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ARAŞTIRMA / RESEARCH

Comparison of logistic EuroSCORE, SYNTAX and EuroSCORE II for predicting 1-year mortality in patients underwent coronary bypass surgery

Koroner bypass cerrahisi geçiren hastalarda 1-yıllık mortaliteyi öngörmede lojistik EuroSCORE, SYNTAX ve EuroSCORE II'nin karşılaştırılması

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Abstract

Purpose: The aim of this study was to compare EuroSCORE II, logistic EuroSCORE and SYNTAX scores in patients who underwent CABG in order to find the ideal scoring system for mortality.

Materials and Methods: This retrospective study attempted to examine the preoperative demographic characteristics, echocardiographic findings, operation notes and files, perfusion cards and observation notes of 228 patients who had undergone CABG surgery in our clinic.

Results: It was found that predictive point of SYNTAX score was greater than 27.5 (>27.5), the logistic regression (LR +) value was 1.5 in order to determine mortality rate. Predictive value of EuroSCORE II was higher than 1.82 (>1.82) and LR+ value was 2.20. It was found that EuroSCORE II was enough to predict one-year mortality rate although its positive predictive value was low. Predictive value of logistic EuroSCORE was higher than 5.71 (>5.71) and the LR+ value was 5.13 to assess the mortality rate. Logistic EuroSCORE was also sufficient to predict one-year mortality rate.

Conclusion: Logistic EuroSCORE was found to be the most effective scoring system in predicting one-year mortality in this study. We conclude that randomized clinical trials need to be performed in order to find an ideal cardiac risk scoring system.

Key words: Coronary artery bypass grafting, risk assessment, mortality

Öz

Amaç: Bu çalışmanın amacı koroner arter bypass greftleme (CABG) operasyonu geçiren hastalarda mortalite açısından uygun skorlama sistemini bulmak amacı ile EuroSCORE II, Lojistik EuroSCORE ve SYNTAX skorlarının karşılaştırılmasıdır.

Gereç ve Yöntem: Kliniğimizde CABG cerrahisi geçiren 228 hastanın demografik özellikleri, ekokardiyografik bulguları, operasyon notları ve dosyaları, perfüzyon ve gözlem notları değerlendirildi.

Bulgular: Mortaliteyi belirlemek amacıyla SYNTAX skorunun prediktif değeri 27.5'ten (>27.5) büyüktü, lojistik regresyon (LR+) değeri ise 1.5 idi. EuroSCORE II'nin prediktif değeri 1.82'den yüksekti (>1.82) ve LR+ değeri 2.20 idi. EuroSCORE II'nin pozitif prediktif değerinin düşük olmasına rağmen bir yıllık mortalite oranını tahmin etmede yeterli olduğu bulundu. Mortalite oranını değerlendirmede Lojistik EuroSCORE'un prediktif değeri 5.71'den büyüktü (>5.71) ve LR+ değeri 5.13 idi. Lojistik EuroSCORE da bir yillik mortalite oranini tahmin etmede yeterliydi.

Sonuç: Çalışmamızda bir yıllık mortaliteyi tahmin etmede lojistik EuroSCORE en etkin skorlama sistemi olarak bulunmuştur. İdeal kardiyak risk skorlama sistemini bulmak için randomize klinik çalışmalara ihtiyaç olduğu kanısındayız.

Anahtar kelimeler: Koroner arter baypas greftleme, risk değerlendirmesi, mortalite

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INTRODUCTION

Cardiovascular diseases (CVD) are one of the leading causes of morbidity and mortality especially in the developing countries[1]. The patients with cardiovascular diseases are prone to develop cardiac events during the preoperative period for coronary artery bypass surgery (CABG) and these increase the mortality rate in this group of patients[1]. Cardiac risk scoring systems have been created in order to minimize patients' waiting time and identify patient groups who will provide the maximum benefit from an early operation. These systems also enable us to form an opinion about operative mortality, morbidity, length of hospital stay and hospital costs based on various risk factors relating to an operation being planned in the patients. For this purpose, many scoring systems are used, and their most commonly used ones are logistic European System for Cardiac Risk Operative Risk Evaluation (EuroSCORE) and EuroSCORE II. EuroSCORE aims to give an idea about mortality and morbidity by calculating the patients' scores according to patients' preoperative data, demographic characteristics and operations. As in many other risk assessment systems, the prevalence of coronary artery disease is also not considered as a risk factor in the EuroSCORE risk system[2]. The SYNTAX score is another risk evaluation system which is based on anatomic localization of the coronary artery atherosclerosis. The risk is identified by evaluating the prevalence of coronary artery disease in the SYNTAX risk scoring system in discordance with the EuroSCORE system[2].

This study aimed to evaluate patients who had undergone CABG surgery using EuroSCORE II, logistic EuroSCORE and SYNTAX scores in order to find the ideal scoring system.

MATERIALS AND METHODS

This retrospective study attempted to examine the preoperative demographic characteristics, echocardiographic findings, operation notes and files, perfusion cards and observation notes of 228 patients who had undergone a CABG surgery in our clinic between January 1, 2012 and January 1, 2013 and control visit after one-year (This study was approved by Bakırköy Dr Sadi Konuk Training and Research Hospital Ethical Commission with a protocol number 2014-188, 15/09/2014). In addition their logistic EuroSCORE, EuroSCORE II and SYNTAX scores were calculated. An online interactive calculator was used to work out logistic EuroSCORE and EuroSCORE II values via a website where their descriptions are also found (http://www.euroscore.org). Cockroft-Gault formula was used for calculating creatinine clearance3. The SYNTAX score was calculated by watching angiography images of patients and using the online interactive calculator at the website (www.syntax.com) where SYNTAX description and studies are found.

Patients with preoperative serum creatinine levels of 200 μmol/lt (2.26 mg/dL) or receiving dialysis treatment prior to preoperative evaluation were considered as chronic kidney disease4. Stroke diagnosis was made by a neurologist using imaging methods after proper physical examination. Development of postoperative renal failure or the need for dialysis was regarded as acute renal failure. Patients died from any postoperative reason (cardiac and non-cardiac) were considered as mortality group. Information about cross clamp time (CCT), cardiopulmonary bypass time (CPBt) and whether an additional surgical intervention performed to the patients has been found from the patients' perfusion cards. Phone numbers were gathered by using patients' control records, and follow-up was done in the 11-13 months postoperatively. Ten patients died within one year.

Echocardiography and the physical examination were performed by the same cardiologist, and ejection fraction (EF), left ventricular end-diastolic diameter (LVEDD) and interventricular septum thickness were measured in the first year postoperatively. Additionally, patients with symptoms of New York Heart Association (NYHA) III-IV, 4 were performed exercises stress test. The patients with positive results in exercise test reffered to myocardial perfusion scintigraphy. Stent placement was performed to symptomatic patients by cardiology department. 140 patients were evaluated after one year. If the patients could not be assessed in their first-year check-up in an orderly manner, the information about their survival status were obtained through phone calls. Patients included in our study were divided into two groups according to their survival status during one-year period. Preoperative demographic data of these two groups were compared in order to determine the factors that affect mortality.

Anesthesia and surgical technique

Combinations of hipnoid, opioid, anxiolytic and amnesic drugs and muscle relaxants were often used during the induction although a standard model of anesthesia induction and maintenance is not available for the patients who underwent cardiac surgery. Considering patients' age and co-morbid diseases as well as their EF values, barbiturates, benzodiazepines, opioids, etomidatepropofol or ketamine were administred alone or in combination. Electrocardiographic values, pulse oximetry, urine output, invasive arterial- and central venous pressure were monitored during surgery. 197 patients were operated at cardioplegic arrest by infusion of blood cardioplegia through antegrade and retrograde procedures by cardiopulmonary bypass with aortic-unicaval two stage cannulation. Six patients underwent supracoronary ascending aortic replacement, five patients underwent carotid endarterectomy with CABG surgery, mitral valve replacement was done to four patients and left ventricularaneurysmectomy was performed to three patients. Similarly, each of 5 patients underwent mitral and aortic valve replacement, Bentall procedure, mitral valve repair, aortic valve repair, De-Vega annuloplasty with left atrial myxoma excision. Thirty-one patients were operated by using beating heart technique, and 3 of them underwent robot-assisted CABG surgery.

Statistical analysis

SPSS 16.0 software (SPSS for Windows 16.0, SPSS Inc., Chicago) was used to analyze the study data. Data were expressed as mean ± standard deviation. Kolmogorov-Smirnov test was performed to determine whether continuous variables are normally distributed. The parametric independent t test and the non-parametric Mann-Whitney U test were carried out to analyze continuous variables. Chi square test was used for categorical variables. Stepwise logistic regression analysis was conducted to determine mortality. Areas under the ROC curve for SYNTAX score, EuroSCOREII and logistic EuroSCORE were calculated to determine mortality. Predictive points were determined based on sensitivity, specificity, positive predictive value, negative predictive value and LR (+) values. The p-values less than 0.05 ($p<0.05$) were considered to be statistically significant.

RESULTS

The average age of 228 patients included in our study was 61.14±17.67 years. Fifty-one of them were women and 177 were men. They were divided into two groups as those alive and dead in the first year follow-up. Patients' demographic data were presented in Table 1. In addition to the demographic data, their perioperative evaluations were carried out according to the groups and were demostrated in Table 2. Post-operative outcomes of the patients were shown in Table 3. Results of statistical analysis suggest that age, EF, intra-aortic balloon pump (IABP) need in the postoperative period, postoperative arrhythmia and acute kidney injury (AKI) were independent predictors of mortality (Tables 1-3).

Table 1. Demographic data of the patients

Variables	Group 1 (n:208)		Group 2 (n:17)		p
Age* (years) (mean±SD)	60.46±10.56		69.06±9.9		0.001
Troponin (preoperative) (mean±SD)	0.98±3.4		1.68±346		0.408
CRP (preoperative) (mean±SD)	2.41±4.11		3.22±5.31		0.496
Ejection fraction* (mean±SD)	53±8.99		44.82±10.63		0.0001
Gender	n	%	n	%	
Female	45	21.43	6	33.33	0.245
Male	165	78.57	12	66.67	
Hypertension	143	68.10	12	66.67	0.901
Diabetes mellitus	116	55.24	9	50.00	0.668
Hyperlipidemia	92	43.81	12	66.67	0.062
Chronic obstructive pulmonary disease	46	22.01	3	16.67	0.597
Smoking	130	61.90	12	66.67	0.689
Cerebrovascular disease	18	8.57	2	11.11	0.715
Previous myocardial infaction	134	63.81	12	66.67	0.808
Chronic kidney disease	25	11.90	5	27.78	0.056
Emergency operation	25	11.90	5	27.78	0.056

Table 2. Preoperative evaluation of the patients

	Group 1	Group 2	p
Coronary anastomosis	2.97±0.99	2.83±0.86	0.566
CCT**	70.23±28.14	91.63±54.63	0.009
CPBt *	116.24±39.8	171±88.84	0.0001

Group 1: One year survival, Group 2: One year mortality), (*p<0,001 , **p<0,05), CCT: Cross clamp time, CPBt: Cardiopulmonary bypass time.

Table 3. Postoperative data of the patients

	Group 1		Group 2		p
	n		n		
Postoperative IABP use *	11	5.24	7	38.89	0.0001
AKI**	27	12.86	5	38.46	0.011
Postoperative cerebrovascular disease	10	4.76	0	0	0.421
Postoperative rhythm disorder **	49	23.33	8	61.54	0.008
Re-hospitalization	13	6.22	2	20	0.092
ICUstay (days) (mean±SD)	3.46±1.91		6.14±5.48		0.0001
Hospital stay (days) (mean ±SD)	11.87±4.49		12.92±5.71		0.438

Group 1: One year survival, Group 2: One year mortality), IABP: Intraaortic balloon pump, AKI: Acute kidney injury, ICU: intensive care unit, (*p<0,001 , **p<0,05)

Moreover, longer CCT, longer CPBt and longer duration of stay in the intensive care unit were found to be statistically significant among factors that affect the mortality (Tables 2-3).

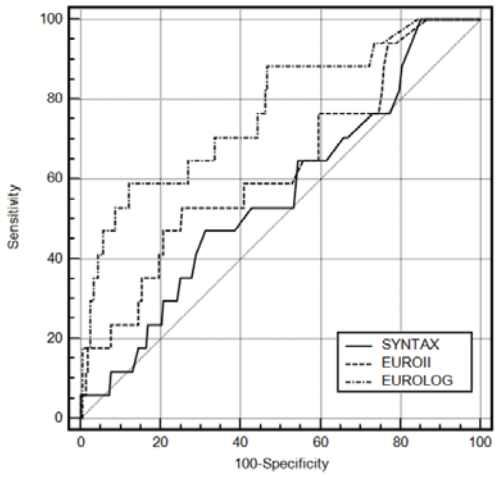

Figure 1. The evaluation of SNYTAX, EuroSCOREII, Logistic EuroSCORE values by ROC analysis

Our results indicate that troponin elevation, CRP elevation, chronic kidney disease, previous myocardial infarctions (MIs), smoking, diabetes mellitus (DM), chronic obstructive pulmonary disease, hypertension and hyperlipidemia were not statistically significant between the groups.

Logistic EuroSCORE value of patients was 3.6±3.71 in the group 1 and 10.06±9.28 in the group 2; EuroSCORE II value was 1.65±1.34 in the group 1 and 2.69±2.73 in the group 2. SYNTAX score was 24.7±7.13 in the group 1 and 26.47±7.39 in the group 2 (Table 4). When compared to EuroSCORE, EuroSCORE II and SYNTAX values among the groups, an increase was observed in the second group and EuroSCORE II and logistic EuroSCORE scores were found to be statistically significant (P <0.001).

Table 3. Postoperative data of the patients

	Group 1	Group 2	p
Logistics EuroSCORE	3.6±3.71	10.06±9.28	0.0001
EuroSCORE II	1.65±1.34	2.69±2.73	0.005
SYNTAX	24.7±7.13	26.47±7.39	0.329

Group 1: One-year survival, Group 2: One-year mortality

Areas under the Receiver Operating Characteristics (ROC) curve for SYNTAX score, EuroSCOREII and logistic EuroSCORE were calculated in differential diagnosis to predict the mortality. The areas under the curve of SYNTAX, EuroSCORE II and logistic EuroSCORE scores were calculated to be 0.561 (0.493-0.626), 0.629 (0.562-0.692), and 0.770 (0.710-0.824), respectively. By comparison with the areas under ROC curve shown in Figure 1, an area of logistic EuroSCORE was found to be statistically significant larger than those of SYNTAX and EuroSCORE II (Table 4).

It was found that predictive point of SYNTAX score was higher than 27.5 (>27.5), its sensitivity was 47.06, its specificity was 68.75, its positive predictive value was 11, its negative predictive value was 94.1 and its logistic regression (LR +) value was 1.5 in order to determine mortality rate. EuroSCORE II was higher than 1.82 (>1.82), sensitivity was 55.56, specificity was 78.76, positive predictive value was 15.9, negative predictive value was 95.2 and LR+ value was 2.20 in order to determine mortality rate. Risk of a patient's mortality with EuroSCORE II value higher than 1.82 was found to be 2.2 times more than that of a patient with EuroSCORE II value less than 1.82. EuroSCORE II was enough to predict one-year mortality rate but its positive predictive value was low. Predictive value of logistic EuroSCORE was higher than 5.71 (>5.71), sensitivity was 61.11, specificity was 88.10, positive predictive value was 30.6, negative predictive value was 96.4 and LR+ value was 5.13 in order to determine mortality rate. Risk of a patient's mortality with logistic EuroSCORE value greater than 5.71 was found to be 5.13 times more than that of a patient with logistic EuroSCORE value less than 5.71. Logistic EuroSCORE was sufficient to predict one-year mortality rate.

Besides, stepwise logistic regression analysis was performed for the variables age, logistic EuroSCORE, EF, IABP use, AKI, post-operative arrhythmia, CCT, CPBt and length of intensive care unit stay that were found to be statistically significant in the univariate analysis. Upon this logistics EuroSCORE and AKI were found to be the factors that affect the mortality.

DISCUSSION

This is a retrospective study investigating effectiveness of perioperative risk scores for coronary bypass surgery. There are several scoring systems for evaluating patients undergoing CABG. In our country, Logistic EuroSCORE and EuroSCORE II systems are widely being used to identify the risk in the field of cardiovascular surgery. These two systems are attempting to identify the risk by utilizing patients' preoperative demographic data such as kidney failure, EF values, degree of urgency of the operation, age, sex, chronic obstructive pulmonary disease, MI and DM. Different from these two systems, the SYNTAX score system focuses on the prevalence of CAD[5-12].

Literature indicates that kidney failure is a mortality marker for patients with CAD independent from the SYNTAX score[13]. Moreover, a study on CAD risk in patients with type 1 DM showed that the risk of developing CAD in the patients accompanying diabetic nephropathy was found to be 29 during their 20 years-follow-up and to be only 2-3 in patients without nephropathy[14]. Considering INTERHEART study, it has been reported that the risk of developing DM and MI in men and women increased two times more than others regardless of ethnic background[15]. Kaya et al have found that there was no statistically significant difference between short and medium-term life expectancy of women and men following CABG surgery[16]. Given gender distribution of the groups, no statistically significant difference has found to be between one-year mortality rates and females and males. The results of our subgroup analysis also demonstrate that incidence of DM, smoking and hypertension were similar to all groups. One might argue that similarity in the risk factors lies behind the similarity in the prevalence of CAD.

Smoking is also well known to be a risk factor in the development of CAD. Continuation of smoking in the postoperative period was found to be associated with poor clinical outcomes in particularly patients with complex CAD[17]. Our study shows that there was no significant difference with respect to the impact of smoking on one-year mortality rate.

Futhermore, it has been established to be no statistically significant difference between the groups in terms of the effect of chronic renal disease and DM on one-year mortality rate. However, 27 patients developing AKI in early postoperative follow-up were assessed and incidence of AKI was seen to have an impact upon one-year mortality rate.

Consistent with the literature, the results of our study revealed that there was a statistically significant difference between two groups in terms of age, EF, high EuroSCORE II and logistic EuroSCORE scores, IABP use, CPBt, CCT, detection of arrhythmia and longer length of stay in intensive care unit. Some factors such as low EF, advanced age, high EuroSCORE and EuroSCORE II scores, long CPBt and CCT, need using postoperative IABP, AKI, arrhythmia and longer length of stay in intensive care unit increase mortality rates in patients undergoing a CABG surgery. A retrospective study on 1250 patients by Hamulu et al[18] suggests that, in a fashion similar to

our study, factors affecting the mortality rate were age (>60 years), low EF (<40), number of bypassed vessels (>4 vessels), longer CCT and prolonged CPBt (>120 minutes), preoperative MI and AKI. In another study in which 200 patients underwent coronary artery bypass grafting consistent with our results, risk factors that most affect the mortality rates have been established to be prolonged CPBt, an involvement in three vessels and IABP use[19].

Logistic EuroSCORE was found to be the most effective scoring system in predicting one-year mortality in this study. Besides, EuroSCORE II score was observed to be statistically significant between the groups, but the SYNTAX score was found to be no statistically significant difference between the groups. Limited number of patients may be one of the reasons for this result. In addition, the fact that SYNTAX score is not statiscally significant for demonstrating one-year mortality rates suggests that the prevalence of CAD alone is not significant for cardiovascular risk. Having looked at the statistical detail of the study, mortality risk of a patient with SYNTAX score higher than 27,5 is 1.5 times more than that of a patient with SYNTAX value less than 27.5. Therefore, SYNTAX score was insufficient to predict 1-year mortality rate. Considering EuroSCORE II, mortality risk of a patient with EuroSCORE II value higher than 1.82 is 2.2 times more than that of a patient with EuroSCORE II less than 1.82. Based on these values, EuroSCORE II was sufficient to estimate one-year mortality rate but still its positive predictive value was low. Mortality risk of a patient with logistic EuroSCORE value higher than 5.71 is 5.13 times more than that of a patient with logistic EuroSCORE value less than 5.71.

Based on this outcome, logistic EuroSCORE was found adequate to estimate one-year mortality rate. It was also established to be the most effective scoring system in predicting the mortality. Consequently, we can infer that there are differences between these two scoring systems in terms of values. In addition, although those who undergone an operation on the first day after the angiography in the logistic EuroSCORE system were considered as emergency patient, these patients were categorized into four separate batches as elective, primary, emergency and rescue operations in the EuroSCORE II system[11].

The sensitivity of the stratification systems can also be assessed by using ROC analysis. The area under the curve gives a general relation between specificity and sensitivity of the scoring system. In general terms, the gerater area under the curve represents the greater positive risk prediction. Thus, the logistic EuroSCORE with an area of 0.770 has much more predictive value in 1-year mortality risk than EuroSCORE II and SYNTAX scoring systems according to the ROC analysis (Table 2).

In a study by Fukui et al. on isolated 412 patients undergoing coronary artery bypass graft between 2010 and 2012, EuroSCORE II and SYNTAX scores were compared. It has been reached the conclusion that these two scoring systems were more effective in using together than using EuroSCORE II and SYNTAX scores separately in order to detect early major complications. EuroSCORE II was found to be more successful in demonstrating the late period mortality[20]. One-hundred and sixteen patients were examined in a study performed by Baykan et al. in order to determine how SYNTAX score in patients undergoing coronary revascularization plays a role in establishing early endpoints. Percutaneous coronary intervention was applied to 61 of them, and 55 underwent a CABG surgery. Results of statistical analysis showed that these three scoring systems can successfully be predicted adverse cardiac events that may occur within the hospital during the early period (first 30 days) and at the end of 6 months[2]. We think the reason why SYNTAX score was succesfull in the present study is that percutaneous coronary intervention and CABG patients are evaluated together.

In addition to these findings, Global Risk Classification being formed the combination of SYNTAX and EuroSCORE was used in a study on patients with left main coronary artery disease and administering a percutaneous treatment. It was found to be more successful than other risk scoring systems in demonstrating two-year mortality rate[21]. In another study among Turkish population, Logistic EuroSCORE was established to be more significant than EuroSCORE II for demonstrating the mortality rate following the CABG surgery, which was also assessed in our study. Researchers have attributed such an outcome to ethnicity, seasonal variations and single-centered study[22].

There are several limitations of this study. When other similar studies are taken into consideration, the number of patients could be higher to assess the

effectiveness of these scoring systems more precise in our study. This issue can sometimes be a major influencing factor in statistical analysis in spite of power analysis but the data of our study showed similar results with the other studies. Another lack is that we compared the scoring systems separately. We could compare the scoring systems as a group with other studies in the literature but the aim of our study is to find out the most effective scoring system in one-year mortality in CABG patients.

As a conclusion, use of risk systems in cardiovascular surgery is highly important to detect mortality, morbidity and cost-effective therapeutic approaches. However, it should not be only one endpoint for analysis of clinical outcomes of mortality and morbidity. Endpoints such as long-term survival rates, readmission to hospital and the need for re-treatment should also be analyzed. In conclusion, use of scoring systems in the patients undergoing a CABG surgery is helpful in identifying mortality and morbidity risks of patients and usage of logistic EuroSCORE from these systems was found to be more effective than the others in estimating the outcome. The reasons why EuroSCORE II is insufficient and SYNTAX score is non-significant may be because of limited numbers of patients in our study and being single-centered study. Combination of SYNTAX and EuroSCORE systems also brings to more significant results[21]. Large-scaled studies, which are supported by many centers and consist of a large number of patients, are needed to be performed in order to find an ideal cardiac risk scoring system.

REFERENCES

1. Kültürsay H. Methods of risk estimation for cardiovascular disease. Arch Turk Soc Cardiol. 2011;39:6-13
2. 2.Baykan OA, Çinçin A, Kefeli U, Caymaz U. Koroner arter revaskülarizasyonu uygulanan hastalarda SYNTAX skorlama sisteminin erken dönem sonlanım noktalarını belirlemedeki rolü. Türk Girişimsel Kard Der. 2014;18:30-40.
3. Cockroft D, Gault MK. Prediction of creatinine clearence from serum creatinine. Nephron. 1976;16:31-41.
4. Farrokhyar F, Wang X, Kent R, Lamy A. Early mortality from off-pump and on-pump coronary bypass surgery in Canada: A comparison of the STS and the EUROSCORE risk prediction algorithms. Can J Cardiol. 2007;23:879-83.
5. Ünüvar N, Mollahaliloğlu S, Yardım N. Türkiye Hastalık Yükü Çalışması 2004. Ankara, Aydoğdu Ofset, 2007
6. Mozaffarian D, Kamineni A, Carnethon M, Djoussé L, Mukamal KJ, Siscovick D. Lifestyle risk factors and new-onset diabetes mellitus in older adults: the cardiovascular health study. Arch Intern Med. 2009;169:798–807.
7. van Klaveren D, Vergouwe Y, Farooq V, Serruys PW, Steyerberg EW. Estimates of absolute treatment benefit for individual patients required careful modeling of statistical interactions. J Clin Epidemol. 2015;68:1366-74.
8. Iqbal J, Zhang YJ, Holmes DR, Morice MC, Mack MJ, Kappetein AP et al. Optimal medical therapy improves clinical outcomes in patients undergoing revascularization with percutaneous coronary intervention or coronary artery bypass grafting: insights from the Synergy Between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery (SYNTAX) trial at the 5-year follow-up. Circulation. 2015;131:1269-77.
9. Karabulut A, Cakmak M. Treatment strategies in the left main coronary artery disease associated with acute coronary syndromes. J Saudi Heart Assoc. 2015;27:272-6.
10. Piek JJ, Claessen BE, Davies JE, Escaned J. Physiology-guided myocardial revascularisation in complex multivessel coronary artery disease: beyond the 2014 ESC/EACTS guidelines on myocardial revascularisation. Open Heart. 2015;2:e000308.
11. Akgül A, Gürsoy M, Bakuy V, Bal Polat E, Kömürcü İG, Kavala AA et al. Koroner arter baypas greftleme sonrası erken mortalitenin belirlenmesinde standart, lojistik Euroscore ve EuroscoreII'nin karşılaştırılması. Anadolu J Cardiol. 2013;13:425-31.
12. Kocabeyoğlu SS, Çetin E, Özyüksel A, Kutas B, Çalışkan A, Özdemir F et al. Yeni bir kalp cerrahisi kliniği: Diyarbakır Eğitim ve Araştırma Hastanesi'nde ilk 195 vakanın sonuçları. Kosuyolu Heart J. 2014;17:20-5.
13. Yan LQ, Guo LJ, Zhang FC, Gao W. The Relationship between kidney function and angiographically-derived SYNTAX score. Can J Cardiol. 2011;27:768–72
14. Tuomilehto J, Borch-Johnsen K, Molarius A, Forsén T, Rastenyte D, Sarti C et al. Incidence of cardiovascular disease in type 1 (insulin dependent) diabetic subjects with and without diabetic nephropathy in Finland. Diabetologia. 1998;41:784-90
15. Yusuf S, Hawken S, Ounpuu S, Dans T, Avezum A, Lanas F et al. INTERHEART Study Investigators.Effects of potentially modifiable risk factors associated with myocardial infarction in 52 countries(the INTERHEART study): case control study. Lancet. 2004;364:937-52
16. Kaya M, İyigün T, İyigün M, Bakır İ, Yeniterzi M.

The results of coronary artery surgery in women and men under the age of 45. Türk Göğüs Kalp Damar Cerrahisi Dergisi. 2013;21:581-7.
17. Zhang YJ, Iqbal J, van Klaveren D, Campos CM, Holmes DR, Kappetein AP et al. Smoking is associated with adverse clinical outcomes in patients undergoing revascularization with PCI or CABG: the SYNTAX trial at 5-year follow-up. J Am Coll Cardiol. 2015;65:1107-15.
18. Hamulu A, Özbaran M, Atay Y, Posacıoğlu H, Aras İ, Büket S et al. Koroner bypass ameliyatında mortalite ve morbiditeye etki eden risk faktörlerinin belirlenmesi ve değerlendirilmesi. Göğüs Kalp Damar Cerrahisi Dergisi. 1995;3:245-52.
19. Kutay V, Ekim H, Kırali K, Güler M, Yakut C. Van ve çevre illerde yaşayan koroner arter hastalarının profili ve CABG sonuçları. Türk Göğüs Kalp Damar Cerrahisi Dergisi. 2003;11:1-4.
20. Fukui T, Uchimuro T, Takanashi S. EuroSCORE II with SYNTAX score to assess risks of coronary artery bypass grafting outcomes. Eur J Cardiothorac Surg. 2015;47:66-71.
21. Capodanno D, Miano M, Cincotta G, Caggegi A, Ruperto C, Bucalo R et al. Euroscore refines the predictive ability of SYNTAX score in patiens undergoing left main percutaneous coronary intervention. Am Heart J. 2010;159:103-9.
22. Kunt AG, Kurtcephe M, Hidiroglu M, Cetin L, Kucuker A, Bakuy V et al. Comparison of original EuroSCORE, EUROSCORE II and STS risk models in a Turkish cardiac surgical cohort. Interact Cardiovasc Thorac Surg. 2013;16:625-9.