

Original article

Re-hospitalization following primary percutaneous coronary intervention in patients with ST-elevation myocardial infarction

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Background: Re-hospitalizations (RHs) after primary percutaneous coronary intervention (primary PCI) in ST-elevated myocardial infarction (STEMI) are not well studied in Thailand. We studied the frequency, causes, and factor that might affect unplanned re-hospitalizations which may be helpful to predict and lead to better effective prevention.

Objectives: We aimed to investigate the frequency, causes, and factors that might affect unplanned re-hospitalizations

Methods: We collected data from the Cardiac Center, King Chulalongkorn Memorial Hospital (KCMH) that included all patients with STEMI who underwent primary PCI and followed them for 1 year after the intervention. Unpaired *t* - test, Chi-squared test, Fischer's exact test were utilized for data analysis with Kaplan-Meier curves regarding their first re-hospitalization.

Results: The study included 96 patients with 15 unplanned RHs patients, 10 (11.36%) patients with unplanned non-cardiac RHs and 5 (5.68%) patients with unplanned cardiac RHs. Only triglyceride level was significantly different between patients with unplanned cardiac RHs and patients without unplanned RHs.

Conclusion: Among the patients with STEMI that underwent primary PCI and followed-up at KCMH, non-cardiac unplanned RHs occurred in 11.36% with various causes. While cardiac unplanned RHs occurred in 5.86% with non ST-elevated myocardial infarction (NSTEMI) as a leading cause.

Keywords: Myocardial infarction, percutaneous coronary intervention, re-hospitalization.

Myocardial infarction is one of the leading causes of death in Thailand and tend to be increasing every year⁽¹⁾, due to lifestyle change and aging society. According to ECS guideline 2017⁽²⁾, treatment of choice for patients with ST-elevated myocardial infarction (STEMI) is primary percutaneous coronary intervention (primary PCI). However, primary PCI in Thailand has some limitations not only capable hospital but also referral system.

Studies about follow-ups after primary PCI in patients with STEMI have been done in many countries⁽³⁾ but not yet in Thailand. The follow-ups in those studies define as re-hospitalizations (RHs) after

intervention including cardiac and non-cardiac causes. The result might help plan which treatment is the most appropriate for patient with STEMI in Thailand.

Methods

Study design and population

We performed a retrospective descriptive study. The data from the Cardiac Center, King Chulalongkorn Memorial Hospital (KCMH) from 1st January 2015 to 31st October 2016 were obtained.

Patients were eligible if they were aged 18 years or above with symptom onset within 24 hours, electrocardiographic criteria for STEMI, and angiographic evidence of at least 1 lesion within infarct vessel. There were no limits regarding the number of treated lesions. The patients must not have comorbid condition with life expectancy of less than 1 year, pregnancy, death in first admission and were not referred for further management from other hospital.

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Procedures and data collection

After collecting and selecting data from cardiac center, all patients were treated with primary PCI according to KCMH standard. We followed each patient for 1 year after intervention using KCMH data based and collected all admission data by 2 collectors independently. Data were composed of two parts. Firstly, first admission details including demographic data (age, sex, race, underlying diseases and past medical history), sign and symptom (heart rate, blood pressure and body mass index (BMI), laboratory investigation (serum creatinine, fasting blood glucose, hemoglobinA_{1c}, lipid profile, CPK level, CK-MB level, troponin-I level), diagnosis and intervention details; and secondly, re-hospitalizations details including cause and number of re-hospitalization within one year after procedure was done. In case of more than one diagnosis, we recorded diagnosis which brought patients to hospital as cause of RHs.

Study end point

Re-hospitalizations (RHs) were defined as readmission in KCMH including both of planned and unplanned admissions. Planned RHs were defined as scheduled readmission after first visit which recorded as no RHs group. Unplanned RHs were defined as unscheduled readmission and Cardiac unplanned RHs were defined as unscheduled readmission from cardiac cause. In case of patients with planned RHs followed by unplanned RHs, these patients were recorded as unplanned RHs. All RHs causes are described in Table 1.

Primary end points were incidences and causes of unplanned cardiac and non-cardiac RHs. Secondary end point were factors that might predict unplanned cardiac RHs.

Statistical analysis

As for continuous variables, we used means and unpaired *t* - test. Regarding the categorical data, we used frequency, percentage, Chi-squared test and Fischer's exact test. The level of significance was set at 0.05. Data were analyzed using IBM-SPSS statistics version 22. We performed Kaplan-Meier curves for first RHs after intervention in both unplanned cardiac RHs and unplanned non-cardiac RHs.

We compared all parameters from Table 2, 3, 4, 5 in no RHs group to unplanned cardiac and unplanned non-cardiac RHs group to investigate which parameter might used to predict unplanned cardiac RHs.

Results

There were 304 patients with STEMI admitted at the Cardiac Center, KCMH from 1st January 2015 and 31st October 2016. Two-hundred and eight patients were referred to other hospitals after discharge ; only 96 patients were included to our study. Eight patients died during the first admission. Drug-eluting stent was the most common type of stent (85.23%) used in the procedure. After the intervention was done, there were 15 unplanned RHs patients, 10 (11.36%) patients with unplanned non-cardiac RHs and 5 (5.68%) patients

Table 1. Causes of unplanned re-hospitalization.

Unplanned cardiac re-hospitalization	No. of RHs (% of RHs)
Acute ST- elevated myocardial infarction	1 (20%)
Unstable angina	1 (20%)
Non ST - elevated myocardial infarction	2 (40%)
Heart failure	1 (20%)
Total	5 (100%)
Unplanned non-cardiac re-hospitalization	No. of RHs (% of RHs)
Cellulitis	1(10%)
Skin rash	1(10%)
Vascular claudication	1(10%)
Liver abscess with K. pneuminae septicemia	1(10%)
Syringomyelia	1(10%)
Simple hyperglycemia	1(10%)
Tracheobronchitis	1(10%)
Acute cholangitis with septic shock	1(10%)
Embolic ischemic stroke	1(10%)
Total	10(100%)

Table 2. Baseline characteristics (First admission only).

	Overall (n = 88)	No unplanned RHs (n = 73)	Unplanned cardiac RHs (n = 5)	Unplanned non-cardiac RHs (n = 10)	P-value cardiac vs no RHs	P-value non- cardiac vs no RHs
Age (years)	59.49 ± 11.62	57.73 ± 10.13	62.4 ± 7.16	70.9 ± 16.99	0.228	0.038
Male	66 (75%)	60 (82.19%)	4 (80%)	2 (20%)	1	0.002
Hert rates (beats/minute)	78.27 ± 19.57	77.27 ± 17.81	91.00 ± 36.47	79.2 ± 21.81	0.449	0.794
Systolic blood pressure (mmHg)	119.02 ± 23.82	119.27 ± 22.54	116.80 ± 27.04	118.30 ± 33.04	0.85	0.93
Diastolic blood pressure (mmHg)	71.67 ± 15.99	72.45 ± 16.42	68.00 ± 8.37	67.80 ± 15.89	0.328	0.405
Serum creatinine (mg/dL)	1.06 ± 0.5 (n = 87)	1.037 ± 0.46 (n = 72)	1.50 ± 1.02	1.016 ± 0.33	0.364	0.863
Fasting plasma glucose (mg/dL)	145.32 ± 57.73 (n = 84)	141.91 ± 55.32 (n = 71)	133.50 ± 59.91 (n = 4)	177.44 ± 71.55 (n = 9)	0.8	0.184
HbA _{1c} (%)	6.79 ± 1.95 (n = 84)	6.57 ± 1.77 (n = 71)	6.94 ± 1.38	8.69 ± 2.85 (n = 8)	0.597	0.076
Total cholesterol (mg/dL)	198.27 ± 52.17 (n = 87)	199.53 ± 49.52	212.6 ± 91.70	180.11 ± 49.62 (n = 9)	0.768	0.294
Triglyceride (mg/dL)	149.21 ± 109.88 (n = 87)	151.97 ± 117.18	116.80 ± 17.51	144.78 ± 72.91 (n = 9)	0.031	0.8
HDL cholesterol (mg/dL)	39.93 ± 11.43 (n = 87)	39.26 ± 10.95	46.00 ± 11.27	42.00 ± 15.16 (n = 9)	0.257	0.612
LDL cholesterol (mg/dL)	135.11 ± 50.29 (n = 87)	135.97 ± 45.96	164.40 ± 99.69	111.89 ± 45.35 (n = 9)	0.56	0.164
Creatine kinase (U/L)	1865.08 ± 1920.24 (n = 84)	1878.29 ± 1759.09 (n = 69)	1635.20 ± 1326.64	1887.4 ± 3132.52	0.719	0.993
CK-MB (U/L)	238.78 ± 249.22	247.14 ± 257.18	296.00 ± 239.14	149.20 ± 185.85	0.68	0.16
Admission duration (days)	4.72 ± 7.17	3.22 ± 3.47	7.20 ± 4.15	14.50 ± 16.30	0.98	0.057
CCU duration (days)	2.46 ± 2.59	2.23 ± 1.73	2.00 ± 1.22	4.4 ± 5.98	0.706	0.284
Diabetes Mellitus	24 (27.27%)	13 (14.77%)	3 (60%)	8 (80%)	0.058	0
Hypertension	44 (50%)	31 (42.46%)	3 (60%)	10 (100%)	0.648	0
Smoking	30 (34.09%)	29 (39.73%)	1 (20%)	0 (0%)	0.644	0.013
Dyslipidemia	70 (79.54%)	56 (76.71%)	5 (100%)	9 (90%)	0.58	0.683
Previous MI	12 (13.63%)	9 (12.33%)	1 (20%)	2 (20%)	0.506	0.615
Stroke	5 (5.68%)	4 (5.48%)	1 (20%)	0 (0%)	0.289	1
CPR	6 (6.82%)	4 (5.48%)	0 (0%)	2 (20%)	1	0.151

Data are expressed as mean ± SD.

RH: Rehospitalizations; HDL: High density lipoprotein; LDL: Low density lipoprotein; CK-MB: creatine kinase-MB; CCU: Coronary care unit;

CPR : Cardiopulmonary resuscitation; MI: Myocardial infarction.

with unplanned cardiac RHs as shown in Table 1 and 2. According to Table 1, NSTEMI was the leading cause of unplanned cardiac RHs (2, 40%) but causes of unplanned non-cardiac RHs were various. According to Table 2, only triglyceride level was significantly different between patients with unplanned cardiac RHs and patients without unplanned RHs. In the other hand, age, sex and underlying diseases (diabetes, hypertension, smoking) were significantly different between patients with unplanned non-cardiac and patients without unplanned RHs. Other variables such as race, chief complaint and complications

during their first visit, and anti-platelets are shown in Table 3, 4, 5 and 6 respectively. The unrecorded data was also shown in Table 2 as decreased in numbers. There was no death during 1 year after intervention and 20 planned RHs patients were admitted for further management, mostly of RHs were cardiac RHs because they had more than 1 vascular lesions. Kaplan-Meier curves showed incidence rate within one year in both unplanned cardiac and non-cardiac RHs which were 5.68% and 11.36 respectively. (Figure 1).

Table 3. Comparisons among races.

		Overall (n = 88)	No RHs (n = 73)	Unplanned cardiac RHs (n = 5)	Unplanned non - cardiac RHs (n = 10)	P - value (cardiac vs no RHs)	P - value (non- cardiac vs no RHs)
Thai	Thai	84, 95.45%	69, 94.52%	5, 100%	10, 100%	1	1
	Indian	1, 1.14%	1, 1.37%	0, 0%	0, 0%		
	South						
Non-Thai	Korean	1, 1.14%	1, 1.37%	0, 0%	0, 0%		
	Singaporean	1, 1.14%	1, 1.37%	0, 0%	0, 0%		
	Belgium	1, 1.14%	1, 1.37%	0, 0%	0, 0%		

Table 4. Comparisons with chief complaints at first visits.

	Overall (n = 88)	No RHs (n = 73)	Unplanned cardiac RHs (n = 5)	Unplanned non- cardiac RHs (n = 10)	P - value (cardiac vs no RHs)	P - value (non-cardiac vs no RHs)
Chest pain	76, 86.36%	68, 93.15%	3, 60%	5, 50%	0.045	0.002
Dyspnea	5, 5.68%	2, 2.74%	1, 20%	2, 20%		
Syncope	3, 3.41%	2, 2.74%	0, 0%	1, 10%		
Headache	1, 1.14%	1, 1.37%	0, 0%	0, 0%		
Elective*	2, 2.27%	0, 0%	1, 20%	1, 10%		
No clinical**	1, 1.14%	0, 0%	0, 0%	1, 10%		

* Planned admission for coronary angiography with percutaneous coronary intervention

**Found STEMI by preoperative (extend fusion T12 - S1) EKG

Table 5. Comparisons with complications from STEMI during first visits.

Missing = 2	Overall (n = 86)	No RHs (n = 72)	Unplanned cardiac RHs (n = 5)	Unplanned non-cardiac RHs (n = 9)	P - value (cardiac vs no RHs)	P - value (non-cardiac vs no RHs)
No complication	69, 80.23%	60, 83.33%	3, 60%	6, 66.67%	0.282	0.24
Arrhythmia	3, 3.49%	3, 4.17%	0, 0%	0, 0%		
Syncope	2, 2.33%	1, 1.39%	0, 0%	1, 11.11%		
Heart failure	9, 10.46%	5, 6.94%	2, 40%	2, 22.22%		
Acute kidney injury	2, 2.33%	2, 2.78%	0, 0%	0, 0%		
Hematoma	1, 1.16%	1, 1.39%	0, 0%	0, 0%		
Death	8, 8.33% (n = 96)	-	-	-	-	-

Table 6. Comparisons of the antiplatelets.

Missing = 3	Overall (n = 85)	No RHs (n = 71)	Unplanned cardiac RHs (n = 5)	Unplanned non-cardiac RHs (n = 9)	P - value (cardiac vs no RHs)	P - value (non-cardiac vs no RHs)
Aspirin alone	1, 1.18%	1, 1.41%	0, 0%	0, 0%	0.453	0.006
Aspirin + Clopidogrel	59, 69.41%	54, 76.06%	3, 60%	2, 22.22%		
Aspirin + Ticagrelor	21, 24.71%	13, 18.31%	2, 40%	6, 66.67%		
Aspirin + Prasugrel	2, 2.35%	2, 2.82%	0, 0%	0, 0%		
Aspirin + Warfarin	2, 2.35%	1, 1.41%	0, 0%	1, 11.11%		

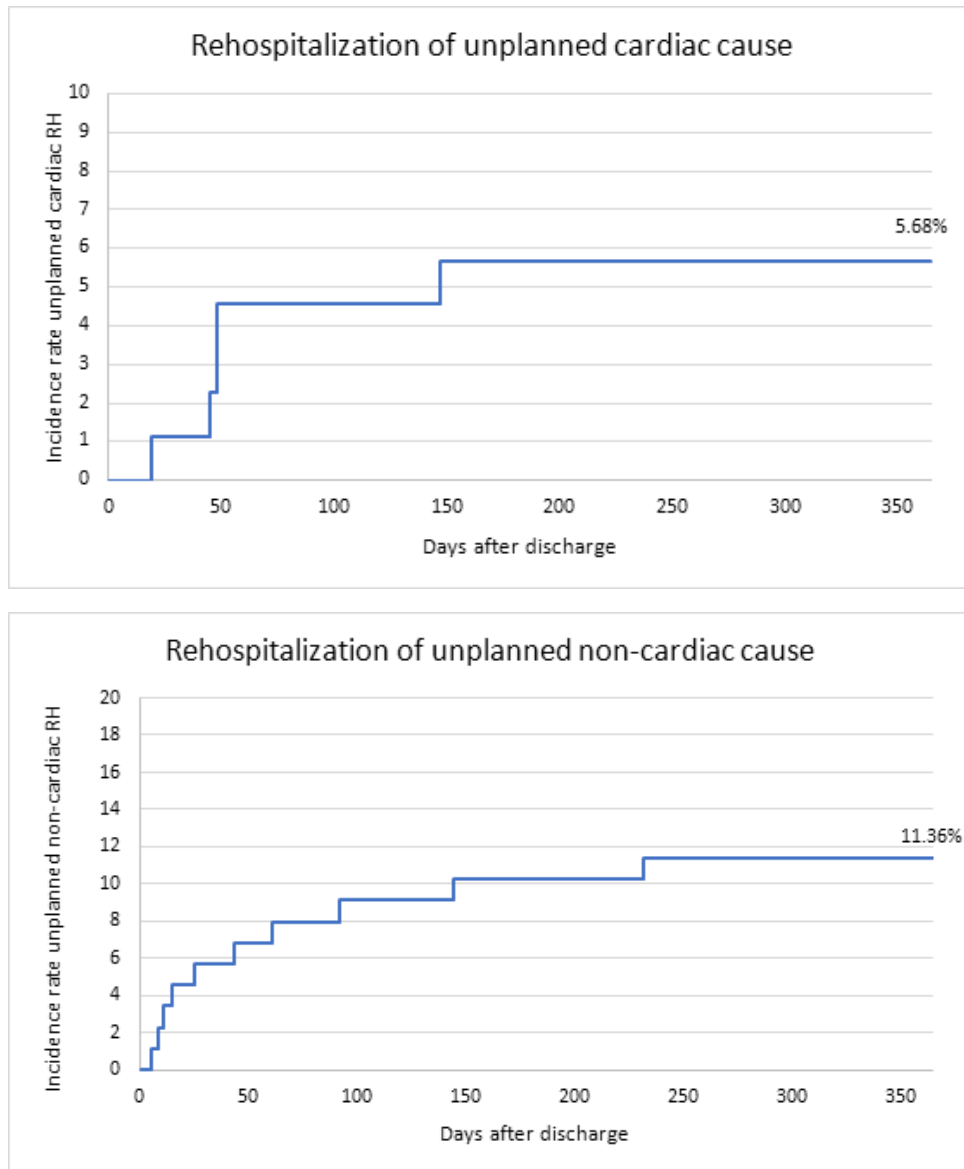


Figure 1. Kaplan-Meier curves showing the incidence rate of unplanned cardiac and noncardiac re-hospitalization within one year.

Unplanned RHs occurred in 15 patients; 5 (5.68%) were cardiac RHs and 10 (11.36%) were non-cardiac RHs. Those with cardiac RHs were aged ranged from 56 to 83 years old and their LDL level were ranged from 104 to 271. Three of five had an impaired left ventricular (LV) systolic function with estimated left ventricular ejection function (LVEF) of 30%, 33% and 40%; others had normal LV systolic function with the estimated LVEF of 56% and 60%.

Twenty admissions were recorded as planned RHs for further management which mostly had more than one culprit lesions.

Discussion

According to Table 5, 9 patients had heart failure before discharge whereas 3 of them were in cardiac RHs group (60%). Hence heart failure before discharge might predict RHs.

The result was not correlated with any previous study (Spitzer E, *et al*⁽³⁾ and Dunlay S, *et al*⁽⁵⁾) which had unplanned cardiac RHs predominately (Spitzer E, *et al*⁽³⁾: unplanned cardiac RHs 11.7% and unplanned non-cardiac 6.9% and Dunlay S, *et al*⁽⁵⁾: unplanned cardiac RHs 42.6% and unplanned non-cardiac 30.2%). This might due to not only size of population that were much fewer than in previous studies^(3,5), rather their follow-up capability, although their age, total cholesterol and LDL level were similar to our results.⁽³⁾ Only Triglyceride level was significantly different between patients with unplanned cardiac RHs and patients without RHs which was higher in non RHs group. However independence effect of Triglyceride level to risk of cardiovascular disease was controversy in previous study.^(6,7)

In previous study^(3,5), independent predictors were LVEF, Syntax score, Diabetes mellitus, Chronic obstructive pulmonary disease (COPD), Anemia, Killip class, Hospital length stay, Complication of intervention. However, predictors of unplanned cardiac RHs cannot be assessed due to the limitation of number of patients enrolled in our study. There are some limitations in this study. The numbers of our participants in the study was low because we did not include referred patient due to the lack of follow-up data in KCMH database. Therefore, we could not infer to population. The numbers of RHs might be missed because patients might be admitted to hospital other than KCMH. Moreover, some patients had more than one conditions which were not only cardiac but also

non-cardiac causes which made us to use chief complaints for recruitment of subjects. In addition, adverse events were not analyzed due to the limited data.

Conclusion

Among patients with STEMI who underwent primary PCI and followed-up at KCMH, non-cardiac unplanned RHs occurred in 11.36% with various causes. While cardiac unplanned RHs occurred in 5.86% with NSTEMI as a leading cause. While predictors of unplanned cardiac RHs could not be concluded due to limitations as above.

Conflict of interest

None of the authors has any potential conflict of interest to disclose.

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