การรอดชีพของผู้ป่วยที่ได้รับการผ่าตัดทำทางเบี่ยงหลอดเลือดหัวใจ โดยใช้เครื่องหัวใจและปอดเทียมในโรงพยาบาลของรัฐ ประเทศไทย

SURVIVORSHIP OF CORONARY ARTERY BYPASS GRAFTING PATIENTS UNDER CARDIOPULMONARY BYPASS IN GOVERNMENT HOSPITALS, THAILAND

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บทคัดย่อ

การวิจัยนี้ใช้รูปแบบการศึกษาแบบย้อนหลังจากผลไปหาเหตุ เพื่อทำการประมาณค่าอัตราการรอดชีพของผู้ป่วยที่เข้ารับการผ่าตัดทำทางเบี่ยงหลอดเลือดหัวใจในโรงพยาบาลสังกัดรัฐบาลในประเทศไทย และหาปัจจัยที่ส่งผลต่อระยะเวลาการรอดชีพในระยะแรก (เสียชีวิตภายใน 30 วัน) หลังได้รับการผ่าตัด ประชากรที่ศึกษา คือ ผู้ป่วยที่ได้รับการผ่าตัดทำทางเบี่ยงหลอดเลือดหัวใจในโรงพยาบาลสังกัดรัฐบาล จากฐานข้อมูลของสมาคมศัลยแพทย์ทรวงอกแห่งประเทศไทย ตั้งแต่วันที่ 1 มกราคม 2549 ถึงวันที่ 31 ธันวาคม 2549 และติดตามสถานะการมีชีพจนถึงวันที่ 31 ธันวาคม 2554

การติดตามผู้ป่วยที่ได้รับการผ่าตัดทำทางเบี่ยงหลอดเลือดหัวใจทั้งสิ้น 1,729 ราย มีช่วงระยะเวลาติดตามการเสียชีวิตระยะแรกอยู่ระหว่าง 0-30 วัน (ค่ามัธยฐาน = 29.4) และช่วงระยะเวลาระหว่าง 0-73 เดือน (ค่ามัธยฐาน = 64.9) ผลการวิจัยในการติดตามตลอดการศึกษา พบว่าหลังผ่าตัดมีผู้ป่วยเสียชีวิตทั้งหมด 18.2% โดย 3% เสียชีวิตในระยะแรก อัตราการรอดชีพของผู้ป่วยที่ 30 วัน 12 เดือน และ 72 เดือน เท่ากับ 97%, 94%, และ 82% ตามลำดับ 85% ของผู้ป่วยที่ได้รับการผ่าตัดมีโอกาสมีชีวิตอยู่ได้ถึงเดือนที่ 47 จากการวิเคราะห์ Cox proportional hazard regression พบว่า ภาวะเหนื่อยก่อนผ่าตัดระดับ 2 เป็นปัจจัยป้องกันโอกาสในการเสียชีวิต (HR 0.47) ความสามารถในการบีบตัวของหัวใจที่พอใช้และแย่ (HR: 2.52 และ 2.77 ตามลำดับ) ระยะเวลาการใช้เครื่องหัวใจและปอดเทียม (HR: 1.007) การใช้เครื่องพยุงการทำงานของหัวใจก่อนและหลังผ่าตัด (HR: 2.91 และ 13.22 ตามลำดับ) และการเกิดภาวะหัวใจล้มเหลวขึ้นใหม่หลังผ่าตัด (HR: 10.49) เป็นปัจจัยเสี่ยงต่อการเสียชีวิตในระยะแรก

ปัจจัยที่ส่งผลต่อระยะเวลาการรอดชีพในระยะแรกที่สำคัญคือภาวะที่สัมพันธ์กับหัวใจ แพทย์และบุคลากรทางการแพทย์ควรตระหนักถึงการวางแผนที่รอบคอบในการประเมินความเสี่ยงและให้ข้อเสนอแนะแก่ผู้ป่วยก่อนการผ่าตัด ในระหว่างผ่าตัดและหลังผ่าตัดควรให้การรักษาด้วยความระมัดระวัง เพื่อช่วยให้โอกาสในการเสียชีวิตหลังผ่าตัดลดลง

คำสำคัญ: การวิเคราะห์ระยะปลอดเหตุการณ์/การผ่าตัดทำทางเบี่ยงหลอดเลือดหัวใจ/ การเสียชีวิตระยะแรก

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***แพทย์ผู้เชี่ยวชาญทางด้านศัลยศาสตร์ทรวงอก ภาควิชาศัลยศาสตร์ สถาบันสุขภาพเด็กแห่งชาติมหาราชินี

Abstract

The study design was a retrospective cohort. The objectives were to estimate the survivorship functions of a patient who underwent isolated coronary artery bypass grafting (CABG) surgery in government hospitals of Thailand and identify factors affecting survival time for early mortality (≤ 30 days mortality) after the surgery. Population were the CABG patients in government hospitals by using data extracted from the database registry of the Society of Thoracic Surgeons of Thailand during January 1, 2006 to December 31, 2006 and followed up the vital status until December 31, 2011.

A total of 1,729 patients were identified. The follow-up time range from 0 to 30 days (median = 29.4) was defined as early mortality and range from 0 to 73 months (median = 64.9) was defined as all study period. All mortality was 18.2% (3% in early mortality). At 30 days, 12-month, and 72-month survival rates for CABG patients were 97%, 94%, and 82%, respectively. The 15^{th} percentiles of event-free survival was 47 months. According to the Cox proportional hazard regression revealed that NYHA class II (Hazard ratio (HR) 0.47), fair and poor left ventricular ejection fraction (HR 2.52 and 2.77, respectively), cardiopulmonary bypass time (CPB) (HR 1.007), pre-operative and post-operative intra aortic balloon pump support (HR 2.91 and 13.22, respectively), and new heart failure after surgery (HR 10.49) were significant factors of early mortality.

The significant risk factors affecting survival time for early mortality were cardiac-related conditions. The physician and health care team should be aware and have an excellent plan for risk assessment and patient counseling in pre-operative period, a caring treatment in intra-operative and post-operative period to reduce the mortality rate.

Keywords: survival analysis, coronary artery bypass graft, early mortality

Introduction

Cardiovascular diseases (CVDs) are the class of diseases that involve the heart and blood vessels. The CVDs are the global important public health problems and are the number one cause of the death globally. In 2012, around 17.5 million people were died by the CVDs which equaled to 31% of all global deaths (World Health Organization [WHO], 2015). The CVDs are the fourth of the top ten causes of death in Thailand and death rate trends to increase. The death rates of CVDs per 100,000 persons were 61.9, 68.8, and 72.1 persons in 2010-2012, respectively (National Statistic Office, 2014). The coronary artery disease (CAD) is the most common type of cardiovascular disease which caused by reducing blood flow to the heart due to a narrowing of the arteries. When the heart does not get enough oxygen and nutrients, the patient will have chest pain or angina (eMedicineHealth, 2012; Seldon, 2015). The CAD is a major cause of death and disability in both men and women in worldwide. In 2013, the Ministry of Public Health reported the number of patients who had the CAD in Thailand and this was the second rank in

cause of death in CVDs. The mortality rate per 100,000 trended to increase continuously from 20.7 persons in 2009 to 23.4 persons in 2013 (Bureau of Policy and Strategy, 2013). There are many ways to treat the CAD. The currently well-established revascularization approaches to treatment of CAD is coronary artery bypass grafting (CABG) surgery. CABG appears to prolong survival, decrease recurrence of angina, and decrease the need for repeat coronary intervention on patients with multivessel CAD (Fuster, O'Rourke, Walsh, & Poole-Wilson, 2008). However, the hospital mortality of isolated CABG has a increasing trend from 3.5% in 2008 to 5.46% in 2012 (The Society of Thoracic Surgeons of Thailand, 2015).

The mortality rate is the one of indicators referring to the treatment quality in cardiac surgery. The early mortality or hospital mortality is defined as death within 30 days after CABG surgery. This reflects institutional habits concerning postoperative patient care (Osswald et al., 1999). However, the mortality rate is not a good and valid measurement for treatment quality because this indicator is the crude mortality rate which does not consider to the risk profile of patients receiving surgery. Without risk stratification, surgeons and hospitals treating high-risk patients will appear to have worse operative results than others. This may influence their referral patterns, the allocation of resources, and even discourage treating high risk patients (Shahian et al., 2004). A logistic regression analysis is the one of possible statistical method to identify the factors affecting survival status, death or survive. However, this technique does not incorporate the information about timing of deaths and focusing on studying interested event (death) and time simultaneously. The survival analysis is proposed as an appropriate statistical technique that allows researchers to gain knowledge to understand the effect of potential factors on survivability of CABG patients (Allison, 2010).

There were previous studies reported the survival rate of CABG patients. Overall patient survival after CABG surgery was 96% and 85% at 1 and 5 years, respectively (Filsoufi, Rahmanian, Castillo, Bronster, & Adams, 2008), and in another study, the survival rate were 86%, 48%, 19%, and 7% at 5, 15, 25, and 35 years, respectively (Gao, Wu, Grunkemeier, Furnary, & Starr, 2006). The risk factors related to survival time in early mortality were pre-operative (such as patient characteristics, noncardiac-related diseases, and cardiac-related factors), intra-operative, and postoperative factors. The majority preoperative factors associated with early mortality were cardiac-related factors such as poor left ventricular ejection fraction (LVEF) (HR 2.89; 95%CI: 1.87-4.47) (Yap et al., 2009), emergency surgery (odd ratio (OR) 3.73; 95% CI: 2.3-6.04) (van Straten et al., 2009), previous myocardial infarction (MI) (HR 1.36; 95% CI: 1.07-1.71) and previous cardiac surgery (HR 2.52; 95% CI: 1.93-3.28) (Gardner et al., 2001). In additional the intra-operative risk factor was CPB time ≥ 97 minutes (HR 3.72; 95% CI: 2.33-5.94) (Naughton, Feneck, & Roxburgh, 2009) and the important postoperative factors were new heart failure (OR 15.93; 95%CI: 4.53-56.0) (Vanky, Hakanson, & Svedjeholm, 2007), perioperative MI (OR 11.13; 95%CI: 2.96-41.83), gastrointestinal complication (OR 8.13;

95%CI: 3.56-18.6) and pulmonary complication (OR 8.22; 95%CI: 4.84-13.98) (Toumpoulis et al., 2008).

However, almost of those studies were done in oversea. The difference in characteristic of patients between Thai patients and foreign patients may affect to risk factors that contribute to mortality. The aim of this study is to estimate the survival time of patient who underwent isolated CABG in government hospitals which the most frequently performed cardiac surgical procedure in Thailand, to seek out the risk factor, and to create model containing significant factors in predicting survival time of early death. The results of this study will fulfill the gap of knowledge regarding survivability of CABG patients and will provide valuable information for physicians to create more effective treatment strategies for CAD patients.

Methods

This study was a retrospective cohort study. The data was extracted from database registry of the Society of Thoracic Surgeons of Thailand (STST) and was collected from all patients who received isolated CABG surgery in government hospitals of Thailand between January 1, 2006 and December 31, 2006. Based on the inclusion criteria of the CAD Thai patients who underwent isolated CABG surgery under CPB, the CABG patients who underwent surgery by on-pump beating heart technique, incomplete information of identification number or operative date of surgery were excluded. The other data was also extracted from the database including pre-operative factors such as patient characteristics, noncardiac-related diseases, and cardiac-related factors, intra-operative factor, and postoperative factors (before hospital discharge). All CABG patients were followed-up the vital status until December 31, 2011. The mortality was verified by the Bureau of Policy and Strategy, the Ministry of Public Health of Thailand. Based on the patient's identification number and cause of death, the disease or condition directly leading to death was indicated. All causes of death could be verified by checking on the list of ICD-10. If they were deceased, the date of death and cause of death were recorded. The details of method were shown in Figure 1.

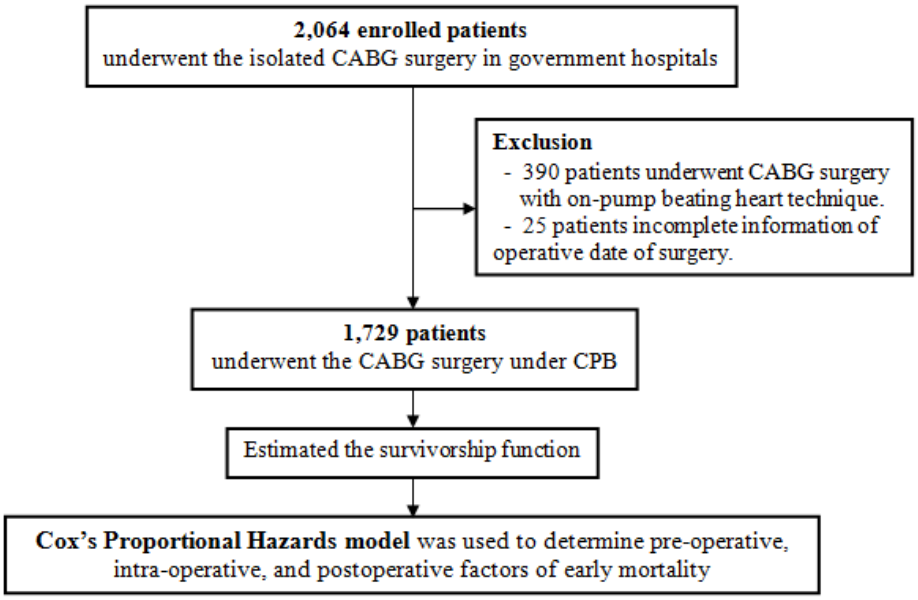


Figure 1 The methodology diagram

Data analysis

The data analysis of study was presented as frequency and percentage for describe categorical independent variables. Mean and standard deviation were used to describe continuous independent variables. The Kaplan-Meier method was used to estimate the survival probabilities and created the survival curve. For estimating the effect of significant factors on survival time for early mortality after CABG by using Cox's proportional hazard model and the model selection was performed by using forward stepwise.

Results

Characteristics of the CABG patients

There were 1,729 CABG patients were included in this study. The follow-up ranged from 0 to 30 days (median 29.4 days) in early mortality and 0 to 73 months (median = 64.9) for all study period.

For pre-operative factors, the mean ages of CABG patients were 62.34 ±11.01 years. The most common patients were female (71.6%). The proportion of CABG patients that had normal BMI was in the same percentage as overweight (48.8% and 40.5%, respectively). Considering smoking history, 61.9% of patients never smoke. In noncardiac-related diseases, the most patients had not noncardiac-related diseases, except hypertension (61.0% versus 39.0%). Considering factors of cardiac-related variables, 38.2% of patients were angina status in CCS class II. The most of dyspnea status was NYHA class II (51.5%) and 62.6% no previous MI. Almost patients had sinus rhythm (90.9%). There were not previous PCI (98.2%) and not

CVT surgery (97.3%). The result of coronary angiogram was no left main disease (71.0%) and the number of diseased coronary arteries was three vessels (70.9%). More than half of the patients was good LVEF (68.7%) and they underwent isolated CABG in elective status (89.9%). For intra-operative factors, the mean of cross-clamp time was 69.44±28.93 minutes and 110.32±45.41 minutes for CPB time. The postoperative variables were complication after CABG surgery. Majority of the CABG patients were not inserted IABP (93.3%) and no complication.

There were 12 statistical significant risk factors in univariate analysis of early mortality. The nine very significant risk factors which p-value < 0.001 were dyspnea status, LVEF, operative status, CPB time, IABP support, renal failure need dialysis, pulmonary complication, new heart failure, and perioperative MI. The three significant risk factors in early mortality patients which p-value < 0.05 were renal disease (p-value = 0.004), angina status (p-value = 0.026), and cross-clamp time (p-value = 0.025). Details of univariate analysis of factors for early mortality in CABG patients were shown in Table 1.

Table 1 The general characteristics of the CABG patients and univariate analysis of early mortality

Independent Variables	All patients (n=1,729)	30 days mortality (n=52)	HR	95%CI		p-value
	n (%)	n (%)		Lower	Upper	
Pre-operative factors						
Patient characteristic						
Age (years) (n = 1,656)	62.34±11.01[b]	52 (100)	1.02	1.00	1.05	0.098
Gender						0.576
Male[a]	491 (28.4)	13 (25.0)	1			
Female	1,238 (71.6)	39 (75.0)	1.19	0.64	2.24	
Body mass index (n = 1,700)	24.41 ± 3.85[b]					0.738
Underweight	181 (10.7)	5 (10.4)	0.88	0.34	2.28	
Normal[a]	830 (48.8)	26 (54.2)	1			
Overweight	689 (40.5)	17 (35.4)	0.79	0.43	1.45	
Smoking status						0.769
None[a]	1,070 (61.9)	30 (57.7)	1			
Ex-smoking	551 (31.9)	19 (36.5)	1.23	0.69	2.19	
Current smoking	108 (6.2)	3 (5.8)	0.99	0.30	3.25	
Noncardiac-related diseases						
Diabetes mellitus						0.563
No[a]	1,065 (61.6)	30 (57.7)	1			
Yes	664 (38.4)	22 (42.3)	1.18	0.68	2.04	
Hypertension (n = 1,707)						0.299
No[a]	665 (39.0)	16 (32.0)	1			
Yes	1,042 (61.0)	34 (68.0)	1.36	0.75	2.47	
Hypercholesterolemia (n = 1,574)						0.485
No[a]	781 (49.6)	21 (44.7)	1			
Yes	793 (50.4)	26 (55.3)	1.23	0.69	2.18	
Renal disease (n = 1,727)						0.004
No[a]	1,599 (92.6)	41 (80.4)	1			
Yes	128 (7.4)	10 (19.6)	3.10	1.55	6.18	
History of pulmonary disease						0.138
No[a]	1,669 (96.5)	48 (92.3)	1			
Yes	60 (3.5)	4 (7.7)	2.38	0.86	6.61	
History of neurological disease						0.305
No[a]	1,668 (98.2)	50 (96.2)	1			
TIA or RIND	6 (0.3)	1 (0.9)	6.16	0.85	44.58	
CVA	28 (1.6)	1 (0.9)	1.18	0.16	8.53	
CVA with full recovery	27 (1.6)	0 (0)	-	-		
Peripheral vascular disease						-
No[a]	1,726 (99.8)	52 (100)	1			
Yes	3 (0.2)	0 (0)	-	-		

[a]Reference group; [b]Mean±standard deviation

Table 1 The general characteristics of the CABG patients and univariate analysis of early mortality (cont.)

Independent Variables	All patients (n=1,729)	30 days mortality (n=52)	HR	95%CI		p-value
	n (%)	n (%)		Lower	Upper	
Cardiac-related factors						
Angina status						0.026
CCS class 0[a]	484 (28.0)	13 (25.0)	1			
CCS class I	171 (9.9)	2 (3.8)	0.43	0.10	1.91	
CCS class II	661 (38.2)	16 (30.8)	0.90	0.44	1.88	
CCS class III	300 (17.4)	12 (23.1)	1.51	0.69	3.31	
CCS class IV	113 (6.5)	9 (17.3)	3.03	1.30	7.09	
Dyspnea status						<0.001
NYHA I[a]	512 (29.6)	16 (30.8)	1			
NYHA II	890 (51.5)	17 (32.7)	0.61	0.31	1.21	
NYHA III	267 (15.4)	9 (17.3)	1.08	0.48	2.45	
NYHA IV	60 (3.5)	10 (19.2)	5.75	2.61	12.67	
Previous MI (n = 1,649)						0.380
No[a]	1,032 (62.6)	29 (56.9)	1			
Yes	617 (37.4)	22 (43.1)	1.28	0.74	2.23	
Pre-operative heart rhythm						0.137
Sinus rhythm[a]	1,572 (90.9)	44 (84.6)	1			
Non-sinus rhythm	157 (9.1)	8 (15.4)	1.85	0.87	3.93	
Previous PCI (n = 1,607)						0.308
No[a]	1,578 (98.2)	48 (96.0)	1			
Yes	29 (1.8)	2 (4.0)	2.30	0.56	9.45	
Previous CVT surgery						0.720
No[a]	1,683 (97.3)	51 (98.1)	1			
Yes	46 (2.7)	1 (1.9)	0.71	0.10	5.14	
Left main disease (n = 1,708)						0.075
Stenosis ≤ 50%[a]	1,212 (71.0)	31 (59.6)	1			
Stenosis > 50%	496 (29.0)	21 (40.4)	1.67	0.96	2.91	
Number of diseased coronary arteries						0.098
None[a]	275 (16.1)	5 (9.8)	1			
One vessel	26 (1.5)	1 (2.0)	2.12	0.25	18.11	
Two vessels	197 (11.5)	2 (3.9)	0.56	0.11	2.89	
Three vessels	1,216 (70.9)	43 (84.3)	1.97	0.78	4.98	
LVEF (n = 1,546)						<0.001
Good (>49%)[a]	1,063 (68.7)	22 (44.0)	1			
Fair (30-49%)	369 (23.9)	18 (36.0)	2.40	1.29	4.47	
Poor (<30%)	114 (7.4)	10 (20.0)	4.39	2.08	9.27	
Operative status						<0.001
Elective[a]	1,554 (89.9)	35 (67.3)	1			
Urgency	114 (6.6)	9 (17.3)	3.59	1.73	7.48	
Emergency	61 (3.5)	8 (15.4)	6.07	2.81	13.08	

[a]Reference group

Table 1 The general characteristics of the CABG patients and univariate analysis of early mortality (cont.)

Independent Variables	All patients (n=1,729)	30 days mortality (n=52)	HR	95%CI		p-value
	n (%)	n (%)		Lower	Upper	
Intra-operative factors						
Cross-clamp time (minutes) (n =1,699)	69.44 ± 28.93[b]	50 (96.2)	1.009	1.002	1.017	0.025
CPB time (minutes) (n = 1,709)	110.32 ± 45.41[b]	51 (98.1)	1.012	1.009	1.015	<0.001
Postoperative factors						
IABP support						<0.001
No[a]	1,613 (93.3)	33 (63.5)	1			
Pre-operative	56 (3.2)	8 (15.4)	7.34	3.39	15.88	
Intra-operative	33 (1.9)	2 (3.8)	3.02	0.73	12.60	
Post-operative	27 (1.6)	9 (17.3)	19.87	9.50	41.55	
Re-operation						0.160
No[a]	1,666 (96.4)	48 (92.3)	1			
Yes	63 (3.6)	4 (7.7)	2.27	0.82	6.29	
New postoperative stroke						0.095
No[a]	1,712 (99.0)	50 (96.2)	1			
Yes	17 (1.0)	2 (3.8)	4.39	1.07	18.04	
Renal failure need dialysis						<0.001
No[a]	1,698 (98.2)	43 (82.7)	1			
Yes	31 (1.8)	9 (17.3)	12.94	6.31	26.57	
Pulmonary complication						<0.001
No[a]	1,666 (96.4)	37 (71.2)	1			
Yes	63 (3.6)	15 (28.5)	11.42	6.27	20.82	
Gastrointestinal complication						0.371
No[a]	1,717 (99.3)	51 (98.1)	1			
Yes	12 (0.7)	1 (1.9)	2.88	0.40	20.83	
New heart failure						<0.001
No[a]	1,693 (97.9)	39 (75.0)	1			
Yes	36 (2.1)	13 (25.0)	19.05	10.16	35.72	
Perioperative MI						
No[a]	1,696 (98.1)	45 (86.5)				
Yes	33 (1.9)	7 (13.5)	9.30	4.19	20.63	<0.001

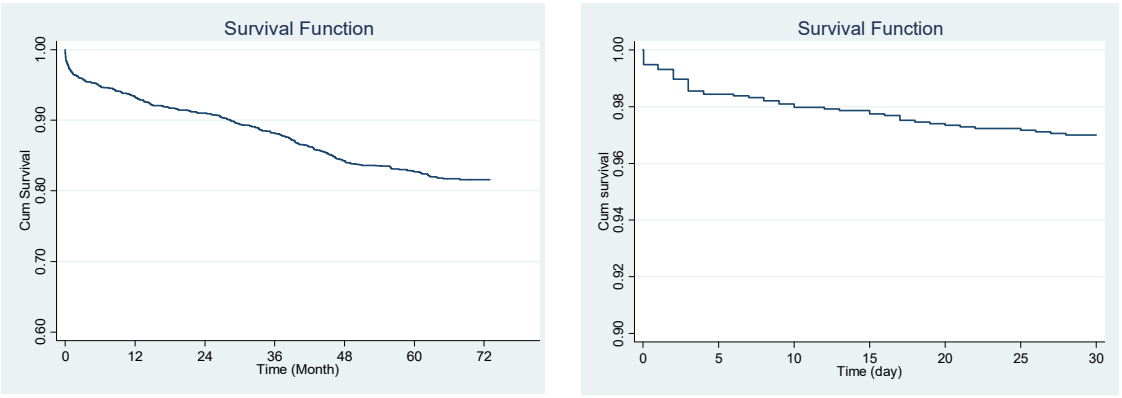
[a]Reference group; [b]Mean±standard deviation

More than half of CABG patients were still alive in 6 years after CABG surgery (81.8%). There were 314 CABG patients died within 6 years (18.2%) and 52 patients died within 30 days after surgery (3%) (Table 2). All of CABG patients died from the causes of cardiac death had 79 patients, 2 patients died from accident and 233 patients died from other causes of death. Therefore, the survival analysis in this study was based on the event that was death from all causes of death.

Table 2 Number of patients after CABG surgery

Patients status	Number	Percentage
Alive	1,415	81.8
Dead	314	18.2
Early mortality (Dead ≤ 30 days)	52	3.0

All patients were received CABG surgery and followed-up to 6 years found that survival rate at 30 days, 12-, 24-, 36-, 48-, 60- and 72-month equaled 96.99% , 94%, 91%, 88%, 85%, 83 and 82%, respectively. The survival curve did not reach the 50th percentile which was shown in Figure 2 (A). So this could not identify median time of overall survival but at the 15th percentiles of event-free survival was 47 months (95% CI 41.20 – 56.93). That means 85% of patients were still living 47 months after CABG surgery. The survival curve of patients who died within 30 days (early mortality) after CABG was shown in Figure 2 (B).



(A) (B)

Figure 2 Kaplan-Meier survival estimate of all CABG patients (A) and early mortality patients (B)

Cox's proportional hazard model

For the results of univariate analysis, the risk factors that associated with early mortality was considered include in the multivariate model by using Cox proportional hazard regression analysis. Forward stepwise selection based on likelihood ratio test was used to

create the best model. The result of the final model showed in Table 3. There were 5 statistically significant variables affecting on event rate and time. Specifically, they were dyspnea status, LVEF, CPB time, IABP support and new heart failure in post-operative.

For dyspnea status in pre-operative surgery, the CAD patients with NYHA class II before surgery had protective risk of early mortality by 53% of those with NYHA class I. The fair and poor LVEF patients had higher risk by 2.52 and 2.77 times relative to normal or good LVEF patients, respectively. For CPB time, a 7% rising for early mortality per ten minutes increase in CPB time. The CABG patients who received pre-operative or post-operative IABP support had higher risk of early mortality by 2.91 and 13.22 times relative to those who did not use IABP support, respectively. In postoperative surgery, if the CABG patients had new heart failure, they had risk of early death equal to 10.49 times of those who did not have new heart failure.

Table 3 Multivariate Cox model of factors associated with early mortality in CABG patients

Independent factors	$\hat{\beta}$	SE	*HR*	95% CI		p-value
				Lower	Upper	
Pre-operative factors						
Cardiac-related factors						
Dyspnea status (NYHA I[a])						
NYHA II	-0.76	0.36	0.47	0.23	0.95	0.036
NYHA III	-0.52	0.47	0.59	0.24	1.48	0.264
NYHA IV	0.50	0.52	1.65	0.59	4.60	0.338
LVEF (Good[a])						
Fair (30-49%)	0.93	0.34	2.52	1.29	4.93	0.007
Poor (<30%)	1.02	0.45	2.77	1.16	6.64	0.022
Intra-operative variables						
CPB time increase10 minutes	0.07	0.02	1.07	1.03	1.11	<0.001
Postoperative variables						
IABP support (No[a])						
Pre-operative	1.07	0.47	2.91	1.17	7.28	0.022
Intra-operative	-0.10	0.82	0.91	0.18	4.54	0.904
Post-operative	2.58	0.40	13.22	6.09	28.70	<0.001
New heart failure (No[a])						
Yes	2.35	0.38	0.49	4.98	22.09	<0.001

[a]Reference group

The Cox's Proportional hazard model for the CABG patients with early mortality in the final step was the following:

$$\ln \frac{h_{1t}}{h_{0t}} = - 0.76 \text{ (NYHA II)} - 0.52 \text{ (NYHA III)} + 0.5 \text{ (NYHA IV)} + 0.93 \text{ (fair LVEF)} + 1.02 \text{ (poor LVEF)} + 0.07 \text{ (CPB time)} + 1.07 \text{ (pre-operative IABP support)} - 0.1 \text{ (intra-operative IABP support)} + 2.58 \text{ (postoperative IABP support)} + 2.35 \text{ (new heart failure)}$$

Assessing the proportion hazards assumption and test for goodness of fit

This assumption was tested by plot of the negative logarithm of the estimated survival function against the logarithm of the survival time and found that curves of each factor in Figure 3 were roughly parallel. When test of Schoenfeld residual to confirm the result obtained from -ln[-ln(survival)] curve, the Scaled Schoenfeld residuals for each factor had the slope (ρ) equal to zero (p-value ≥ 0.05) and p-value of the global testing was equal to 0.781. Therefore, it was appropriate to assume that no evidence of the proportional hazard assumption had been violated.

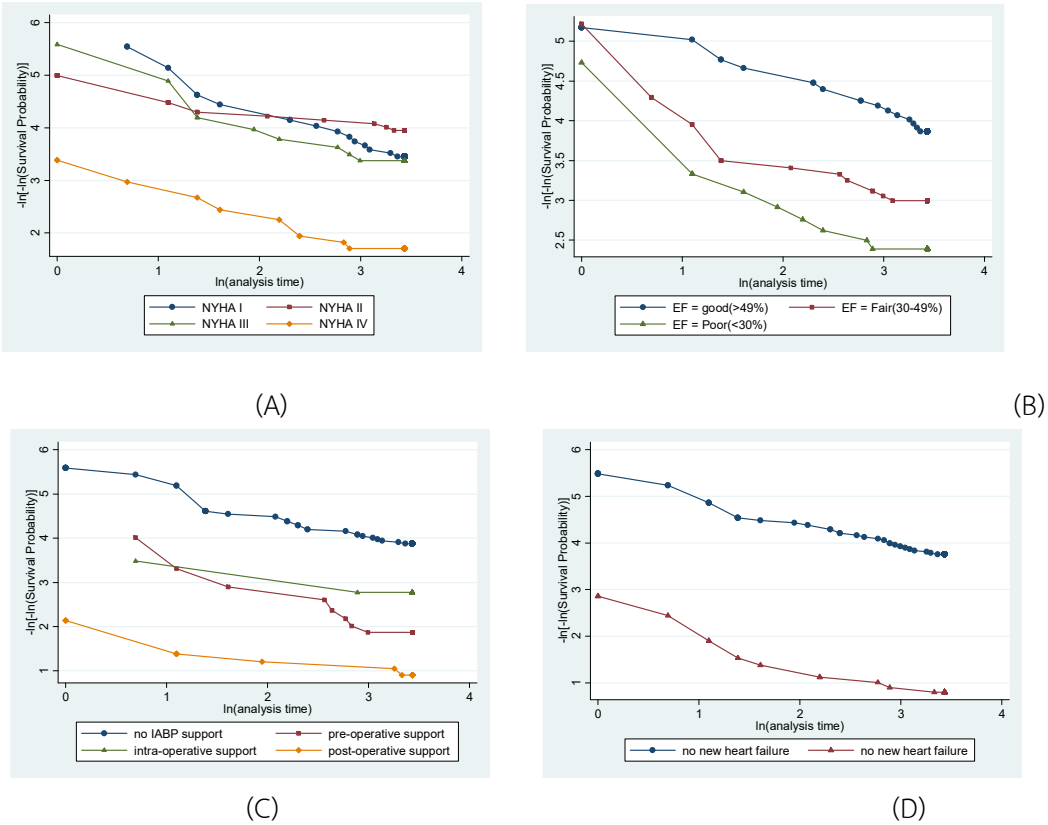


Figure 3 Test of proportional-hazards assumption stratified by dyspnea status (A), LVEF (B), IABP support (C) and new heart failure (D) plotted on a –ln –ln scale

For test of Cox proportional hazard model fitted the data by plot of the cumulative hazard versus Cox-snell residual. Figure 4 showed that graphs of Cox model for CABG patients with early mortality fit well to the data. The hazard function followed the 45 degree line closely except for very large values of time. It was very common for models with censored data to have some wiggling at large values of time and it was not something which should cause much concern. Overall we would conclude that the final model fitted the data well.

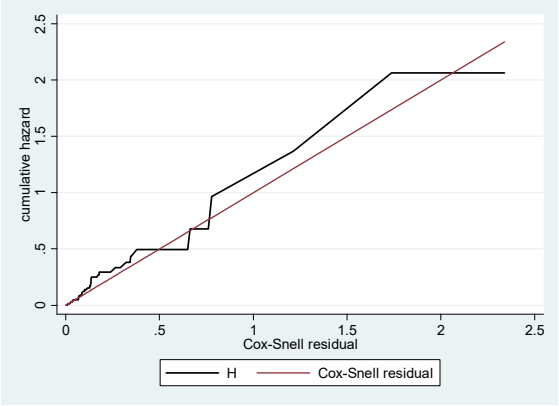


Figure 4 The goodness-of-fit test of Cox proportional hazard model for early mortality

Discussion

In this study, mortality within 30 days after CABG surgery was 3.0%. This result was very similar to other studies (2.5%-3.5%) (Filsoufi, Rahmanian, Castillo, Bronster, & Adams, 2008; Gardner et al., 2001; Vanky, Hakanson, & Svedjeholm, 2007). Overall patient survival after CABG surgery was 94% and 83% at 1 and 5 years, respectively. These were similar to the study of Filsoufi et al. in 2008 found that the survival rate were 96% and 85% (Filsoufi, Rahmanian, Castillo, Bronster, & Adams, 2008). This was a confirmation of the satisfactory average level of the CABG surgery performances in government hospitals, Thailand.

The risk factors associated with early mortality were NYHA class II. However, in the other study found that NYHA class II did not associated with early mortality. The result of Gardner et al. (Gardner et al., 2001) showed that NYHA functional class III or IV had greater effects in the short-term period (HR 1.43; 95% CI 1.14 - 1.81; $p = 0.003$). This result conflicted with the result of multivariate analysis from other studies and also conflicted with the result of univariate analysis because this study might have some variables adjustment. For LVEF, the result was similar to the studies of Hedberg et al. and Yap et al. (Hedberg, Boivie, & Engstrom, 2011;Yap et al., 2009) They found that poor LVEF was risk factor that associated with hospital mortality (HR 2.89; 95% CI 1.87 - 4.47; $p < 0.001$ and HR 2.1; 95% CI 1.8 – 2.46; $p < 0.001$, respectively). From the result of this study and the previous several studies, the

clinician should concern about patient selection for surgery. Myocardial protection and preservation should be awared during surgery under CPB with arrest heart.

For CPB time in intra-operative factors, the result in this study was the same as result of Hedberg et al. and Naughton et al. (Hedberg, Boivie, & Engstrom, 2011; Naughton, Feneck, & Roxburgh, 2009). Therefore, CPB time should be reduced in order to reduce the effect of the CPB on mechanism of body system which effect to risk of early death.

For postoperative variables, the study of Gardner et al. (Gardner et al., 2001) was shown that preoperative use of an IABP had greater effect on the short-term period (HR 2.27; 95% CI 1.69 – 3.03; p = 0.009). However there were no any previous studies showed that post-operative IABP support had effect on the early mortality. Moreover, the new heart failure after CABG surgery was a very high risk factor that similar to the study of Vanky et al. (OR 15.93; 95% CI 4.53 - 56.0; p < 0.001) (Vanky, Hakanson, & Svedjeholm, 2007).

For assessing the proportion hazards assumption in Figure 3 found that dyspnea status (NYHA class I-IV) had intesection of curve in NYHA class I, II, and IV. There was intesection between pre-operative and intra-operartive IABP support. Although the curves of both factors departed from proportional hazard assumption, however when test of Schoenfeld residual to confirm the result obtained from -ln[-ln(survival)] curve. The Scaled Schoenfeld residuals of dyspnea status and IABP support had the slope equal to zero (p-value = 0.276 and 0.429, respectvely) Therefore, they were appropriate to assume that no evidence of the proportional hazard assumption had been violated.

Conclusion

At 30 days, 12-month, and 72-month survival rates for CABG patients were 97%, 94%, and 82%, respectively. The risk factors for early mortality identified in this study can augment preoperative risk assessment and counseling of patients. Clinicians and health care teams should be aware of the importance of cardiac-related variables and postoperative complication as predictors of early mortality. The cohort studies with data management and monitoring should be suggested to use for studying the risk factors for the early mortality patients after CABG surgery.

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