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Evaluating the Pre-Operative Predictors of Length of Hospital Stay After Coronary Artery Bypass Graft Surgery

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ABSTRACT

Background: Several economic and academic aspects encourage researchers to evaluate the determinants of short and prolonged length of hospital stay (LOS) after common and expensive procedures such as heart surgeries. Our goal was to assess and evaluate the impact of major pre-operative factors on length of stay after coronary artery bypass graft surgery (CABG). Materials and Methods: We retrospectively analyzed 1377 patients who had undergone CABG surgery from 2006 to 2012. All demographic and basic medical information were obtained from the hospital`s cardiac surgery department database. Early discharge was defined as ≤5 days and hospitalization more than 5 days was accounted as prolonged length of stay (PLOS). Univariate and multivariate regression methods were used to determine the predictors that were significantly (p-value<0.05) related to the length of hospitalization. Results: In 1377 patients 640 (46.5%) had a hospital stay more than 5 days and the remaining 737 had hospitalization fewer than or equal to 5 days. In univariate analysis Glomerular Filtration Rate (GFR), hypertension, diabetes mellitus (DM), age, gender, Left Ventricular Ejection Fraction (LVEF) and Body Mass Index (BMI) showed significant relation to duration of hospitalization for more than 5 days (p-value<0.05). Our final regression model was conducted using forward stepwise regression. Only determinants (GFR<60, hypertension, age>60, DM, Gender and LVEF<40) found significantly related to length of stay through the multivariate analysis were included in this model. Conclusion: Preoperative health status and age are among the most important factors that can predict the length of hospital stay after CABG surgery. As well as pre-operative factors, post-operative complications and difference in efficiency of care among hospitals will also affect hospital duration and subsequent costs.

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INTRODUCTION

Increased life expectancy, high fat diet, smoking and industrial life-style are the most important risk factors for ischemic heart disease (IHD) in societies. The incidence of IHD worldwide is desperately increasing nowadays and will probably become the most common cause of death in the near future. The best treatment for patients with left main coronary artery stenosis and those with three-vessel involvement is CABG surgery. Open heart surgery, is one of the most common and expensive operations in the world [1,2]. Length of stay in hospital is a major contributor to the cost of this surgery around the world [3,4]. As suggested in previous studies, the comorbidities and general health condition of patients before CABG influence the postoperative complications and duration of stay [5]. Therefore identification and management of these factors will help reduce hospital stay duration, expenses and consequential burden to the patient and health system [6-8].

In this study, we attempt to evaluate the significance of preoperative factors in length of hospital stay in Iranian population. As there is a recognized variability in services provided by caregivers in different centers, affecting the LOS in hospital, we selected Imam Khomeini general teaching hospital in Tehran. We believe this

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hospital can be a good representative of our country due to well-distributed patients from different socioeconomic levels.

MATERIALS AND METHODS

This retrospective study, including 1377 patients who underwent isolated CABG surgery for the first time, was conducted in Imam Khomeini general teaching Hospital from April 2006 to March 2012. Patients undergoing other cardiac surgery (valvular surgery, aneurysmectomy and surgeries for congenital heart disease) were excluded from the study. Thirty-one patients who died before the fifth day after surgery were excluded. Since we think they might have lots of combined major comorbidities predisposing them to early postoperative death. Patients' data (date of surgery, date of discharge, age, general and other pre- and post-operative health status) were extracted from hospital database. Glomerular filtration rate (GFR) was calculated according to the Cockcroft-Gault equation. Prolonged ventilation was defined as ventilation more than 24 hours and LVEF was measured using transthoracic echocardiography. Length of hospital stay (LOS) was calculated according to the surgery date and discharge date .The cut of point of early or prolonged length of stay was determined by our data distribution, prior studies and experts' opinions [5,10].

Statistical Analysis:

Values are given as mean± SD. Independent sample T-test was used to compare means of quantitative variables in subgroups of length of stay. Associations between dichotomous data were analyzed with Chi-square method. In factors with low prevalence we used Fisher's Exact-test to evaluate the 2×2 tables. Univariate analysis in binary logistic regression was also used to define the relation between predictors and outcome in terms of Odds ratio and confidence interval. To form the final regression model we used forward stepwise logistic regression. Analysis was performed with SPSS 13 (Chicago package).

Results:

A total number of 1377 patients who underwent CABG and also had our inclusion criteria were enrolled in the study. All demographic and clinical characteristics for the patients are illustrated in Table 1. The overall mean age was 60±10.5, 30% were female. The mean age of female patients in this study was 60.37±10.9 and 50.3±9.3 for male patients. The mean of patients' age, was 57 in ≤5 days hospitalization and 62 in >5 days. According to independent sample T-test analysis, the difference between mean of age, was significant both between the two LOS subgroups (p-value=0.000) and between gender subgroups (p=0.012), 7.2±5.3 in female vs. 6.4±4.8 in men. The mean and median of hospital stay were 7 and 5 days, respectively. According to the median of our data and previous studies we defined early discharge time as stay fewer than 5 days in hospital, so, our binary output (length of state) was categorized in two groups: ≤5 days and >5days. Distribution of the length of stay in our patients is shown in Figure1.

Post-operative mortality rate in groups with more than 5 days stay was 5.2%.

GFR value of less than 60 ml/min, was the most significant predictor in our regression model. Independent clinical predictors of prolonged LOS are displayed as Odds Ratios with 95% confidence intervals in Table 2.

We formed our regression model in stepwise logistic regression using predictors that had significant relation with outcome in univariate analysis. In our model we only entered preoperative risk factors. In univariate analysis BMI≥35 (extremely obese) showed significant relation with LOS, but in overweight and obese patients the relation was not statistically significant.

We then did multivariate analysis with all significant variables of Table 2 in forward stepwise method and formed the final regression model with the six previously proven important predictors of LOS. BMI≥35 was not included in the model because it did not add independent predictive value. Therefore GFR<60, age≥60, female gender and hypertension had the greatest score in stepwise analysis. Although post-operative complications were not included in the regression model, because of their importance and prevalence we show them in Figure 2 and Table 4. We compared prevalence of various pre-operative factors, Figure 3.

In-addition, age, LVEF and GFR are categorized in three subgroups and considered the subgroup with the least theoretical relation to the outcome (LOS) as the reference group, Table2. The most prevalent complications of the surgery in our patients were re-bleeding and atrial fibrillation, 5.4% and 4.7%, respectively, Table 4. The mean of LOS in patients with post-operative pneumonia and sternal wound infection was the longest among other complications, 25.5 and 25.6 days respectively, Table 4. Association between LOS and post-operative complications was also analyzed, the chi-square and relative risk of each factor is separately calculated, Table 5. According to the relative risks, wound infection and prolonged ventilation are amongst the strongest predictors of LOS. Since, the patients diagnosed with sepsis were few (5 or less), we analyzed the relation between post-operative septicemia and LOS with fisher's exact test. The risk of LOS >5 days in septic patients was 2.16 times greater than patients without septicemia (p=0.022). As explained before, 5 days was considered as the point which we categorized our outcome (LOS). With this assumption COPD history was not associated to the LOS.

However, if we had defined 7 days as the prolonged hospital stay, there would have been a significant relation between COPD and LOS, p=0.026, OR=3.14 CI 95% (1.15-8.60).

Table 1: Basic demographic and medical information of all patients (n=1377).

Predictor	Prevalence	Mean(LOS)	Median(LOS)	LOS ≤5 days	LOS >5 days
Hypertension					
YES	44.8%	7.31	6	39.8%	50.6%
NO	55.2%	6.1	5	60.2%	49.4%
Age					
age<60	50.4%	5.93	5	58.6%	40.9%
60≤age <70	29%	7.1	5	27.4%	30.8%
age≥70	20.6%	7.75	6	14%	28.3%
Diabetes mellitus					
Yes	32.7%	7.21	6	28.6%	37.3%
no	67.3%	6.37	5	71.4%	62.7%
Sex					
Male	70%	6.42	5	74.9%	25.1%
Female	30%	7.16	6	64.4%	35.6%
Dyslipidemia					
Yes	31%	6.73	5	30.9%	31.1%
no	69%	6.61	5	69.1%	68.9%
BMI*					
BMI <25	33.8%	6.49	5	33.8%	33.9%
25≤BMI<35	61.9%	6.68	5	63%	60%
BMI≥35	4.3%	7.35	6	3.3%	5.5%
GFR**					
GFR<60	34.6%	7.89	6	25.1%	45.6%
60≤GFR<90	42.7%	5.89	5	48.7%	35.7%
GFR≥90	22.7%	5.99	5	26.2%	18.6%
LVEF***					
LVEF<40	22.9%	7.43	6	19.9%	26.4%
40≤LVEF<50	25.6%	6.91	5	24.2%	27.2%
LVEF≥50	51.5%	6.16	5	55.9%	46.4%

*Body mass index, **glomerular filtration rate, ***Left ventricular ejection fraction

Table 2: Pre-operative major risk factors, univariate analysis (n=1377).

Pre-operative factor	P-value in univariate analysis	Odds ratio(95% confidence interval)
Hypertension	0.000	1.55(1.25-1.92)
Age		
age<60		1
60≤age <70	0.000	1.6(1.25-2.06)
age≥70	0.000	2.89(2.17-3.85)
Diabetes mellitus	0.001	1.48(1.18-1.86)
Female sex	0.000	1.65(1.3-2.08)
Dyslipidemia	0.95	1(0.80-1.26)
BMI*		
BMI ≥25	0.995	0.999(0.799-1.25)
BMI≥30	0.61	1.06(0.82-1.37)
BMI≥35	0.045	1.71(1.01-2.99)
GFR**		
GFR<60	0.000	2.56(1.9-3.43)
60≤GFR<90	0.814	1.03(0.87_1.37)
GFR≥90		1
LVEF***		
LVEF<40	0.001	1.59(1.22-2.08)
40≤LVEF<50	0.02	1.35(1.04-1.73)
LVEF≥50		1
COPD****	0.96	1.024(0.39-2.67)

*Body mass index, **Glomerular filtration rate, ***Left ventricular ejection fraction, ****Chronic obstructive pulmonary disease

Table 3: Multivariate analysis including GFR<60, Age, HTN, LVEF≤40%, Gender and DM (n=1377).

Predictor	Odds ratio (95% confidence interval)	P-value in multivariate analysis
GFR<60	1.97(1.54-2.54)	0.000
Age≥60	1.99(1.60-2.48)	0.000
Gender(female)	1.49(1.15-1.92)	0.002
Hypertension	1.38(1.15-1.73)	0.0025
LVEF<40%	1.43(1.14-1.80)	0.002
Diabetes mellitus	1.45(1.14-1.84)	0.002

Table 4: Post-operative complications, descriptive analysis in groups of length of stay (n=1377).

Post-operative complications	Prevalence (n=1377)	Mean (days)	Median (days)	LOS ≤5 days	LOS >5 days
Sternal wound infection	1%	25.6	24	0%	1.9%
Atrial fibrillation	4.7%	8.7	7	1.4%	8.4%
Pneumonia	1.5%	25.5	22	0.1%	3.1%
Sepsis	0.4%	23.4	20	0%	0.8%
Stroke	1.2%	17.7	9	0.15%	2.4%
Prolonged ventilation	2.9%	17.4	14	0.3%	5.9%
Reoperation for bleeding	5.4%	8.1	6	3.1%	8%
Mortality	2.4%	19.4	17	------	5.2%

Table 5: Evaluating the association between post-operative complications and length of stay (n=1377).

Post-operative complications	Relative risk	χ^2	P-value
Sternal wound infection	2.17	13.94	0.000
Atrial fibrillation	1.89	38.75	0.000
Pneumonia	2.08	20.38	0.000
Stroke	2.04	14.52	0.000
Prolonged ventilation	2.10	38.99	0.000
Reoperation for bleeding	1.52	15.83	0.000

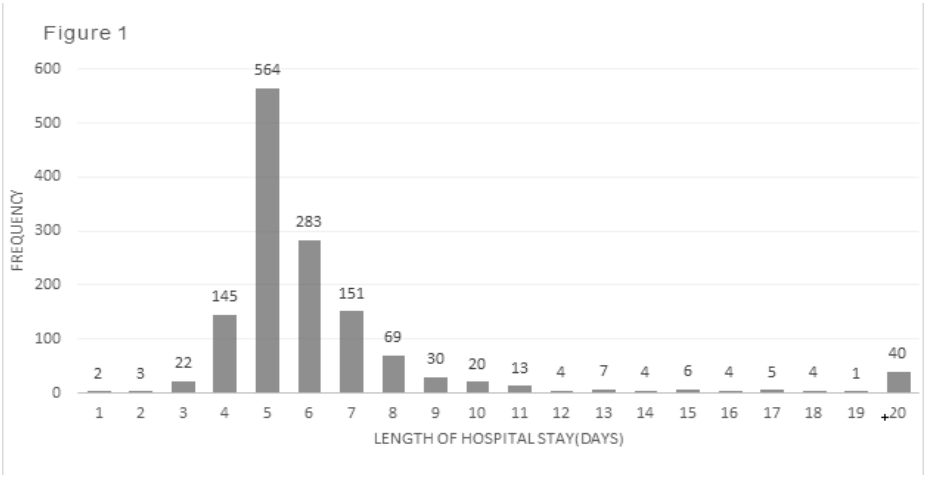

Fig. 1: Frequency distribution of the length of stay after CABG surgery in all of the population (n=1377).

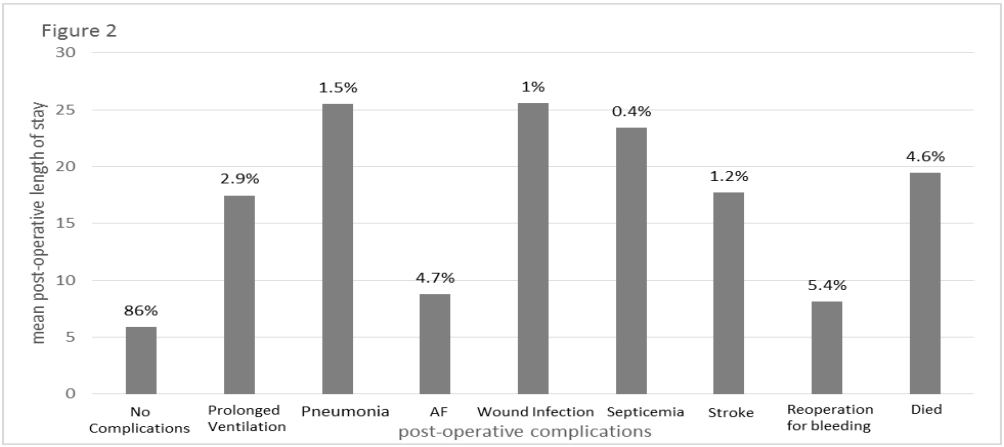

Fig. 2: Post-operative complication. The percentage above each bar represents the present of this complication in our sample size. The prevalence for mortality is the proportion of all deaths to the general population. However, we excluded death before 5 days in the analysis so the mean of LOS here, is regarding to those who died after 5 days.

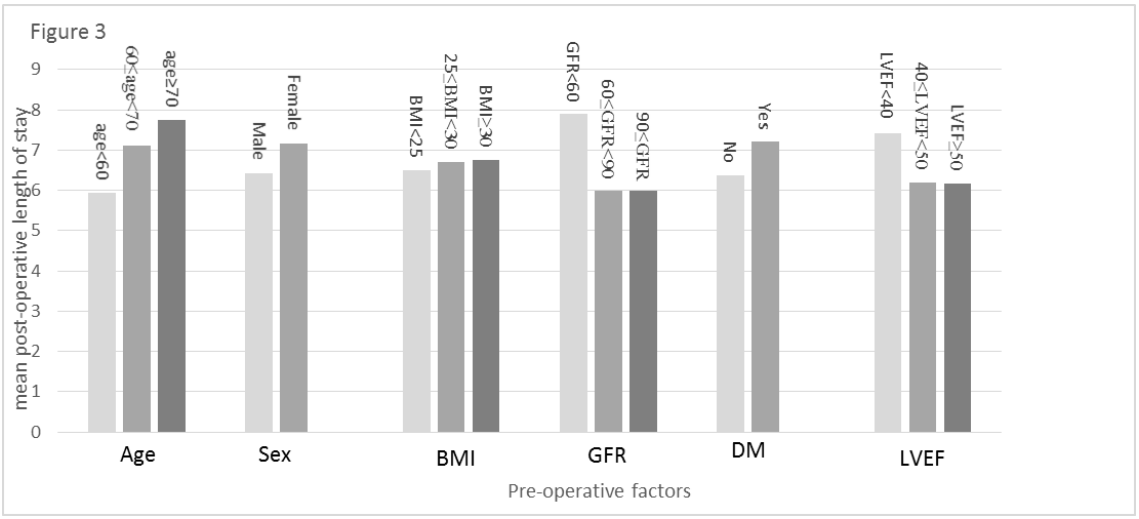

Fig. 3: On-admission preoperative major risk factors and health status of all the patients (n=1377).

Discussion:

Time for hospital discharge after major surgeries is still an important issue in order to curtail the hospital charges, favoring for the patient and the health-care system. Obviously, many pre- and post-operative factors affect the length of stay in hospitals. Complications of surgery, if present, would probably increase the length of stay [11]. Preoperative risk factors may approximately predict the likelihood of occurrence of post-operative complications. Patients' basic health status and on-admission comorbidities can be used to make prediction of LOS more precise [5]. For example in patients older than 70 years the incidence of neurologic defects increases and this will lead to longer hospitalization [11]. Although, the accuracy of prediction will not be precise, but still it may help estimate the duration of hospital stay at the time of admission. Regarding the purpose of this study, which is predicting the length of hospital stay before the surgery, and also in order to achieve practically useful results we have not entered post-operative complications in our regression model. Although all complications are reported in terms of frequency and the mean LOS has been calculated. It was also mentioned in previous studies that considering both pre- and post-operative predictors, might cause the co-linearity problem in analysis of the results (as discussed above about age and neurologic defects). Clinical settings and practice variations can both alter the frequency of complications, so the LOS [11]. Inter hospitals care and quality variability will also influence the LOS. This variability remained unexplained even when adjusting the model for postoperative complications (10). In our study in the largest general hospital in Iran we could ignore the role of these hospitals' variability in LOS. Almost similar to prior related studies [4-6,10-19] major factors like: age, gender, ejection fraction and comorbidities (DM, HTN and kidney problems) affect the early or prolonged discharge time.

As noted before, mean age of female patients in this study was higher than male patients while women were less likely to undergo CABG surgery (30% vs. 70%). In a study by Choi *et al.*, [20], morbid obesity was associated with increased resource utilization (spending more time in the hospital after surgery). We also found morbid obesity (BMI≥35) associated with LOS.

The cut off point for prolonged or early discharge varies in several previous studies and this may affect the relation between major risk factors and LOS. As an instance, with the change of cut off point from 5 to 7 days the relation between COPD history and LOS became significant in univariate analysis. In previous studies [7,21], COPD was related to LOS but with different cut-offs for LOS.

In our study sternal wound infection not only was significantly related to the LOS but also had the highest mean of LOS in post-operative complications. Peterson et al came to same conclusion [21].

Unfortunately lots of our main data were incomplete so we were mandated to limit our analysis on fewer patients (1377 patients from the almost 3000 cases of CABG surgery in the hospital in that time frame). This concern always threatens retrospective designs. Many other risk factors were discussed and analyzed in previous studies but none of them contained all of them at the same time. This kind of health issues, which are affected by lots of predictors, confounders and interactions, are always at the center of debate among scientists and epidemiologists. However, we hope future studies and meta-analysis of these kinds of articles will help achieving accurate and practical conclusions.

Conclusion:

CABG surgery is among the most common and costly procedures so it is in the point of concentration of public health investigators, economic researchers and also health policy makers. Variation in categories of

determinants in LOS prediction (pre vs. postoperative factors and also quality of care in different hospitals) makes deciding the range of the length of stay as a complicated subject. However, we believe preoperative factors and basic health status of patients are the most important predictors in this field.

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Conflict of interest:

There is no conflict of interest in this study.

REFERENCES

[1] Porter, H.B., 1998. Health resource utilization and quality of life outcomes of low-risk coronary artery bypass graft patients: a comparison study. Can. J. Cardiovasc Nurs., 9(1): 10-5.
[2] Birim, Ö., A.J. Bogers, A.P. Kappetein, 2012. Comparing cost aspects of coronary artery bypass graft surgery with coronary artery stenting. J Cardiovasc Surg (Torino), 53(5): 641-50.
[3] Cowper, P.A., E.R. DeLong, E.D. Peterson, E.L. Hannan, K.T. Ray, M. Racz, D.B. Mark, 2002. Variability in cost of coronary bypass surgery in New York State: potential for cost savings. Am Heart J., 143: 130-9.
[4] Cowper, P.A., E.R. DeLong, E.D. Peterson, J. Lipscomb, L.H. Muhlbaier, J.G. Jollis, D.B. Pryor, D.B. Mark, 1997. Geographic variation in resource use for coronary artery bypass surgery. Med Care, 35: 320-33.
[5] Johnston, G., J.R. Goss, J.A. Malmgren, J.A. Spertus, 2004. Health Status and Social Risk Correlates of Extended Length of Stay Following Coronary Artery Bypass Surgery. Ann Thorac Surg., 77(2): 557-62.
[6] Rosen, A.B., J.O. Humphries, L.H. Muhlbaier, C.I. Kiefe, T. Kresowik, E.D. Peterson, 1999. Effect of clinical factors on length of stay after coronary artery bypass surgery: results of the cooperative cardiovascular project. Am Heart J., 138(1 Pt 1): 69-77.
[7] Turley, K., M. Tyndall, C. Roge, M. Cooper, K. Turley, M. Applebaum, H. Tarnoff, 1994. Critical pathway methodology: effectiveness in congenital heart surgery. Ann Thorac Surg., 58: 57-65.
[8] Hamilton, A., C. Norris, R. Wensel, A. Koshal, 1994. Cost reduction in cardiac surgery. Can J Cardiol., 10: 721-7.
[9] Parsonnet, V., D. Dean, A.D. Bernstein, 1989. A method of uniform stratification of risk for evaluating the results of surgery in acquired adult heart disease. Circulation, 79(suppl I): I-3-I-12.
[10] Lazar, H.L., C. Fitzgerald, S. Gross, T. Heeren, G.S. Aldea, R.J. Shemin, 1995. Determinants of length of stay after coronary artery bypass graft surgery. Circulation, 92(9 Suppl): II20-4.
[11] Weintraub, W.S., E.L. Jones, J. Craver, R. Guyton, C. Cohen, 1989. Determinants of prolonged length of stay following CABG. Circulation, 80: 276-84.
[12] Mauldin, P.D., W.S. Weinbtraub, E.R. Becker, 1994. Predicting hospital costs for first-time coronary artery bypass grafting from preoperative and postoperative variables. Am J Cardiol., 74: 772-5.
[13] Ghali, W.A., R.E. Hall, A.S. Ash, M.A. Moskowitz, 1999. Identifying pre- and postoperative predictors of cost and length of stay for coronary artery bypass surgery. Am J Med Qual., 248-54.
[14] Smith, L.R., C.A. Milano, B.S. Molter, J.R. Elbeery, D.C. Sabiston Jr, P.K. Smith, 1994. Preoperative determinants of postoperative costs associated with coronary artery bypass graft surgery. Circulation, 90: II-124-8.
[15] Smith, P.K., L.R. Smith, L.H. Muhlbaier, 1997. Risk stratification for adverse economic outcomes in cardiac surgery. Ann Thorac Surg., 64: S61-3.
[16] Herlitz, J., G. Brandrup, H. Emanuelsson, *et al*., 1997. Determinants of time to discharge following coronary artery bypass grafting. Eur J Cardio-Thorac Surg., 11: 533-8.
[17] Butterworth, J., R. James, R. Prielipp, *et al*., 2000. Female gender associates with increased duration of intubation and length of stay after coronary artery surgery. Anesthesiology, 92: 414-24.
[18] Lahey, S.J., B.C. Borlase, P.T. Lavin, S. Levitsky, 1992. Preoperative risk factors that predict hospital length of stay in coronary artery bypass patients >60 years old. Circulation, 86: II-181-5.
[19] Tu, J.V., S.B. Jaglal, D. Naylor, D. Phil, 1995. Steering Committee of the Provincial Adult Cardiac Care Network Ontario. Multicenter validation of a risk index for mortality, intensive care unit stay, and overall hospital length of stay after cardiac surgery. Circulation, 91: 677-84.
[20] Choi, J.C., F.G. Bakaeen, L.D. Cornwell, T.K. Dao, J.S. Coselli, S.A. LeMaire, D. Chu, 2012. Morbid obesity is associated with increased resource utilization in coronary artery bypass grafting. Ann Thorac Surg., 94(1): 23-8.

[21] Eric D. Peterson, Laura P. Coombs, T. Bruce Ferguson, A. Laurie Shroyer, Elizabeth R. DeLong, Fred L. Grover, Fred H. Edwards, 2002. Hospital Variability in Length of Stay After Coronary Artery Bypass Surgery: Results From The Society of Thoracic Surgeon's National Cardiac Database. Ann Thorac Surg., 74: 464-73.