REVIEW ARTICLE

Risk models for patients undergoing robotic surgery, minimal invasive heart surgery and open-heart surgery

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Abstract

In this study; we tried to compile risk scoring systems (Original EuroSCORE, EuroSCORE II and STS) used in robotic surgery, minimally invasive cardiac surgery and open-heart surgery in the context of the literature. As a result, literature study of risk scoring systems in the robotic surgery was not found. In minimally invasive cardiac surgery, few studies are available. The effectiveness of existing risk scoring systems has not been established in these studies. Therefore, further investigations are required for developing risk scoring systems in robotic surgery and minimally invasive cardiac surgery. In open heart surgery, there is still no "gold standard" scoring system in all populations. Due to the increased case diversity, we believe that the commonly used risk scoring systems must be updated. Widely used risk-scoring systems are not effective in minimally invasive cardiac surgery and this is supporting our idea. Each clinic should choose the appropriate risk scoring system according to their own experience and case diversity.

Keywords: Robotic surgery, minimal invasive heart surgery, heart surgery, risk model

Introduction

Invasive techniques or open surgical methods may be applied in addition to medical treatment in the management of heart diseases. Hybrid interventions, minimally invasive cardiac surgery and robotic cardiac surgery techniques have begun to develop in recent years to reduce the risks of open surgical procedures. The choice of treatment options is decided by National or International guidelines. In addition, the risk of mortality and morbidity that the treatment option will cause in the patient is taken into consideration. Mortality and morbidity associated with surgical procedures is one of the important performance indicators to assess the outcome of the relevant surgical procedure. Necessity to develop risk scoring systems arose for predicting the mortality and morbidity of the treatment option in the preoperative period. For this reason, many risk-scoring systems have been established and started to be used [1]. Risk scoring systems are statistical and objective. Today, the most commonly used risk scoring systems are the European System for Cardiac Operative Risk Evaluation (EuroSCORE), EuroSCORE II and the Society of Thoracic Surgeons (STS).

In this study; we tried to compile risk scoring systems (Original EuroSCORE, EuroSCORE II and STS) used in robotic surgery, minimally invasive cardiac surgery and open-heart surgery in the context of the literature.

Discussion

Risk scoring systems do not only give information about operative mortality and morbidity. It provides useful information in surgical strategy planning, a more accurate comparison of the results of different centers and a cost analysis foresight. It also informs the physician about the suitability of the surgical method preferred for the patient. Although there are many risk factor classifications designed for this purpose, most widely used original EuroSCORE, EuroSCORE II and STS risk scorings will be investigated in the context of the current literature in this review.

EuroSCORE is the most commonly used risk scoring system. It is more frequently used in Europe than in the United States. The original EuroSCORE was developed in 1999 by examining the data of approximately 19,000 patients who underwent adult cardiac surgery [2]. Even though the original EuroSCORE is still in use today, in 2012 the meta-analysis of 67 trials concluded that the original EuroSCORE risk scoring system was not suitable. In the same study, Original EuroSCORE was found to be inadequate in predicting the mortality rate in high-risk patients [3]. EuroSCORE II risk classification was developed in 2012 after the fact that the

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original EuroSCORE was inadequate to predict operative mortality [4]. One of the most important reasons for the widespread use of EuroSCORE risk classification is to update itself.

The STS score was developed in 1994 [5]. This system provides important information about mortality as well as morbidity. It may be more effective for evaluating the cost analysis of the preferred treatment. Table 1 shows the parameters evaluated in each of the 2 risk scoring systems (EuroSCORE and STS). When the parameters in Table 1 are examined, it is more likely that the STS score will give better information about mortality as well as morbidity.

Table 1. Parameters assessed in EuroSCORE and STS risk scorings

Risk Parameters	EuroSCORE	STS
Age	+	+
Female Gender	+	+
Obesity		+
Diabetes Mellitus	-	+
Renal Disease	-	+
Dialysis	+	+
Peripheral Arterial Disease	-	+
COPD	+	+
Hypertension	+	+
Infective Endocarditis	-	+
Cerebrovascular Disease	-	+
Immunosuppression	+	+
Cardiogenic Shock	-	+
Past MI	-	+
IABP / Inotropic Drug	+	+
Emergency Surgery	+	+
Reoperation	+	+
Ejection Fraction	+	+
Ventricular Arrhythmia	+	+
Valvular heart disease	+	+
Post MI VSD	+	-
Pulmonary Hypertension	+	+
Stable Angina	+	+

COPD: Chronic Obstructive Pulmonary Disease, MI: Myocardial Infarction, IABP: Intraaortic balloon pump, VSD; Ventricular Septal Defect

In 1992, Higgins et al. had begun to develop and use the Cleveland clinical scoring system [6]. Although it was claimed to have similar results with EuroSCORE, it had significant disadvantages of being retrospective and focusing on mortality and giving less information about morbidity. It has been widely used in North America and has found relatively few uses in European countries. It is not frequently used in our country. For this reason, this study has not been discussed in detail in the literature.

Ad et al. Compared the STS, the original EuroSCORE and the EuroSCORE II in the monocentric series of 11788 patients. EuroSCORE II was found to be superior to the original EuroSCORE in predicting operative mortality. EuroSCORE II and STS risk models were found to be similar in prediction of operative mortality. However, EuroSCORE II was superior to STS in complex surgeries [7]. Kuwaki et al found that EuroSCORE II was better in low-risk patients and STS scoring system was better in high-risk patients undergoing to aortic valve replacement [8].

When the literature was searched, especially in the last 10 years, it was determined that different risk scoring systems made more accurate estimations in different populations. EuroSCORE II risk scoring method was found to be better in patients undergoing single valve operation in Chinese population [9]. When the New Zealand patient population was examined, STS and EuroSCORE II showed similar results and were superior to the original EuroSCORE in this patient group [10]. In the population of Pakistan, EuroSCORE II was found to be better in patients with isolated aortic valve replacement patients, and STS scoring system found to be better in patients undergoing combined coronary and valve surgery. In isolated coronary artery bypass graft surgery, STS score was found to be superior to EuroSCORE risk classification [11]. In the Indian population, EuroSCORE II was found to be better for all surgical subgroups. EuroSCORE II was considered acceptable for coronary artery bypass graft surgery patients and excellent for valve surgery [12]. Fındık et al. reported that best risk scoring system for predicting mortality in Turkey was the original EuroSCORE risk stratification [13]. When we evaluate all these literature data, it is seen that different risk scoring systems are better in different surgical procedures in the same population. EuroSCORE risk classification is generally better in European countries and therefore seems to be widely used especially in European countries.

Due to technology and increasing surgical experience, there has been an increase in the number and variety of patients who can be operated by cardiac surgeons. With the widespread use of primary percutaneous transluminal coronary angioplasty, use of clopidogrel and ticagrelor has increased before emergency or early surgery candidates. This will increase the risk of bleeding in the postoperative period and increase mortality and morbidity. For this reason, we think that these factors should be added in risk scoring systems which are widely used today. On the other hand, with development of technology and increasing surgical experience, there is an increase in the number of patients undergoing 3rd or 4th operation. We believe that risk scoring should be updated for patients who are undergoing to 3rd or 4th operation in an increasing way for each operation, rather than just re-operation. Based on our experience with open heart surgery in our clinic, we think that one of the most important factors determining operative mortality and morbidity is the general condition and effort capacity (so called "frailty") of the patient. We observed that mortality and especially morbidity was higher in patients with poor general condition and effort capacity, despite low risk scoring system scores. We take these factors into account when taking patient's informed consent for surgery, even these are not mentioned enough in risk-scoring systems. For this reason, we believe that these factors should be included in risk scoring systems. We use EuroSCORE risk scoring system at our clinic, based on our experience and concordant with the literature we think EuroSCORE risk scoring system is more appropriate for Turkey.

The evaluation, creation and updating stages of risk scoring systems are based on patient-based results. Yes, these scores are

statistical and objective, but the experience of surgeon is not taken into consideration. We believe that surgeons' experience is as important as patient-based outcomes and that surgical experience should be taken into account when establishing risk-scoring systems.

Can EuroSCORE be used in minimally invasive cardiac surgery? Margaryan et al. found that the original EuroSCORE and EuroSCORE II risk classification systems were inadequate to predict operative mortality in minimally invasive cardiac surgery [14]. We believe that this is due to minimally invasive surgery is not performed routinely in each patient. Since minimally invasive cardiac surgery is selected and applied in a limited group of patients, general risk scoring systems may not be appropriate for this type of surgery.

Is every patient undergoing cardiac surgery eligible for minimally invasive or robotic surgery? It is clear that the experience of the center will play an important role as well as patient compliance. The major obstacles to the widespread use of minimally invasive and especially robotic cardiac surgery are the anatomical unsuitability of the patient, the difficulty and slowness of the surgeon's learning process. These procedures should not be used in patients with low ejection fraction and severe cardiomegaly, as the cross-clamp times in robotic and minimally invasive cardiac surgery will be longer than in conventional methods. In addition, robotic and minimally invasive surgery should not be performed in patients with pericardial adhesions such as pericarditis and radiotherapy, patients with aortic aneurysm, cirrhotic bleeding disorder and femoral artery occlusion for cannulation. In patients with high risk scores, we believe that using minimally invasive techniques instead of conventional techniques, if there is anatomic suitability and surgical experience, may lead to better results.

Long term results were similar in selected patients when compared with robotic isolated coronary artery bypass graft surgery and conventional coronary artery bypass graft surgery techniques. Early results of the robotic mitral valve surgery were also acceptable. Which risk scoring system should we use in robotic cardiac surgery? The answer to this question was searched in the literature and there were no statements in this regard. We believe that with the increase in the number of cases, more studies on comparison of risk-scoring system will be reported [15,16].

Conclusion

Literature study of risk scoring systems in the robotic surgery was not found. In minimally invasive cardiac surgery, few studies are available. The effectiveness of existing risk scoring systems has not been established in these studies. Therefore, further investigations are required for developing risk scoring systems in robotic surgery and minimally invasive cardiac surgery.

In open heart surgery, there is still no "gold standard" scoring system in all populations. Due to the increased case diversity,

we believe that the commonly used risk scoring systems must be updated. Widely used risk-scoring systems are not effective in minimally invasive cardiac surgery and this is supporting our idea. Each clinic should choose the appropriate risk scoring system according to their own experience and case diversity.

References

1. Nilsson J, Algatsson L, Höglund P, et al. Comparison of 19 preoperative risk stratification models in open-heart surgery. Eur heart J. 2006;27:867-74.

2. Roques F, Nashef SA, Michel P, et al. Risk factors and outcome in European cardiac surgery: analysis of the EuroSCORE multinational database of 19030 patients. Eur J Cardiothorac Surg. 1999;15:816-22.

3. Siregar S, Groenwold RH, Heer F, et al. Graaf Y, Herwerden LA. Performance of the orijinal Euro SCORE.Eur J Cardiothorac Surg. 2012;41:746-54.

4. Nashef SA, Roques F, Sharples LD, et al. Euro SCORE II. Eur J Cardiothorac Surg. 2012;41:734-44.

5. Clark RE. The Society of Thoracic Surgeons National Database status report. Ann Thorac Surg. 1994;57:20-6.

6. Higgins TL, Estafanous FG, Loop FD, et al. Stratification of morbidity and mortality outcome by preoperative risk factors in coronary artery bypass patients. A clinical severity score. JAMA. 1992;267:2344-8.

7. Ad N, Holmes SD, Patel J, et al. Comparison of Euro SCORE II, orijinal Euro SCORE, and the society of thoracic surgeons risk score in cardiac surgery patients. Ann Thorac Surg. 2016;102:573-9.

8. Kuwaki K, Inaba H, Yamamoto T, et al. Performance of the Euro SCORE II and the society of thoracic surgeons score in patients undergoing aortic valve replacement for aortic stenosis. J Cardiovasc Surg. 2015;56:455-62.

9. Zhang GX, Wang C, Wang L, et al. Validation of Euro SCORE II in Chinese patients undergoing heart valve surgery. Heart Lung Circ. 2013;22:606-11.

10. Wang TK, Choi DH, Ramanathan T, et al. Comparing performance of risk scores for combined aortic valve replacement and coronary bypass grafting surgery. Heart Lung Circ. 2016;25:1118-23.

11. Rabbani MS, Qadir I, Ahmed Y, et al. Heart valve surgery: Euro SCORE vs. Euro SCORE II vs. society of thoracic surgeons score. Heart Int. 2014;9:53-8.

12. Kar P, Geeta K, Gopinath R, et al. Mortality prediction in Indian cardiac surgery patients: validation of european system for cardiac operative risk evaluation II. Indian J Anaesth. 2017;61:157-62.

13. Findik O, Haberal I, Akyildiz M, et al. A comparison of the sensitivity and specificity of the Euro SCORE, Cleveland, and CABDEAL risk stratification systems in the Turkish population. Turk Gogus Kalp Dama. 2012;20:458-66.

14. Margaryan R, Moscarelli M, Gasbarri T, et al. Euro SCORE Performance in minimally invasive cardiac surgery: discrimination ability and external calibration. Innovations (Phila). 2017;12:282-6.

15. Kofler M, Stastny L, Reinstadler SJ, et al. Robotic versus conventional coronary artery bypass grafting: direct comparison of long-term clinical outcome. Innovations (Phila). 2017;12:239-46.

16. Senay S, Gullu AU, Kocyigit M, et al. Robotic mitral valve replacement for severe rheumatic mitral disease: perioperative technique, outcomes, and early results. Innovations (Phila) 2014;9:292-6.