Factors Associated with Getting Timely Coronary Catheterization of Patients with Acute Ischemic Heart Disease of Hospitals in Thailand

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Abstract The objective of this study was to investigate the current effectiveness of timely coronary catheterization among patients with acute ischemic heart disease and to study the rates of timely coronary catheterization separated according to various hospital factors, including the study of various hospital factors affecting the timely delivery of coronary catheterization of patients with acute ischemic heart disease in Thailand. The secondary data during 2018-2019 was collected from 1,180 hospitals serving cardiac patients in Thailand and analyzed by using descriptive statistics and inferential statistics. The difference between variables were conducted by one-way ANOVA and the relationship between variables were analyzed by multiple regression analysis. The study found that Thailand still has problems with both a shortage of cardiac catheterization centers and improper concentration of the cardiac catheterization center. Most of the hospitals that serve cardiac patients in Thailand (89%) do not have a cardiac catheterization facility, especially in the Northeast area of Thailand. Instead, a high concentration of cardiac catheterization center was found in hospitals in Bangkok (10.42%). It's also found that cardiac catheterization rooms are often located in larger hospitals with size of more than 120 beds (80.77%). As such problems contribute to the rate of timely cardiac catheterization. In general, Thailand has not yet passed the threshold (more than 50%) because it can only achieve 49.15%, especially the 7th health service area (Khon Kaen, Kalasin, Mahasarakham, Roi Et) has a low rate of timely treatment (15. 22%). The results found that the mean rate of timely catheterization statistically better among the hospitals larger than 120 beds, hospitals with cardiac catheterization center and private hospitals, and by analyzing the relationship between various factors of hospitals including the number of beds, the established period, proportion of the number of cardiac catheterization centers to the number of service area hospitals in where the hospital is located, type of hospital and the existence of cardiac catheterization center to the rate of timely catheterization by analyzing multiple regression analysis, it was found that various hospital factors can jointly predict trends of the rate of timely treatment at a moderate level, 24 percent (adjusted R^2 = 0. 246). The results suggest that the rate of timely coronary catheterization is currently lagging and the Thai Ministry of Public Health budget should be allocated to provide more cardiac catheterization centers and should be more inclusive throughout the country especially in the northeastern provinces where there is still a shortage.

Keywords: timely coronary catheterization, acute ischemic heart disease, Thailand

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1. Introduction

The situation of ischemic heart disease is a major public health problem in the world and also in Thailand. World Health Organization found that 7.4 million people died from ischemic heart disease in 2012, or 12.2 percent of all deaths. In 2018 the mortality was raised to 17.9 million, accounting for 31 percent of the world's cause of death [1]. The ischemic heart disease situation in Thailand according

to the Ministry of Public Health found that the mortality rate is likely to increase from the past. In 2015, the mortality rate was 28.92 per hundred thousand population or an average of 2 people per hour increased from the previous year, 2012 with a mortality rate of 23.45 per hundred thousand population [2].

Acute ischemic heart disease is caused by the lack of blood supply to the heart muscle due to blood clots in the coronary arteries and resulting in acute myocardial infarction. They usually have immediate symptoms such as severe chest pain, fainting, loss of consciousness, and possibly

sudden death [3]. Especially if the electrocardiography (ECG) abnormalities are characterized by elevated ST segment at least 2 consecutive leads. This is specifically called "ST Elevation Myocardial Infarction (STEMI)". It will cause a very high mortality rate of nearly 50 percent, especially if you experience cardiogenic shock. More than half of all acute deaths from this type of heart disease have never shown symptoms before [4]. Treatment according to acute ischemic heart disease guidelines by European Heart Medical Association 2017 [5] and Guidelines of the Association of Cardiologists of Thailand 2014 [3] prescribe coronary catheterization and percutaneous coronary intervention (PCI) treatment to enlarge the blood vessels is a gold standard treatment. The European Heart Association [5] and the Association of Cardiologists of Thailand [6] have determined that this group of patients should be PCI within 120 minutes from the time the patient comes to the hospital (Door to balloon time). Because if treated later than that time, the heart muscle may be permanent death and caused to a permanent decrease in heart function or death [7,8,9]

At present, most of Thai hospitals still have no cardiac catheterization room, especially in rural provinces. When experiencing acute ischemic heart disease patients who need cardiac catheterization procedure, they need to refer the patients to other hospitals which have cardiac catheterization room. The Thai referral system is therefore very important to the effectiveness of the current treatment for acute ischemic heart disease. The Thai Ministry of Public Health divided the area of responsibility of the cardiac referral system in 13 health service areas

according to the criteria of the Thai National Health Security Office (NHSO) [10] as shown in Table 1, which still found the problem that the referral system in Thailand is not effective due to the access rate of treatment (Door to balloon time) within 120 minutes as follows. The patient arrived at the origin hospital until the time the patient had balloon angioplasty in destination hospital passing Door to balloon time rates are as low as 30-40%, especially in hospitals under the Ministry of Public Health, which is the hospital where the majority of the country's citizens are admitted. Causing the results of treatment still have a low survival rate, especially if cardiogenic shock is associated with only 50-60% survival rate in this group of patients. Considering the data from the Bureau of Strategic Medicine, Department of Medicine, Ministry of Public Health of Thailand has set indicators for referral and treatment or STEMI patients, according to the service plan has set a target (Key Performance Index: KPI) rate of receiving treatment by Primary Percutaneous Coronary Intervention (Primary PCI) within 120 minutes, more than 50 percent will be treated as criteria. It was found that in 2008, the rate of patients receiving timely treatment was only 12.8 percent. Same as in 2017, only 30 percent were found [11].

From the above data reflects the problem, research question of referral system for patients with acute ischemic heart disease of hospitals in Thailand today, Is there an important current condition? Is it effective or not? And what hospital factors affect the effectiveness of timely cardiac catheterization of the acute ischemic heart disease referral system of hospitals in Thailand?

Table 1. Health service areas as specified by the National Health Security Office (NHSO)

Health service area	Provinces in responsibility
Area 1 Chiang Mai	Chiang Mai, Chiang Rai, Phayao, Mae Hong Son, Lampang, Lamphun, Phrae, Nan
Area 2 Phitsanulok	Phitsanulok, Tak, Phetchabun, Sukhothai, Uttaradit
Area 3 Nakhon Sawan	Nakhon Sawan, Kamphaeng Phet, Chai Nat, Phichit, Uthai Thani
Area 4 Saraburi	Saraburi, Ayutthaya, Lopburi, Sing Buri, Ang Thong, Pathum Thani, Nonthaburi, Nakhon Nayok
Area 5 Ratchaburi	Ratchaburi, Kanchanaburi, Prachuap Khiri Khan, Phetchaburi, Samut Songkhram, Nakhon Pathom, Suphanburi, Samut Sakhon
Area 6 Rayong	Rayong, Chanthaburi, Chachoengsao, Chonburi, Trat, Sa Kaeo, Prachinburi, Samut Prakan
Area 7 Khon Kaen	Khon Kaen, Kalasin, Maha Sarakham, Roi Et
Area 8 Udon Thani	Udon Thani, Sakon Nakhon, Nakhon Phanom, Nong Khai, Nong Bua Lam Phu, Loei, Bueng Kan
Area 9 Nakhon Ratchasima	Nakhon Ratchasima, Chaiyaphum, Buriram, Surin
Area 10 Ubon Ratchathani	Ubon Ratchathani, Mukdahan, Yasothon, Si Saket, Amnat Charoen
Area 11 Suratthani	Suratthani, Krabi, Chumphon, Nakhon Si Thammarat, Phangnga, Phuket, Ranong
Area 12 Songkhla	Songkhla, Trang, Narathiwat, Pattani, Phatthalung, Yala, Satun
Area 13 Bangkok	Bangkok

Source: National Health Security Office Ministry of Public Health. 2016: pages 40-45.

2. Materials and Methods

2.1. Study Design and Population

This research study was a correlation study conducted for 3 months from October to December 2020. The population used in this research are hospitals under the Ministry of Public Health and private hospitals that are cardiology service units of the Thai Ministry of Public Health, 1,180 hospitals.

2.2. Objectives

1. To study the current effectiveness of timely coronary catheterization of patients with acute ischemic heart disease of hospitals in Thailand.

2. To study the rates of timely coronary catheterization separated by various hospital factors.

3. To study the factors of the hospital that affect the timely receiving of coronary catheterization of Acute ischemic heart disease patients in Thai hospitals.

2.3. Data Collection and Analysis

2.3.1. Data Collection

This study uses the record form as a tool for collecting secondary data about hospital factors such as health service area, the number of hospital beds, time of establishment, The existence of a cardiac catheterization room, type of hospital (Government / Private) and the rate of timely primary cardiac catheterization (Primary PCI) within 120 minutes. Data was compiled from the results the Thai Ministry of Public Health reports in the fiscal year 2019 [12].

2.3.2. Data Management and Analysis

Data was entered into excel version 13 and was analyzed using SPSS 25 according to the objectives as follows:

Objective 1 Study the current condition of the referral system for patients with acute ischemic heart disease of hospitals in Thailand. This was done by analyzing the content, using descriptive statistics, frequency, percentage and presenting both overall, and by area of hospital health service, number of beds, length of establishment, the existence of a cardiac catheterization room, type of hospital (Government / Private)

Objective 2 To study the rates of timely coronary catheterization separated by various factors of the hospital by health service area, the number of beds, established period. Analysis of the differences between more than 2 groups of variables was done by one-way ANOVA analysis, while the existence of cardiac catheterization room and hospital type (Government / Private) using the method of analyzing the difference between the two variables with the Unpaired t test.

Objective 3 Study of hospital factors affecting timely coronary catheterization of patients with acute ischemic heart disease of hospitals in Thailand using Multiple Regression Analysis methods (MRA).

3. Results

From the study of total 1,180 hospitals (86.69% government, 13.31% private) found that most of the cardiac catheterization rooms (42%) were located in Bangkok, while the 7th health service area (Khon Kaen, Kalasin, Maha Sarakham, Roi Et) had the lowest number of cardiac catheterization rooms (0.76%). Based on the proportion of the number of cardiac catheterization centers to the total number of hospitals in each area, it was found that the group with a small proportion (<5%) were health service areas at 7,8,10. Groups with a moderate proportion (5-10%) were health service areas at 1,2,3,9,11,12 while the groups with a large proportion (> 10%) were the health service area at 4,5,6,13. The 13th health service area (Bangkok) was the highest proportion (44. 71%), while the health service area 7 (Khon Kaen, Kalasin, Maha Sarakham, Roi Et) has the least proportion of the number of cardiac catheterization centers (1.02%). In addition, the majority (667; 56.53%) of the Thai hospital is a 30-90-bed hospital (medium size) with an established period of 30-60 years (690; 58.48%). Only 11% of Thai hospitals have cardiac catheterization rooms (130 hospitals). The rooms are often located in big hospitals which size larger than 120 beds (105; 80.77%), therefore most hospitals in Thailand do not have cardiac catheterization center and require referral of cardiac patients.

Table 2. The mean rate of timely cardiac catheterization (within 120-minute) in patients with acute ischemic heart disease is classified according to different aspects of the hospital in the Thai cardiac referral system

	No. of hospitals (%)	No. of cath centers (%)	Percent proportion of the No. of cath centers to the No. of hospitals	Percent proportion of timely cardiac catheterization rate
Health service area				
1	118 (10.00)	9 (6.92)	7.62	27.69
2	54 (4.57)	3 (2.30)	5.56	54.65
3	58 (4.91)	3 (2.30)	5.17	67.35
4	86 (7.29)	11 (8.46)	12.79	29.68
5	83 (7.02)	9 (6.92)	10.84	61.45
6	104 (8.81)	15 (11.53)	14.42	62.55
7	83 (7.02)	1 (0.76)	1.02	15.22
8	96 (8.14)	3 (2.30)	3.13	48.81
9	116 (9.83)	6 (4.61)	5.17	57.47
10	75 (6.40)	1 (0.76)	1.33	31.91
11	95 (8.05)	7 (5.38)	7.37	40.43
12	89 (7.54)	7 (5.38)	7.86	78.89
13	123 (10.42)	55 (42.00)	44.71	64.03
The proportion of the number of cardiac catheterization centers to the total number of hospitals in each area				
Small (<5%)	254 (21.5)	5 (3.85)	1.97	32.84
Moderate (5-10%)	530 (44.9)	35 (27.00)	6.60	52.13
Large (>10%)	396 (33.6)	90 (69.15)	22.73	55.64
The number of beds				
Less than 30	109 (9.24)	0 (0.00)	0	44.07
30-90	667 (56.53)	9 (6.93)	1.35	48.18
91-120	124 (10.50)	16 (12.30)	12.90	49.66
More then 120	280 (23.73)	105 (80.77)	37.50	53.20

	No. of hospitals (%)	No. of cath centers (%)	Percent proportion of the No. of cath centers to the No. of hospitals	Percent proportion of timely cardiac catheterization rate
The established period				
Less than 30 yr.	390 (33.05)	53 (40.77)	13.59	52.17
30-60 yr.	690 (58.48)	42 (32.30)	6.09	47.50
More than 60 yr.	100 (8.47)	35 (26.93)	35.00	48.86
The existence of cardiac catheterization center				
No	1050 (89.00)	1050 (89.00)	0	48.25
yes	130 (11.00)	130 (11.00)	100	56.37
Type of hospital				
Government	1023 (86.69)	54 (41.54)	5.28	47.73
Private	157 (13.31)	76 (58.46)	48.40	58.46
Over all	1,180 (100)	130 (100)	11.00	49.15

If considering the effectiveness of timely coronary catheterization within 120 minutes, it will be found that the overall picture of Thailand has not met the criteria (more than 50%) due to only 49.15% achieved. The 12th health service area had most timely treatment rates (78.89%), while the 7th health service area had the lowest rates of timely treatment (15.22%). Other factors found that the best mean rates of achieving treatment in time were found in hospitals larger than 120 beds (53.20%). Hospitals with cardiac catheterization centers found higher mean rates of timely treatment than those without (56.37% vs. 48.25%). %) and private hospitals have a higher mean of timely treatment than that of the government hospitals (58.46% vs. 47.73%), as shown in Table 2.

Comparison of mean rates of timely coronary catheterization by different health service areas by comparing the mean with statistical F-test and one-way analysis of variance method (ANOVA) at a significance level 0.05, found at least two health-service areas have different mean values (F- prob = 0.00), and when continuing with the multiple comparison test with the Scheffe statistic, it was found that all health service districts had a different mean of timely treatment.

Results of the test to compare the mean rates of timely catheterization separated by the proportionate of the number of cardiac catheterization centers to the number of hospitals in each service area by comparing the mean by statistical F-test with one way analysis of variance (ANOVA) at 0.05 level of significance, at least 2 health service areas were found with the mean difference (F- prob = 0.00) and continuous testing with the multiple comparison test with the Scheffe statistic. The service area which has a small proportion of the number of cardiac catheterization centers to the number of hospitals will find the average rate of getting treatment in a less time than the moderate group and we also find that the moderate proportion group has the average rate of timely treatment lower than the large proportion group as shown in Table 3.

Table 3. Results for the comparison of mean percentage of timely coronary catheterization rates classified by the number of cardiac catheterization centers to the number of hospitals of the health service area.

The proportion of the number of cardiac Cath centers. (Rate of timely coronary catheterization)	**Moderate** (5-10%) (52.13 %)	**Large** (>10%) (55.64 %)	Results of the proportion of the number of cardiac catheterization center with different mean rates of timely coronary catheterization
Small (<5%) (32.84 %)	-19.28*	-22.80*	(Small, Moderate) (Small, Large)
Moderate (5-10%) (52.13 %)		-3.51*	(Moderate, Large)
Large (>10%) (55.64 %)			

Note: Analysis of the multiple-match test with the Scheffe method
* Significant level P < 0.05.

Table 4. Results for the comparison of mean percentage of timely coronary catheterization rates by hospital size (the number of beds)

Size of the hospital (The no. of beds) (Rate of timely coronary catheterization)	**30-90 beds** (48.18 %)	**91-120 beds** (49.66 %)	**More than 120 beds** (53.20 %)	Results of the size of the hospital with different mean rates of timely coronary catheterization
Less than 30 beds (44.08 %)	-4.10	-5.58	-9.13*	(Less than 30 beds, More than 120 beds)
30-90 beds (48.18 %)		-1.48	-5.02*	(30-90 beds, More than 120 beds)
91-120 beds (49.66 %)			-3.54	
More than 120 beds (53.20 %)				

Note: Analysis of the multiple-match test with the Scheffe method
* Significant level P < 0.05.

Table 5. Results for the comparison of mean percentage of timely coronary catheterization rates by the established period of hospital

Established period (Rate of timely coronary catheterization)	30-60 yr. (47.50 %)	More than 60 yr. (48.85 %)	Results of the established period of the hospital with different mean rates of timely coronary catheterization
Less than 30 yr. (52.16 %)	4.66*	3.30	(less than 30 yr., 30-60 yr.)
30-60 yr. (47.50 %)		-1.36	
More than 60 yr. (48.85 %)			

Note: Analysis of the multiple-match test with the Scheffe method
* Significant level P < 0.05.

Table 6. Results for the comparison of mean percentage of timely coronary catheterization rates by the existence of catheterization room and type of hospital

	Mean (SD)	P- value
The existence of cardiac catheterization center. No Yes	48.25 (18.06) 56.37 (14.58)	**0.00***
Type of hospital Government Private	47.73 (18.23) 58.46 (11.80)	**0.00***

Note: Analysis of the multiple-match test with the unpaired t test method
* Significant level P < 0.05.

Comparing the mean rates of timely catheterization, separated by hospital size (the number of beds) by F-test with one way analysis of variance (ANOVA) at a significance level 0.05 found that there were at least two service zones with a different mean (F- prob = 0.00), and when testing continued with the multiple comparison test with the Scheffe statistic, it was found that the hospital size with less than 30 beds has a less average rate of timely catheterization than the hospital with more than 120 beds. It was also found that the hospital with the number of beds 30-90 beds had a lower average rate of timely catheterization than the hospital with more than 120 beds as in Table 4.

Comparing the mean rates of timely treatment, separated by the establishment of the hospital with F-test and one way analysis of variance method (ANOVA) at a significance level 0.05 was found that at least two groups had different mean values (F- prob = 0.00) and when testing continued with the multiple comparison test with the Scheffe statistic. It was found that hospitals with less than 30 years of the establishment had a higher average rate of timely treatment than the hospital with a period of 30-60 years as shown in Table 5.

Comparing the mean percentage of timely coronary catheterization rates with unpaired t at a significant level of 0.05, it was found that hospitals with cardiac catheterization center have a statistically significant higher rate of timely catheterization than hospitals without cardiac catheterization center and also found that private hospitals had statistical significance higher rates of receiving timely treatment than the government hospitals as shown in Table 6.

The analysis of the relationship between hospital factors consisted of the number of beds, time of establishment, proportion of the number of cardiac catheterization centers to the number of hospitals in the health service area in which the hospital is located (low, medium, high), type of hospital (government, private), the existence of cardiac catheterization center (yes, no) and rate of timely treatment with multiple regression analysis (MRA) was used with a 95% confidence level. It was

found that various factors in the hospital can predict trends of the rate of timely treatment (Y) by 24 percent (adjusted R2 = 0. 246). When the predictor factors were written as a trend of prediction equation of the rate of timely catheterization (Y) using various hospital factors when determining X_1= the number of beds, X_2= the established period (years), the dummy variant D1 = health service areas with a small proportion of the number of coronary catheterization rooms, D2 = health service areas with the number of coronary catheterization rooms, D3 = the existence of cardiac catheterization room, D4 = hospital type. The prediction equation is obtained as follows:

$$Y = 53.157 + 0.007X_1 - 0.055X_2 - 18.944D1 + 2.069D2 + 0.827D3 + 5.346D4$$

Case 1. The hospital is in health service areas with a small proportion of the number of cardiac catheterization centers to the number of hospitals (D1 = 1, D2 = 0), no cardiac catheterization center (D3 = 0), government hospital (D4 = 0)

$$Y = 34.213 + 0.007X_1 - 0.055X_2$$

Case 2. The hospital is in the health service area with a small proportion of the number of cardiac catheterization centers to the number of hospitals (D1 = 1, D2 = 0), no cardiac catheterization center (D3 = 0), private hospital (D4 = 1)

$$Y = 39.554 + 0.007X_1 - 0.055X_2$$

Case 3. The hospital is in health service areas with a small proportion of the number of cardiac catheterization centers to the number of hospitals (D1 = 1, D2 = 0), having cardiac catheterization center (D3 = 1), government hospital (D4 = 0)

$$Y = 35.04 + 0.007X_1 - 0.055X_2$$

Case 4. The hospital is in health service areas with a small proportion of the number of cardiac catheterization centers to the number of hospitals (D1 = 1, D2 = 0),

having cardiac catheterization center (D3 = 1), private hospital (D4 = 1)

$$Y = 40.386 + 0.007X_1 - 0.055X_2$$

Case 5. The hospital is in health service areas with a moderate proportion of the number of cardiac catheterization centers to the number of hospitals (D1 = 0, D2 = 0), no cardiac catheterization center (D3 = 0), government hospital (D4 = 0)

$$Y = 53.157 + 0.007X_1 - 0.055X_2$$

Case 6. The hospital is in the health service area with the proportion of the number of cardiac catheterization centers to the average number of hospitals (D1 = 0, D2 = 0), no cardiac catheterization center (D3 = 0), private hospital (D4 = 1)

$$Y = 58.503 + 0.007X_1 - 0.055X_2$$

Case 7. The hospital is in health service areas with a moderate proportion of the number of cardiac catheterization rooms to the number of cardiac hospitals (D1 = 0, D2 = 0), having cardiac catheterization center (D3 = 1), government hospital (D4 = 0)

$$Y = 53.984 + 0.007X_1 - 0.055X_2$$

Case 8. The hospital is in health service areas with a moderate proportion of the number of cardiac catheterization centers to the average number of hospitals (D1 = 0, D2 = 0), having cardiac catheterization center (D3 = 1), private hospital (D4 = 1)

$$Y = 59.33 + 0.007X_1 - 0.055X_2$$

Case 9. The hospital is in the health service area with a large proportion of the number of cardiac catheterization centers to the number of hospitals (D1 = 0, D2 = 1), no cardiac catheterization center (D3 = 0), government hospital (D4 = 0)

$$Y = 55.226 + 0.007X_1 - 0.055X_2$$

Case 10. The hospital is in the health service area with a large proportion of the number of cardiac catheterization centers to the number of hospitals (D1 = 0, D2 = 1), no cardiac catheterization center (D3 = 0), private hospital (D4 = 1)

$$Y = 60.572 + 0.007X_1 - 0.055X_2$$

Case 11. The hospital is in health service area with a large proportion of the number of cardiac catheterization centers to the number of hospitals (D1 = 0, D2 = 1), having cardiac catheterization center (D3 = 1), government hospital (D4 = 0)

$$Y = 56.053 + 0.007X_1 - 0.055 X_2$$

Case 12. The hospital is in the health service area with a large proportion of the number of cardiac catheterization centers to the number of hospitals (D1 = 0, D2 = 1), having cardiac catheterization center (D3 = 1), private hospital (D4 = 1)

$$Y = 61.399 + 0.007X_1 - 0.055X_2$$

Note: Health service areas with a small proportion of cardiac catheterization centers (<5%) are service areas 7,8,10. Health service areas with a ratio of the moderate number of cardiac catheterization centers to the number of hospitals (5-10%) are the area 1,2,3,9,11,12 and the health service areas with a large proportion of cardiac catheterization centers to hospitals (> 10%) are area 4,5,6,13.

4. Discussion

4.1. The Current Condition of the Referral System for Patients with Acute Ischemic Heart Disease of Hospitals in Thailand

The referral system for patients with acute ischemic heart disease of hospitals in Thailand still not good because most of the hospitals that serve the cardiac patients in Thailand (89%) do not have a cardiac catheterization facility, especially in the Northeastern region area (the health service area of 7, 8, 10 which the number of cardiac catheterization centers to the number of hospitals was still low (<5%). On the other hand, there was a high concentration of the number of cardiac catheterization center in Bangkok (10.42 percent). It was also found that cardiac catheterization centers are usually found only in large size hospitals with the number of beds is more than 120 (105; 80.77%), while most of Thailand's hospitals have only 30-90 beds (56. 23%), these cause the majority of acute ischemic heart patients must be transported to another hospital that is equipped with tools, some of which need to travel far away as a result, the overall situation of timely coronary catheterization among patients with heart disease in Thailand was found to be poor because there was still a timely treatment rate of only 49.15% by almost half (46%) of the total health service areas were found to be ineffective for the indication of primary coronary angioplasty within 120 minutes (rate of timely treatment < 50%), which is health service area 1 (27.69%), area 4 (29.68%), area 7 (15.22%), area 8 (48.81%), area 10 (31.91%) and area 11 (40.43%).

Most of the patients who receive proper treatment are in Bangkok, admitted to large or private hospitals which are a minority of service hospitals in Thailand. Nowadays, Ischemic heart disease patients in Thailand have not received the appropriate treatment as they should be given. This is consistent with the data from the Thai Ministry of Public Health [13] found that during the year 2018, the overall rate of timely coronary catheterization rate was 51% with a median of 170 minutes. The longest delay was 363 minutes in the 10th health service area (Ubon Ratchathani). Suphot Sri Mahachota et al. had collected the data about the overall treatment rate of patients with acute angina in Thailand for 2 times. Firstly, they study in 3, 836 patients from 17 hospitals from 2002 to 2003 [14] (Suphot Sri Mahachota; et al. 2007: 10) and the results found that the rate of timely coronary angiography was only 34%. Secondly, study in 2012 [15], the data were collected from 1,102 patients, 39 hospitals between 2007 and 2008. The time from the hospital arrival until the coronary vessel was opened (Door to balloon time) was 127 minutes, the rate of timely coronary angiography was only 12.3 percent.

4.2. The Rates of Timely Coronary Catheterization Separated by Various Factors of the Hospital

The factors of the hospital from this study found that in the southern region of Thailand especially in the 12th health service area (Songkhla, Trang, Narathiwat, Pattani, Phatthalung, Yala, Satun) had the highest rates of timely treatment (78.89%), while the 7th health service area (Khon Kaen, Kalasin, Mahasarakham, Roi Et) which located in the northeastern region had the lowest rates of timely treatment (15. 22%). This finding is consistent with the result of previous studies [16,17,18,19] showed that many provinces in the northeastern region had suffered from delayed treatment and problems of delayed treatment usually occur in the health service area which had an insufficient number of cardiac catheterization centers and the proportion of the number of cardiac catheterization centers to the number of hospitals was less, while Bangkok had the highest proportion and the number of cardiac catheterization centers but due to traffic congestion, the rate of timely treatment is less than other areas. While the hospital size factor (the number of beds) found that larger hospitals (more than 120 beds) had higher rates of timely treatment due to the cardiac catheterization center usually set up in a large hospital and the treatment of coronary artery stenosis requires collaboration between multiple departments and require close supervision from cardiac specialized nurses. Small hospitals or community hospitals do not have enough potential so when there is a patient with acute coronary artery disease which unable to perform the treatment, therefore, the patient must be referred to another hospital. Spend time on the referral process. As a result, treatment is often not timely. Sometimes the patient needs to be referred to a distant hospital. Factors in the time of establishment found that hospitals established in the last 30 years will find higher rates of timely treatment than long - established hospital because the cardiac catheterization machine, which is a modern technology often located in modern hospitals because today there is more competition in technology [20] especially in the private sector which have more flexibility in capital and equipment. Result in more cardiac catheterization center and the rate of timely catheterization of private hospital was better than government hospital.

According to this study, it can be seen that hospital factors (the number of beds, time of establishment, type of hospital, and the existence of cardiac catheterization center) were related to the rates of timely coronary catheterization at the moderate levels (r = 0.499). These factors jointly forecast the rate of timely coronary catheterization by 24 percent (Adjust $R^2 = 0.246$). The proportion of the number of cardiac catheterization centers to the number of hospitals in the health service area and the number of hospital beds were correlated in the same direction with the rate of timely treatment while the establishment time factor was correlates in opposite directions.

5. Conclusion

Based on the findings, the following conclusions were made:

Thailand still has problems with both a shortage of cardiac catheterization centers and improper concentration of the cardiac catheterization center. Most of the hospitals that serve cardiac patients in Thailand do not have a cardiac catheterization facility, especially in the Northeast area of Thailand. High concentration of cardiac catheterization center was found in Bangkok (10.42%). Overall situation of timely coronary catheterization among patients with heart disease in Thailand was found to be poor because there was still a timely treatment rate of only 49.15% by almost half (46%) of the total health service areas were found to be ineffective for the indication of primary coronary angioplasty within 120 minutes and the mean rate of timely catheterization statistically better among the hospitals larger than 120 beds, hospitals with cardiac catheterization center and private hospitals.

6. Recommendations

1. Thai Ministry of Public Health should allocate the budget to provide more cardiac catheterization centers throughout the country especially in the northeastern provinces, where there is a shortage and the rates of timely coronary artery catheterization are currently lagging.

2. From the study results by analyzing the differences between variables and the various hospital factors effecting on the rate of timely catheterization by multiple regression analysis, Thai Ministry of Public Health should focus on developing a system for referring ischemic heart patients especially in the long - established hospital, small hospitals with fewer beds and more emphasis on the development of government hospitals.

3. There should be further research on other factors. In addition to the hospital factors that affect the rate of timely coronary catheterization, such as personnel factors, budget, supporting factor, and administrative factor.

4. Further research should be conducted in health service areas where there is a problem in the incidence of poor timely coronary artery catheterization rate. To find specific causes in each area and find solutions to such problems.

Conflicts of Interests

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