STS score in Egyptian cardiac surgical patients who will undergoe CABG procedure. Also, it will provide a foundation of this model if it is fitting the status of Egyptian patients with an acceptable level of accuracy to predict the morbidity and mortality with good clinical performance.

Patients and Methods

This was a hospital-based prospective, descriptive study done at the Cardiothoracic Surgery Department of ElKasr Alaini Hospital.

A computerized registry of all patients who underwent isolated CABG operation over the period from septemper 2018 to June 2020 was used after exclusion of patients who were not gone with our inclusion criteria and those with incomplete data.

These patients were selected for this study after approval of the local ethical committee as per the following inclusion and exclusion criteria:

Inclusion Criteria:

- 18 years of age or more.
- Isolated CABG surgery. .

Exclusion Criteria:

- Under 18 years of age.
- Weight of body less than 30 KG.
- Congenital heart surgery.
- Isolated valve surgery
- CABG and valve surgery
-

All factors have been recorded in our database for and patient data set, which include demographic and administrative, preoperative risk factors, intraoperative, postoperative data, complications, mortality and morbidity.

A comprehensive set of variables and definitions had been used to go parallel with variables of the STS National Databases.

All patients were evaluated thoroughly during the operations and their intensive care unit stay till their transfer to the ward and their discharge from the hospital.

The major postoperative assessment was defined as follows to go parallel with definitions of the STS National Databases.

Statistical Analysis

Data was entered and statistically analyzed in version 25 of the Statistical Package of Social Science Software (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). For quantitative variables, and frequency and percentage for qualitative variables, data was represented using mean and standard deviation. The comparison was carried out using Chi square or Fisher's exact tests between groups for qualitative variables whereas the comparison was carried out using independent sample t-tests for quantitative variables. Curve analysis of receiver operating characteristics (ROC) was conducted to explore the overall validity of different scores and determine the most suitable cut-off point through Youden indexwith the appropriate validity measures e.g. sensitivity, specificity…….. Hosmer–Lemeshow test for goodness of fitwas used to calibrate different scores through matching the observed values with that expected by scores within each decile subgroup. Statistically significant P values less than or equal to 0.05 have been regarded.

Results

STS model showed good **calibration** in Hosmer and Lemeshow Test in predicting mortality (P=0.99), morbidity (P=0.858), renal failure (P=1.0), neurological complications(P=0.986), DSW infection (P=0.38) and long length of stay(P=0.66).
*Also it showed bad calibration in predicting prolonged ventilation (P= 0.06).
*However, it could not be assessed for reoperation and short length of stay because there were no events.

STS showed good **discrimination** power in predicting mortality (AUC was 0.974 and 95% CI for AUC 0.937-1.0) ,morbidity (AUC for STS was 0.811 and 95% CI for AUC 0.679-0.943), renal failure (The AUC for STS was 1.0 and 95% CI for AUC 1.0-1.0), neurological complications (The AUC for STS was 0.979and 95% CI for AUC 0.950-1.0), prolonged ventilation (The AUC for STS was 0.816 and 95% CI for AUC 0.671-0.961), DSWI (The AUC for STS was 0.758and 95% CI for AUC 0.673-0.842) and prolonged Length of Stay (The AUC for STS was 0.745 and 95 % CI for AUC 0.454-1.0) .
*However, it could not be assessed for reoperation and short length of stay because there were no events.

Some **correlations** were found during study and have to be mentioned:
*low EF, urgent or emergent status and IABP insertion were found significantly related to mortality, morbidity and prolonged ventilation.
*HTN and previous MI were significantly correlated with morbidity and prolonged ventilations.
*Unstable angina was also related to mortality and morbidty (Table1-14 and Fig1).

Table (1): ROC curve values to explore the discriminant ability of. STS in predicting mortality.

ROC analysis for mortality

AUC	95% CI	P value	Cut off point	Sens	Spec	PPV	NPV	Acc
0.974	0.937-1.0	0.001	≥ 1.75	100.0%	92.7%	36.4%	100.0%	93.0%

AUC=area under the curve, **CI**=confidence interval, **Sens**=sensitivity, **Spec**=Specificity, **PPV**=positive predictive value, **Acc**=accuracy.

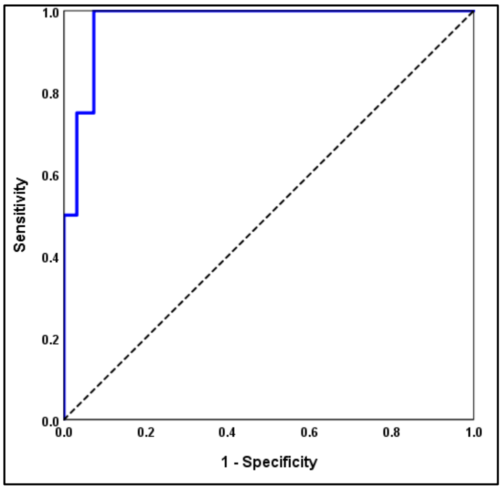

Fig. (1): ROC curve to explore the discriminant ability of STS score in predicting mortality.

Table (2): Hosmer and Lemeshow Testfor STS in predicting mortality. Hosmer and Lemeshow Test for Mortality (X^2=1.311, df=8, P=0.995)

	Mortality				
	No		**Yes**		**Total**
	Observed	**Expected**	**Observed**	**Expected**	
1	10	10.0	0	0.0	10
2	10	10.0	0	0.0	10
3	10	10.0	0	0.0	10
4	11	10.9	0	0.1	11
5	11	10.9	0	0.1	11
6	10	9.9	0	0.1	10
7	10	9.9	0	0.1	10
8	10	9.8	0	0.2	10
9	9	9.6	1	0.4	10
10	5	5.0	3	3.0	8

Table (3): ROC curve values to explore the discriminant ability of STS score.in predicting morbidity or mortality. **ROC analysis for morbidity or mortality**

AUC	**95%CI**	**Pvalue**	**Cutoff point**	**Sens**	**Spec**	**PPV**	**NPV**	**Acc**
0.811	0.679-0.943	0.000	≥ 10.74	73.3%	83.5%	44.0%	94.7%	82.0%

AUC=area under the curve, **CI**=confidence interval, **Sens**=sensitivity, **Spec**=Specificity, **PPV**=positive predictive value, **Acc**=accuracy.

Table (4): Hosmer and Lemeshow Testfor STS in predicting morbidity. Hosmer and Lemeshow Test for Morbidity or mortality (X^2=3.993, df=8, P=0.858)

	Morbidity or mortality				
	No		**Yes**		**Total**
	Observed	**Expected**	**Observed**	**Expected**	
1	11	10.6	0	0.4	11
2	10	9.6	0	0.4	10
3	10	10.5	1	0.5	11
4	9	9.5	1	0.5	10
5	9	9.3	1	0.7	10
6	9	9.1	1	0.9	10
7	11	9.8	0	1.2	11

8	7	8.1	3	1.9	10
9	7	6.5	3	3.5	10
10	2	2.0	5	5.0	7

Table (5): ROC curve values to explore the discriminant ability of STS in predicting renal failure. ROC analysis for RF

AUC	95%CI	Pvalue	Cutoff point	Sens	Spec	PPV	NPV	Acc
1.0	1.0-1.0	0.001	≥ 11.36	100.0%	100.0%	100.0%	100.0%	100.0%

AUC=area under the curve, **CI**=confidence interval, **Sens**=sensitivity, **Spec**=Specificity, **PPV**=positive predictive value, **Acc**=accuracy.

Table (6): Hosmer and Lemeshow Test for STS in predicting renal failure. Hosmer and Lemeshow Test for RF (X^2=0.0, df=8, P=1.0)

	RF				
	No		**Yes**		**Total**
	Observed	**Expected**	**Observed**	**Expected**	
1	10	10.0	0	0.0	10
2	11	11.0	0	0.0	11
3	11	11.0	0	0.0	11
4	10	10.0	0	0.0	10
5	10	10.0	0	0.0	10
6	11	11.0	0	0.0	11
7	10	10.0	0	0.0	10
8	10	10.0	0	0.0	10
9	10	10.0	0	0.0	10
10	5	5.0	2	2.0	7

Table (7): ROC curve values to explore the discriminant ability of STS in predicting neurological complications.
ROC analysis for permanent stroke

AUC	95%CI	Pvalue	Cutoff point	Sens	Spec	PPV	NPV	Acc
0.979	0.950-1.0	0.001	≥ 1.15	100.0%	95.9%	42.9%	100.0%	96.0%

AUC=area under the curve, **CI**=confidence interval, **Sens**=sensitivity, **Spec**=Specificity, **PPV**=positive predictive value, **Acc**=accuracy.

Table (8): Hosmer and Lemeshow Testfor STS in predicting neurological complications. Hosmer and Lemeshow Test for Permanent stroke (X^2=1.809, df=8, P=0.986)

	Permanent stroke				
	No		**Yes**		**Total**
	Observed	**Expected**	**Observed**	**Expected**	
1	11	11.0	0	0.0	11
2	9	9.0	0	0.0	9
3	11	11.0	0	0.0	11
4	10	9.9	0	0.1	10
5	11	10.9	0	0.1	11
6	10	9.9	0	0.1	10
7	10	9.9	0	0.1	10
8	11	10.8	0	0.2	11
9	10	9.7	0	0.3	10
10	4	5.0	3	2.0	7

Table (9): ROC curve values to explore the discriminant ability of STS in predicting prolonged ventilation.
ROC analysis for prolonged ventilation

AUC	95%CI	Pvalue	Cutoff point	Sens	Spec	PPV	NPV	Acc
0.816	0.671-0.961	0.000	≥ 7.98	75.0%	87.5%	45.0%	96.3%	86.0%

AUC=area under the curve, **CI**=confidence interval, **Sens**=sensitivity, **Spec**=Specificity, **PPV**=positive predictive value, **Acc**=accuracy.

Table (10): Hosmer and Lemeshow Testfor STS in predicting prolonged ventilation. Hosmer and Lemeshow Test for Prolonged ventilation (X^2=14.837, df=8, P=0.062)

	Prolonged ventilation				
	No		**Yes**		**Total**
	Observed	**Expected**	**Observed**	**Expected**	
1	11	10.7	0	0.3	11
2	10	9.7	0	0.3	10
3	9	10.6	2	0.4	11
4	10	9.6	0	0.4	10
5	10	9.5	0	0.5	10
6	9	9.4	1	0.6	10
7	11	10.1	0	0.9	11
8	7	8.7	3	1.3	10
9	9	7.1	1	2.9	10
10	2	2.6	5	4.4	7

Table (11): ROC curve values to explore the discriminant ability of STS in predicting DSW infection. ROC analysis for DSW infection

AUC	**95%CI**	**Pvalue**	**Cutoff point**	**Sens**	**Spec**	**PPV**	**NPV**	**Acc**
0.758	0.673-0.842	0.377	≥ 0.36	100.0%	75.8%	4.0%	100.0%	76.0%

AUC=area under the curve, **CI**=confidence interval, **Sens**=sensitivity, **Spec**=Specificity, **PPV**=positive predictive value, **Acc**=accuracy.

Table (12): Hosmer and Lemeshow Testfor STS in predicting DSW infection. Hosmer and Lemeshow Test for DSW infection (X^2=8.555, df=8, P=0.381)

	DSW infection				
	No		**Yes**		**Total**
	Observed	**Expected**	**Observed**	**Expected**	
1	10	9.9	0	0.1	10
2	10	9.9	0	0.1	10
3	11	10.9	0	0.1	11
4	11	10.9	0	0.1	11
5	11	10.9	0	0.1	11
6	11	10.9	0	0.1	11
7	10	9.9	0	0.1	10
8	9	9.9	1	0.1	10
9	10	9.9	0	0.1	10
10	6	5.9	0	0.1	6

Table (13): ROC curve values to explore the discriminant ability of STS in predicting long length of stay.
ROC analysis for long length of stay >14 d

AUC	**95%CI**	**Pvalue**	**Cutoff point**	**Sens**	**Spec**	**PPV**	**NPV**	**Acc**
0.745	0.454-1.0	0.237	≥ 3.51	100.0%	54.1%	4.3%	100.0%	55.0%

AUC=area under the curve,**CI**=confidence interval,**Sens**=sensitivity, **Spec**=Specificity, **PPV**=positive predictive value, **Acc**=accuracy.

Table (14): Hosmer and Lemeshow Testfor STS in predicting long length of stay. Hosmer and Lemeshow Test for PLOS > 14 d (X^2=5.863, df=8, P=0.663)

	PLOS > 14 d				
	No		**Yes**		**Total**
	Observed	**Expected**	**Observed**	**Expected**	
1	10	9.9	0	0.1	10
2	10	9.8	0	0.2	10
3	10	9.8	0	0.2	10
4	10	9.8	0	0.2	10
5	10	9.8	0	0.2	10
6	10	10.8	1	0.2	11

7	10	9.8	0	0.2	10
8	10	9.8	0	0.2	10
9	10	9.8	0	0.2	10
10	8	8.6	1	0.4	9

Correlations found between variables and outcome
Comparisons regarding Mortality:
There was a statistically significant correlation between unstable angina ,low EF ,urgent or emergent status, IABP insertion and mortality as shown in the figures below (P<0.05) .
On the otherhand, there is no significant correlation found between HTN, DM, smoking, previous MI, HF, LM stenosis and mortality (P>0.05)(Table 15)

Table (15): Comparisons regarding Mortality

	Mortality		
	Yes (n=4)	**No (n=96)**	**P value**
HTN			
Yes	1 (25)	17 (17.7)	0.554
No	3 (75)	79 (82.3)	
DM on insulin			
Yes	2 (50)	50 (52.1)	1.000
No	2 (50)	46 (47.9)	
Smoking			
Yes	3 (75)	84 (87.5)	0.432
No	1 (25)	12 (12.5)	
Previous MI			
Yes	1 (25)	6 (6.3)	0.255
No	3 (75)	90 (93.8)	
HF			
Yes	2 (50)	23 (24)	0.260
No	2 (50)	73 (76)	
Angina at admission			
Stable	1 (25)	84 (87.5)	**0.010**
Unstable	3 (75)	12 (12.5)	
LM stenosis			
Yes	3 (75)	25 (26)	0.065
No	1 (25)	71 (74)	
EF	42 ± 11.5	55.1 ± 9.4	**0.020**
Status			
Elective	0 (0)	66 (68.8)	**0.000**
Urgent	3 (75)	30 (31.3)	
Emergent	1 (25)	0 (0)	
IABP			
Yes	3 (75)	2 (2.1)	**0.000**
No	1 (25)	94 (97.9)	

Comparisons regarding Prolonged ventilation
There was a statistically significant correlation between HTN ,previous MI ,low EF, urgent or emergent status, IABP insertion and prolonged ventilation as shown in the figures below (P<0.05) .

On the otherhand, there is no significant correlation found between DM, smoking, HF,Angina status , LM stenosis and prolonged ventilation (P>0.05)(Table 16)

Comparisons regarding Morbidity or mortality:
There was a statistically significant correlation between HTN ,previous MI ,unstable angina,low EF, urgent or emergent status, IABP insertion and morbidity and mortality as shown in the figures below (P<0.05) .

On the otherhand, there is no significant correlation found between DM, smoking, HF , LM stenosis and morbidity and mortality (P>0.05)(Table 17)

Table (16) : Comparisons regarding Prolonged ventilation

	Prolonged ventilation		
	Yes (n=12)	**No (n=88)**	**P value**
HTN			
Yes	5 (41.7)	13 (14.8)	**0.038**
No	7 (58.3)	75 (85.2)	
DM on insulin			
Yes	7 (58.3)	45 (51.1)	0.640
No	5 (41.7)	43 (48.9)	
Smoking			
Yes	10 (83.3)	77 (87.5)	0.653
No	2 (16.7)	11 (12.5)	
Previous MI			
Yes	4 (33.3)	3 (3.4)	**0.004**
No	8 (66.7)	85 (96.6)	
HF			
Yes	5 (41.7)	20 (22.7)	0.169
No	7 (58.3)	68 (77.3)	
Angina at admission			
Stable	8 (66.7)	77 (87.5)	0.079
Unstable	4 (33.3)	11 (12.5)	
LM stenosis			
Yes	5 (41.7)	23 (26.1)	0.308
No	7 (58.3)	65 (73.9)	
EF	44.3 ± 11	56 ± 8.8	**0.000**
Status			
Elective	3 (25)	63 (71.6)	**0.000**
Urgent	8 (66.7)	25 (28.4)	
Emergent	1 (8.3)	0 (0)	
IABP			
Yes	5 (41.7)	0 (0)	**0.000**
No	7 (58.3)	88 (100)	

Table (17): Comparisons regarding Morbidity or mortality

	Morbidity or mortality		
	Yes (n=15)	**No (n=85)**	**P value**
HTN			
Yes	7 (46.7)	11 (12.9)	**0.005**
No	8 (53.3)	74 (87.1)	
DM on insulin			
Yes	10 (66.7)	42 (49.4)	0.217
No	5 (33.3)	43 (50.6)	
Smoking			
Yes	13 (86.7)	74 (87.1)	1.000
No	2 (13.3)	11 (12.9)	
Previous MI			
Yes	4 (26.7)	3 (3.5)	**0.009**
No	11 (73.3)	82 (96.5)	
HF			
Yes	5 (33.3)	20 (23.5)	0.518
No	10 (66.7)	65 (76.5)	
Angina at admission			
Stable	10 (66.7)	75 (88.2)	**0.047**
Unstable	5 (33.3)	10 (11.8)	
LM stenosis			
Yes	7 (46.7)	21 (24.7)	0.117
No	8 (53.3)	64 (75.3)	
EF	46.1 ± 10.7	56.1 ± 8.8	**0.000**
Status			
Elective	4 (26.7)	62 (72.9)	**0.000**

Urgent Emergent	10 (66.7) 1 (6.7)	23 (27.1) 0 (0)	
IABP Yes No	 5 (33.3) 10 (66.7)	 0 (0) 85 (100)	 **0.000**

DISCUSSION

Complex coronary Artery disease (CAD) in clinical administration still poses a challenge. As the standard treatment for complex CAD, Coronary Artery Bypass Graft surgery (CABG) has been developed. Medical guidelines have adopted prognostic models and are now largely used to evaluate risk and guide therapy (**Gonzales-Tamayo et al., 2018).**

The score systems that result are useful in determining the risk of side effects in populations which share similar risk profiles **(Van Dieren et al.2012).**

In addition, these tools could be used to evaluate and improve the quality of medical services and to start comparing risk profiles between distinct populations **(Braile et al. 2010)**

While risk estimation techniques are not explicitly designed to measure the risk of individual patient complications, they are largely used to assist doctors in decision-making, particularly in the context of cardiothoracic surgery **(Ferguson et al. 2002).**

Before using the models at locations far off the original cohort, it is advisable to consider the variations in population characteristics across all these potential applications. It is recognised that in comparing to the original source cohort, variations in baseline factors, ethnic (or more specifically, genetically determined) features, as well as environmental factors, could result in major diversions. For example, in an Australian cohort various from the derivation cohort, Yap and peers evaluated the use of EuroSCORE, and the calibration of the model in such new patients was deemed low **(Yap et al.2006).**
Ideally, risk estimation scores must be established at each particular site, taking both local genetic and environmental issues into account **(Almeida et al.2003) .**

Actually, the use of the STS technique is spread in North American hospitals, helping to boost the efficiency of heart surgery, as seen in distinct publications **(Anderson et al.1999).**

STS database subscription was recently opened for applicants outside the United states of america, and TotalCor Hospital, a one-hundred-bed facility involved in the management of patients with cardiovascular disease located in Sao Paulo, Brazil, became the first institution to take part as an international member **(Grover et al.2001)**

Furthermore, we didn't find a significant corelation between **smoking** and occurrence of morbidity or mortality or prolonged ventilation (P>0.05), Despite the proven impact of smoking on the results of patients receiving unstable angina or acute myocardial infarction (MI). **(Nael Al-Sarraf. et al., 2008).**

Dimas et al. (2014) study on the Brazilian population has demonstrated good calibration indices for both mortality (X2=6.78, P=0.56) and overall morbidity (X2=6.69, P=0.57). ROC-curve (AUC) region analysis showed good results in detecting the likelihood of death (AUC 0.76; P<0.001), renal failure (AUC 0.79; P<0.001), prolonged ventilation (AUC 0.80; P<0.001), reoperation (AUC 0.76; P<0.001) and significant morbidity (AUC 0.75; P<0.001), that is a combination of the post-surgery complications evaluated. The STS scoring system did not show similar findings for short-term hospital stay (AUC 0.57, P=0.47), long hospital stay, and owing to a low number of occurrences in the population studied, stroke and wound infection can not be properly checked **(Dimas et al. 2014).**
Shahian et al. (2018) reported that the overall model performance was excellent. The c-index for deaths became 0.8 and the c-index for other endpoints varied in the overall population from 0.653 for reoperation to 0.793 for renal failure with an acceptable calibration.

Farough et al. (2017) reported also good accuracy of STS score in predicting mortality. Also, the risk of stroke, prolonged ventilation and kidney failure was predicted by STS with good discriminating power in the data recorded.

A meta-analysis also done comparing scores for perioperative mortality concluded that the STS score (and also the EuroscoreII) outperform the ACEF (Age, Creatinine and Ejection Fraction) score on discrimination **(Patrick. etal. 2016)**.

Niv. et al. (2007) reported that STS score is a good predictor for operative mortality with slight advantage over the Euroscore**.**

Concerning mortality assessment in specific:
Gonzales-Tamayo et al. (2018), reported that mortality was 3.4% slightly lower than our study (4%). They reported also that STS score demonstrated good performance and accuracy for short term mortality.

Dimas et al. (2014) also reported there was no differences between observed and expected mortality (X2=6.78, P=0.56). They have overall mortality rate 4.3% (47/1083), while the observed mortality was 2.3 % (15/659) in the isolated CABG group.

Farough et al. (2007) reported that the observed post-surgery deaths became 1.8% (95% CI 1.3% to 2.4%) for off-pump CABG and 1.5% (95% CI 1.1% to 2.1%) for on-pump CABG. The Hosmer-Lemeshow goodness-of-fit test suggested reasonable precision for both on-pump and off-pump CABG surgery. For STS in off-pump CABG, the region under the ROC curve became 0.81 (95 % CI 0.73 to 0.90) (P=0.567). For STS in on-pump CABG, the region under the ROC curve became 0.82 (95 % CI 0.73 to 0.91) (P=0.616). They concluded that both the risk algorithms for STS and EuroSCORE are good predictors of early CABG surgery mortality, whether on-pump or off-pump. They concluded also that to generalize these data, they need much broader sampling of Canadian centres**).**

The overall mortality rate was reported by **Niv et al. (2007)** at 1.8 %; 2.9 % for women patients and 1.5 % for men. The overall STS mortality expected became 2.6 %; for women and men patients, 4.1 % and 2.1 %, respectively.

Concerning morbidity:
Dimas et al. (2014) reported that there was no differences between observed and expected morbidity (X2=6.69, P=0.57)**.**

Concerning DSWI:
A special study focusing on sterna wound infection done by **Pedro Silvio et al**. (2011) reported higher incidence of infection 7.2% (143/1975) compared to our study (1%) and stated that STS score can be successfully be used in predicting DSWI in CABG patients.

Coming to important preoperative risk factors which were neglected by STS scoring systems:
We have noticed that some risk factors that we frequently used to find at our institution are ignored by STS scoring system like hypercholesterolemia which has to be adjusted properly and also hypothyroidism which also has to be adjusted well otherwise it will affect the postoperative course like for example the conscious level postoperative .Also, poor mobility secondary to musculoskeletal or other reason , high systolic pulmonary artery pressure (but chronic lung disease ,pneumonia and tobacco smoking are present as indicators of the chest condition) are ignored by the score .

The study done by **Munir et al. (2006)** showed that **hypercholesterolemia** affects the myocardial angiogenic process, resulting in endothelial dysfunction.

In our study **hypothyroidism** had no influence on morbidity or mortality. However, the hemodynamic effects of hypothyroidism are well documented and alter postoperative course. **(Larsen et al., 2003).**

Risk factors known to impact results are also not listed in the model itself, such as coronary artery and ascending aortic disease profiles.

Bernhard et al. (2012) found that a joining of specific score components from the Euro SCORE and STS, estimating the risk of mortality and the SYNTAX score, representing the complexity of coronary artery disease, can give more accurate results in evaluation risk in individual patients.

Finally, it is possible to explain variations in score findings in multiple and different ways:
Hypothetical methodological mistakes, changes in case-mix or **differences** in disease etiology, surgical activity;individual surgeon variation, which is known to be significant, surgical techniques, socioeconomic reasons; the defect in referral system result in delayed presentation of patients to cardiac surgery, protocols, and postoperative care.

The Study strengths:

- A relatively large sample size from previously done local studies allowed better analysis of risk factors.
- Another point that all risk factors included in the STS scoring system were available in our data base allowing calculation of STS values and comparison with the previous results properly.

The Study Limitations:

- The main limitation is that it is a single-center observational study that may restrict the generalisation of our study results to other centers.
- Moreover, due to it is a unicentric study, our sample is not representative of the whole Egyptian population.
- Surgical and anesthetic technique may also play a role, but it was not possible to evaluate these factors in detail.

In addition, our research has indicated a poor ability to predict a short hospital stay period, which is probable to be clarified by our institution's current use of releasing patients on the sixth or seventh post-operative day, implying that almost none of the study patients left the hospital before to that point in time.

Conclusion

- In evaluating the relative effect of specific risk factors on surgical results, risk models are broadly applied. These models allow surgeons to select the optimal therapy option for a particular patient and to advise patients accordingly. They enable the comparison of post-surgery outcomes and help to evaluate quality-improvement programs
- Our study concluded that, in the population studied subjected to CABG procedures, the STS scoring system has been well calibrated to be utilized, capable of detecting mortality and most of the results examined. Moreover, the statistical methodologies utilised in our study cannot replace the precise and long-term observation of our own population with the development of mathematical methodologies which reflect local genetic and environmental features by the use of suitable databanks.
- STS model showed good **calibration** in Hosmer and Lemeshow Test in predicting mortality, morbidity, renal failure,neurological complications, DSW infection and long length of stay.

*Also it showed bad calibration in predicting prolonged ventilation

*However, it could not be assessed for reoperation and short length of stay because there were no events.

- STS showed good **discrimination** power in predicting mortality, morbidity, renal failure, neurological complications, prolonged ventilation, DSWI and prolonged Length of Stay.

*However, it could not be assessed for reoperation and short length of stay because there were no events.

Recommendations

It's imperative at the end of our study to provide some recommendations that may be useful for future patients before operating upon them. These recommendations have been drawn in the light of our given results.

1- A multicentric study, rather than a unicentric analysis, would therefore be ideal to further validation of STS score risk model.

2-A national dataset for all cardiac surgery patients help to collect all risk factors that influence our patients' outcome, aiding in better risk assessment.

3-We invite and promote others interested in this area to develop and advise risk models to be used in such situations.

4-A new score gathering selected risk factors from the STS score and those scored reflecting the complexity of coronary artery disease can lead to improved precision in predicting the individual risk of a particular cardiac intervention.

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