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Comparison of in-hospital death following ST-elevation myocardial infarction between secondary emergency and tertiary emergency

Hiroki Yoshida[1] · Kenichi Sakakura[1] · Kei Yamamoto[1] · Yousuke Taniguchi[1] · Takunori Tsukui[1] · Masaru Seguchi[1] · Hiroyuki Jinnouchi[1] · Hiroshi Wada[1] · Takashi Moriya[2] · Hideo Fujita[1]

Abstract

In most areas in Japan, patients with ST-elevation myocardial infarction (STEMI) would be transferred to the secondary hospitals or tertiary hospitals according to the judgement of emergency medical service (EMS) staff members. We hypothesized that in-hospital outcomes would be worse in STEMI patients judged as tertiary emergency than in those judged as secondary emergency, which may support the judgement of the current EMS systems. The purpose of this study was to compare in-hospital outcomes of STEMI between patients judged as secondary emergency and those judged as tertiary emergency. We included 238 STEMI patients who were transferred to our institution using EMS hotline, and divided those into the secondary emergency group ($n = 106$) and the tertiary emergency group ($n = 132$). The primary endpoint was in-hospital death. The prevalence of shock was significantly higher in the tertiary emergency group than in the secondary emergency group (32.6% vs. 10.4%, $p < 0.001$). The GRACE score was significantly higher in the tertiary emergency group than the secondary emergency group [146 (118–188) vs. 134 (101–155), $p < 0.001$]. The incidence of in-hospital death was significantly higher in the tertiary emergency group than in the secondary emergency group (8.0% vs. 2.1%, $p = 0.014$). The multivariate logistic regression analysis revealed that the tertiary emergency was significantly associated with in-hospital death (OR 3.52, 95% CI 1.24–10.02, $p = 0.018$) after controlling age and gender. In conclusion, the tertiary emergency was significantly associated with in-hospital death. Our results might validate the judgement of levels of emergency by local EMS staff members.

Keywords Acute myocardial infarction · ST-elevation myocardial infarction · Secondary emergency · Tertiary emergency

Introduction

In Japan, emergency facilities have been classified into three levels based on resources, administration, staff, and education [1, 2]. Primary emergency facilities provide care for walk-in patients, secondary emergency hospitals provide in-hospital care for acute illness and trauma, and tertiary emergency hospitals provide total care for critically ill and severe traumatized patients [1, 2].

✉ Kenichi Sakakura
  ksakakura@jichi.ac.jp

1 Division of Cardiovascular Medicine, Saitama Medical Center, Jichi Medical University, 1-847 Amanuma, Omiya, Saitama 330-8503, Japan

2 Department of Emergency and Critical Care Medicine, Saitama Medical Center, Jichi Medical University, Saitama, Japan

Patients with ST-elevation myocardial infarction (STEMI) would be transferred to the secondary hospitals or tertiary hospitals according to the judgement of emergency medical service (EMS) systems including on-site emergency life-saving technician [1]. If EMS staff members judge STEMI patients as secondary emergency, those patients would be transferred to secondary emergency hospitals as well as tertiary emergency hospitals, because some secondary emergency hospitals are primary percutaneous coronary intervention (PCI)-capable hospitals [3]. However, if EMS systems judge STEMI patients as tertiary emergency, those patients may not be transferred to nearby secondary emergency hospitals, and may be transferred to far tertiary emergency hospitals [4], which may result in the delay of reperfusion therapy. In other words, the judgement of EMS would have an impact on clinical outcomes of STEMI patients. However, the judgement of EMS has not been validated in STEMI patients. We hypothesized that in-hospital clinical outcomes were worse in STEMI patients judged as tertiary emergency

than in those judged as secondary emergency, which may support the judgement of the current EMS systems. The purpose of this study was to compare in-hospital outcomes of STEMI between patients judged as secondary emergency and those judged as tertiary emergency.

Methods

Study design

We reviewed all AMI patients treated at our institution (Saitama Medical Center, Jichi Medical University) between April, 2016 and December, 2018. Our institution has been a tertiary emergency hospital since April, 2016 in Saitama city, Japan. In 2018, Saitama city had approximately 1.3 million residents within the area of 217 km^2, and had 2 tertiary emergency hospitals including our institution. Other than 2 tertiary emergency hospitals, Saitama city had at least 6 primary PCI-capable hospitals, which were classified as secondary emergency hospitals. Our institution received both patients with tertiary emergency and with secondary emergency, and both patients were initially managed in the emergency room by staff members including emergency physicians and residents. In most cases, cardiologists were called to the emergency room by emergency physicians when the tentative diagnosis of STEMI was made, typically after 12-leads electrocardiogram. The timing to call cardiologists was not decided by the EMS judgement, but was decided by the emergency physicians.

The inclusion criteria were (1) patients with STEMI, and (2) hotline from EMS was used. The exclusion criteria were (1) second or more than second STEMI during the study period, (2) walk-in visit, (3) in-hospital onset, and (4) patients who were transferred from other hospitals. The final study population was divided into a secondary emergency group and a tertiary emergency group according to the levels of emergency which was judged by the local EMS staff members. In general, the secondary emergency is defined as a condition that requires admission due to the emergency illness or trauma [1]. The tertiary emergency is defined as a condition that requires total care for critically severe illness or trauma and admission to intensive care units [1]. The criteria of severe chest pain were impaired consciousness (Japan Coma Scale ≥ 100), abnormal respiration (respiratory rate < 10/min, ≥ 30/min), asymmetry in breath sounds, abnormal breathing, abnormal pulse (< 50/min, ≥ 120/min), abnormal blood pressure (< 90 mmHg, ≥ 200 mmHg), low SpO_2 (< 90%), shock state, cyanosis, severe chest pain lasting for ≥ 20 min, arrhythmia (ventricular tachycardia, multifocal paroxysmal ventricular complex), severe back pain, abnormal ST–T change in electrocardiogram, or asymmetry in blood pressure [5]. However, the final judgement whether

secondary or tertiary emergency was at the discretion of each local EMS.

The primary endpoint was in-hospital death. This study was approved by the institutional review board, and written informed consent was waived because of the retrospective study design. The data collection and storage were performed anonymously, according to the Japan Ministry of Health, Labour and Welfare guidelines.

Definitions

Acute myocardial infarction (AMI) was defined according to the universal definition [6, 7]. Diagnostic ST elevation was defined as new ST elevation at the J point in at least two contiguous leads of 2 mm (0.2 mV), and the AMI patients with ST elevation were diagnosed as STEMI [8]. Hypertension was defined as systolic blood pressure (SBP) > 140 mmHg, diastolic blood pressure > 90 mmHg, or medical treatment for hypertension [9]. Diabetes mellitus was defined as hemoglobin A1c ≥ 6.5% or treatment for diabetes mellitus [10]. Dyslipidemia was defined as total cholesterol ≥ 220 mg/dL, low-density lipoprotein cholesterol ≥ 140 mg/dL, or treatment for dyslipidemia [10]. We used the laboratory data at admission. Since we could not measure some laboratory data such as HbA1c or low-density lipoprotein (LDL) cholesterol levels at off hours (night or holidays), we substituted the earliest HbA1c or LDL cholesterol levels since admission for the laboratory data at admission. Shock was defined as SBP < 90 mmHg, vasopressors required to maintain blood pressure, or attempted cardiopulmonary resuscitation [10]. The Global Registry of Acute Coronary Events (GRACE) risk score was calculated [11]. Left ventricular ejection fraction (LVEF) was measured by transthoracic echocardiography during the index hospitalization. LVEF was calculated through either modified Simpson's method, Teichholz method, or eyeball estimation. A Teichholz method was adopted only when a modified Simpson's method was not available. An eyeball estimation was adopted only when both modified Simpson's method and Teichholz method were not available. We also calculated estimated glomerular filtration rate (eGFR) using serum creatinine (Cr), age, weight, and gender according to the following formula: $eGFR = 194 \times Cr - 1.094 \times age - 0.287$ (male), or $eGFR = 194 \times Cr - 1.094 \times age - 0.287 \times 0.739$ (female) [12].

Statistical analysis

Data were expressed as mean ± SD, median (interquarter range), or percentage. Categorical variables were presented as numbers (percentage) and were compared using Pearson's χ^2 test or Fisher's exact test. For continuous variables, the Shapiro–Wilk test was performed to determine whether the continuous variables were normally distributed or not.

Normally distributed continuous variables were compared using a Student t test. Otherwise, continuous variables were compared using a Mann–Whitney U test. The multivariate logistic regression analysis was performed to investigate the association between the tertiary emergency and in-hospital death. In this model, in-hospital death was adopted as a dependent variable. The tertiary emergency, age, and sex were adopted as independent variables. The odds ratio (OR) and the 95% confidence interval (CI) were also calculated. Statistical significance was defined as a two-sided $p < 0.05$. Statistical analyses were performed with SPSS 25.0 for Windows (SPSS, Chicago, IL, USA).

Results

From April 2016 to December 2018, a total of 775 AMI patients were admitted to our medical center. After excluding 537 patients who were compatible with exclusion criteria, the final study population consisted of 238 STEMI patients who were divided into the secondary emergency group ($n = 106$) and the tertiary emergency group ($n = 132$) (Fig. 1).

The comparison of patient's characteristics between the secondary emergency and tertiary emergency groups is shown in Table 1. The prevalence of shock on admission was significantly higher in the tertiary emergency group (32.6%) than in the secondary emergency group (10.4%) ($p < 0.001$). Oxygen supply at admission was more frequently required in the tertiary emergency group (71.2%) than in the secondary emergency group (42.5%) ($p < 0.001$), and ventilator support was also more frequently required in the tertiary emergency group (34.8%) than in the secondary emergency group (9.4%) ($p < 0.001$). The Glasgow Coma Scale at admission was significantly lower in the tertiary emergency group than the secondary emergency group ($p < 0.001$), and the GRACE score was significantly higher in the tertiary emergency group than in the secondary emergency group ($p < 0.001$).

Table 2 shows the comparisons of lesions and procedural characteristics between the secondary emergency group and the tertiary emergency group. Most of the lesions and procedural characteristics were similar between the groups except the size of guide catheter and mechanical support. Door to balloon time was not different between the 2 groups. VA-ECMO support was more frequently used in the tertiary emergency group (15.9%) than in the secondary emergency group (3.8%) ($p = 0.002$).

Table 3 shows the comparison of clinical outcomes between the secondary emergency group and the tertiary emergency group. Peak CK, CK-MB, length of hospital stay, and length of CCU stay were comparable between the 2 groups. The incidence of in-hospital death was significantly higher in the tertiary emergency group (8.0%) than
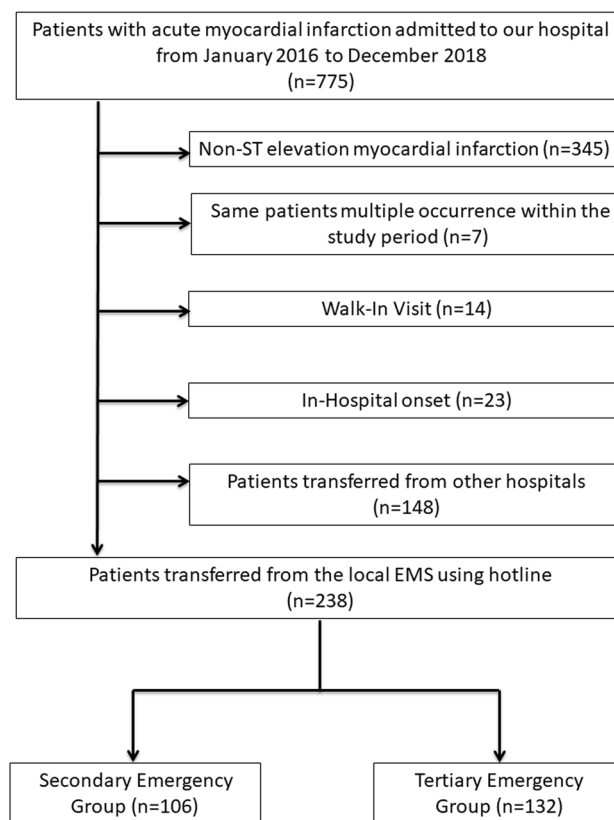

Fig. 1 Study flowchart. *EMS* emergency medical services

in the secondary emergency group (2.1%) ($p = 0.014$). The multivariate logistic regression analysis was performed to confirm the association between the tertiary emergency and in-hospital death (Table 4). The tertiary emergency was significantly associated with in-hospital death (OR 3.52, 95% CI 1.24–10.02, $p = 0.018$) after controlling age and gender.

Discussion

The present study included 238 STEMI patients using hotline from EMS, and divided into the secondary emergency group ($n = 106$) and the tertiary emergency group ($n = 132$) according to the local EMS decision. Severe conditions such as shock or high Killip class (class 3/4) were more frequently observed in the tertiary emergency group than in the secondary emergency group. The GRACE risk score was significantly higher in the tertiary emergency group than the secondary emergency group, which reflected greater severity in the tertiary emergency group. The incidence of in-hospital death was higher in the tertiary emergency group than in the secondary emergency group, which was also confirmed by the multivariate logistic regression analysis. Our results suggest that the decision of EMS is reasonable to discriminate the highest-risk group from STEMI patients.

Table 1 Comparison of patient characteristics between the secondary emergency and the tertiary emergency

	All ($n=238$)	Secondary emergency ($n=106$)	Tertiary emergency ($n=132$)	p value
Age, year	68.2 ± 14.5	67.2 ± 14.6	68.9 ± 14.4	0.410
Male, n (%)	180 (75.6)	78 (73.6)	102 (77.3)	0.51
Body mass index	23.6 (21.7–26.0) ($n=230$)	24.3 (21.8–27.5) ($n=104$)	23.2 (21.6–24.8) ($n=126$)	0.015
Current smoker, n (%)	88 (37)	39 (36.8)	49 (37.1)	0.955
Hypertension, n (%)	176 (73.9) ($n=235$)	80 (75.5) ($n=105$)	96 (72.7) ($n=130$)	0.680
Diabetes mellitus, n (%)	90 (37.8)	50 (47.2)	40 (30)	0.008
Dyslipidemia, n (%)	116 (48.7)	59 (55.7)	57 (43.2)	0.056
Total cholesterol, mg/dL	169 (145–196) ($n=219$)	171 (144–203) ($n=100$)	169 (146–191) ($n=119$)	0.684
LDL cholesterol, mg/dL	102 (80–123) ($n=219$)	100 (80–127) ($n=101$)	105 (81–123) ($n=118$)	0.690
eGFR, mL/min/1.73 m^2	63.8 (46.4–78.2)	67.8 (46.4–79.8)	60.0 (44.5–75.8)	0.141
Lactate, mg/dL	25.8 (17.1–45.3) ($n=111$)	20.7 (15.2–29.2) ($n=47$)	36.0 (18.4–76.8) ($n=64$)	<0.001
Hemodialysis, n (%)	7 (2.9)	3 (2.3)	4 (3.8)	0.703
History of previous myocardial infarction, n (%)	15 (6.4) ($n=236$)	7 (6.6) ($n=106$)	8 (6.2) ($n=130$)	0.888
History of previous PCI, n (%)	24 (10.2) ($n=236$)	13 (12.3) ($n=106$)	11 (8.5) ($n=130$)	0.336
History of previous coronary artery bypass grafting, n (%)	0 (0) ($n=236$)	0 (0) ($n=236$)	0 (0) ($n=236$)	
History of previous cerebrovascular disease, n (%)	22 (9.3) ($n=236$)	13 (12.3) ($n=106$)	9 (6.9) ($n=130$)	0.160
History of previous heart failure, n (%)	22 (9.3) ($n=237$)	13 (12.3) ($n=106$)	9 (6.9) ($n=131$)	0.155
Killip class 1 or 2, n (%)	165 (69.3)	92 (86.8)	73 (55.3)	<0.001
Cardiac arrest at outside of hospital, n (%)	22 (9.2)	1 (0.9)	21 (15.9)	<0.001
Shock on admission, n (%)	54 (22.7)	11 (10.4)	43 (32.6)	<0.001
Systolic blood pressure at admission, mmHg	132.0 ± 36.6 ($n=233$)	141.7 ± 35.8 ($n=106$)	123.9 ± 35.5 ($n=127$)	0.001
Diastolic blood pressure at admission, mmHg	79.3 ± 21.9 ($n=233$)	83.5 ± 21.1 ($n=106$)	75.7 ± 22.0 ($n=127$)	0.024
Heart rate at admission, bpm	78.0 (61.3–93.8) ($n=234$)	78.0 (66.0–93.5) ($n=106$)	76.0 (59.0–116.0) ($n=128$)	0.349
Brain natriuretic peptide, pg/mL	64.8 (19.8–240.4) ($n=221$)	77.9 (20.4–251.5) ($n=99$)	54.2(17.6–198.6) ($n=122$)	0.469
Oxygen saturation (SpO_2) at admission, %	98.0 (96.0–100.0) ($n=226$)	98.0 (96.0–100.0) ($n=105$)	99.0 (96.0–100.0) ($n=121$)	0.128
Oxygen supply at admission, n (%)	139 (58.4)	45 (42.5)	94 (71.2)	<0.001
Ventilator support within 24 h after admission, n (%)	56 (23.5)	10 (9.4)	46 (34.8)	<0.001
Glasgow Coma Scale at admission	15.0 (14.0–15.0)	15.0 (15.0–15.0)	15.0 (12.0–15.0)	<0.001
Consciousness disorder at admission, n (%)	56 (23.5)	12 (11.3)	44 (33.3)	<0.001
Ventricular tachycardia before hospitalization, n (%)	4 (1.7)	1 (0.9)	3 (2.3)	0.630
Ventricular fibrillation before hospitalization, n (%)	13 (5.5)	1 (0.9)	12 (9.1)	0.006
GRACE Score	138 (108–167) ($n=232$)	134 (101–155) ($n=106$)	146 (118–188) ($n=126$)	<0.001
Left ventricular ejection fraction, %	51.2 (40.0–60.0) ($n=225$)	53.9 (42.5–61.7) ($n=100$)	50.2 (37.6–58.7) ($n=125$)	0.080
Medical therapy at admission				
Aspirin, n (%)	31 (13.6) ($n=228$)	15 (14.6) ($n=103$)	16 (12.8) ($n=125$)	0.699
Thienopyridine, n (%)	19 (8.3) ($n=228$)	9 (8.7) ($n=103$)	10 (8.0) ($n=125$)	0.841
Statin, n (%)	46 (20.2) ($n=228$)	22 (21.4) ($n=103$)	24 (19.2) ($n=125$)	0.686
Calcium channel blocker, n (%)	84 (36.8) ($n=228$)	37 (35.9) ($n=103$)	47 (37.6) ($n=125$)	0.794
ACE inhibitors or ARBs, n (%)	73 (32.0) ($n=228$)	36 (35.0) ($n=103$)	37 (29.6) ($n=125$)	0.389
Beta-blockers, n (%)	28 (12.3) ($n=228$)	16 (15.5) ($n=103$)	12 (9.6) ($n=125$)	0.174
Diuretics, n (%)	16 (7.0) ($n=228$)	7 (6.8) ($n=103$)	9 (7.2) ($n=125$)	0.905

Table 1 (continued)

	All ($n = 238$)	Secondary emergency ($n = 106$)	Tertiary emergency ($n = 132$)	p value
Oral antidiabetics, n (%)	46 (20.2) ($n = 228$)	24 (23.3) ($n = 103$)	22 (17.6) ($n = 125$)	0.286
Insulin, n (%)	15 (6.6) ($n = 229$)	7 (6.7) ($n = 104$)	8 (6.4) ($n = 125$)	0.920
Warfarin, n (%)	2 (0.8) ($n = 236$)	1 (0.9) ($n = 106$)	1 (0.8) ($n = 130$)	0.885
DOAC, n (%)	2 (0.8) ($n = 236$)	0 (0) ($n = 106$)	2 (1.5) ($n = 130$)	0.200

Data were expressed as mean $\pm$ SD, median (interquarter range), or numbers (percentages). A Student's t test was used for normally distributed continuous variables, and Mann–Whitney U test was used for abnormally distributed continuous variables. A Chi-square test was used for categorical variables

ACE angiotensin-converting enzyme, *ARB* angiotensin receptor blocker, *DOAC* direct oral anticoagulant, *eGFR* estimated glomerular filtration rate, *LDL* low-density lipoprotein, *PCI* percutaneous coronary intervention,

Although some studies compared the clinical outcomes of acute coronary syndrome between the secondary hospitals and the tertiary hospitals [13, 14], there were few studies comparing clinical outcomes of STEMI between the secondary emergency and the tertiary emergency, because the secondary emergency in our study was not identical to the secondary emergency hospital. Our intention was not to compare the clinical outcomes of STEMI between the secondary emergency hospitals and the tertiary emergency hospitals, but to compare the clinical outcomes of STEMI between the secondary emergency and the tertiary emergency, which was judged by the local EMS.

We should discuss why in-hospital death was more frequently observed in the tertiary emergency group than in the secondary emergency group. When patients complained chest pain, the criteria of the tertiary emergency were mostly based on the abnormal vital signs such as low blood pressure (< 90 mmHg). Since it is well known that shock was a strong determinant of in-hospital death in patients with STEMI [15–17], it is not surprising that STEMI patients with abnormal vital signs had worse clinical outcomes. Moreover, STEMI patients with low SpO_2 (< 90%) were also categorized to the tertiary emergency. STEMI patients with low SpO2 would be at least Killip class 3, which is also known as an established risk factor [18, 19].

Clinical implications of the present study should be noted. Since in-hospital death was more frequently observed in STEMI patients with tertiary emergency than in those with secondary emergency, the judgement by local EMS staffs might reflect the patient's severity. Although specific patient's characteristics such as age, sex, history of previous myocardial infarction, or LVEF were not different between the 2 groups, vital conditions such as systolic blood pressure or shock were significantly different between the 2 groups. Because vital conditions rather than detailed patient's background could easily be judged by the EMS providers, the current algorism focusing on vital conditions might be reasonable for selecting truly high-risk STEMI patients.

Study limitations

The present study has the following limitations. Since this study was a single-center, retrospective study, there were inherent selection biases. The judgement whether secondary or tertiary emergency depended on local EMS staff members. Although there was a guideline regarding the tertiary emergency [5], the judgement whether secondary or tertiary emergency depended on local EMS staff members. In other words, it was unknown whether local EMS staff members strictly obeyed the guideline regarding the tertiary emergency. The reasons why local EMS staffs judged as tertiary emergency were not specified. Furthermore, our study results would be influenced by the local emergency system in Saitama city. Recently, pre-hospital 12-lead ECG was introduced to some local emergency systems in Japan, and the impact of pre-hospital 12-lead ECG for patients with STEMI was reported in literatures [20, 21]. However, pre-hospital 12-lead ECG was not officially introduced to the local EMS in Saitama City during the study period. There were significant differences in the quality of care for patients with AMI between rural areas and metropolitan areas [22]. Our results may not be applicable to other areas in Japan, because our results could be justified only when equivalent pre-hospital judgments are made by the EMS providers in the other areas. In the multivariate logistic regression analysis, we could not enter all clinical variables, because the number of in-hospital death was 24 and the number of events per variable should be less than 10 [23, 24]. Therefore, our multivariate logistic regression analysis showed the association between tertiary emergency and in-hospital death after controlling age and gender rather than the determinants of in-hospital death in patients with STEMI.

Conclusions

As compared to the secondary emergency, the tertiary emergency was significantly associated with in-hospital death. Our results might validate the judgement of levels of emergency by local EMS staff members.

Table 2 Comparison of lesions and procedural characteristics between the secondary emergency group and the tertiary emergency group

	All (n = 238)	Secondary emergency (n = 106)	Tertiary emergency (n = 132)	p value
Underwent coronary angiography, n (%)	232 (97.5)	104 (98.1)	128 (97.0)	0.576
Number of narrowed coronary arteries				0.170
1, n (%)	117 (50.4) (n = 232)	57 (54.8) (n = 104)	60 (46.9) (n = 128)	
2, n (%)	64 (27.6) (n = 232)	30 (28.8) (n = 104)	34 (26.6) (n = 128)	
3, n (%)	51 (22.0) (n = 232)	17 (16.3) (n = 104)	34 (26.6) (n = 128)	
CTO in non-culprit arteries, n (%)	25 (10.8) (n = 232)	7 (6.7) (n = 104)	18 (14.1) (n = 128)	0.089
Revascularization strategy to the culprit lesion				0.356
PCI, n (%)	220 (92.4)	101 (95.3)	119 (90.2)	
Coronary artery bypass grafting, n (%)	2 (0.8)	1 (0.9)	1 (0.8)	
Medication, n (%)	16 (6.7)	4 (3.8)	12 (9.1)	
Infarct-related artery				0.663
Left main trunk–left anterior descending artery, n (%)	119 (50.0)	54 (50.9)	65 (49.6)	
Left circumflex artery, n (%)	24 (10.1)	12 (11.3)	12 (9.1)	
Right coronary artery, n (%)	87 (36.6)	38 (35.8)	49 (37.1)	
Not determined, n (%)	8 (3.4)	2 (1.9)	6 (2.5)	
Initial TIMI flow grade				0.514
0, n (%)	140 (60.3) (n = 232)	58 (55.8) (n = 104)	82 (64.1) (n = 128)	
1, n (%)	23 (9.9) (n = 232)	10 (9.6) (n = 104)	13 (10.2) (n = 128)	
2, n (%)	37 (15.9) (n = 232)	20 (19.2) (n = 104)	17 (13.3) (n = 128)	
3, n (%)	32 (13.8) (n = 232)	16 (15.4) (n = 104)	16 (12.5) (n = 128)	
Final TIMI flow grade				0.405
0, n (%)	3 (1.3) (n = 232)	0 (0) (n = 104)	3 (1.3) (n = 128)	
1, n (%)	2 (0.9) (n = 232)	1 (1.0) (n = 104)	1 (0.8) (n = 128)	
2, n (%)	17 (7.3) (n = 232)	9 (8.7) (n = 104)	8 (6.3) (n = 128)	
3, n (%)	210 (90.5) (n = 232)	94 (90.4) (n = 104)	116 (90.6) (n = 128)	
Approach site				0.338
Radial, n (%)	165 (71.1) (n = 232)	79 (76.0) (n = 104)	86 (67.2) (n = 128)	
Brachial, n (%)	3 (1.3) (n = 232)	1 (1.0) (n = 104)	2 (1.6) (n = 128)	
Femoral, n (%)	64 (27.6) (n = 232)	24 (23.1) (n = 104)	40 (31.3) (n = 128)	
Size of guide catheter				0.010
6Fr, n (%)	168 (72.4) (n = 232)	84 (80.8) (n = 104)	84 (65.6) (n = 128)	
7Fr, n (%)	64 (27.6) (n = 232)	20 (19.2) (n = 104)	44 (34.4) (n = 128)	
≥ 8Fr, n (%)	0 (0) (n = 232)	0 (0) (n = 104)	0 (0) (n = 128)	
Door to balloon time, min	70.0 (57.5–96.3) (n = 215)	70.5 (55.5–93.5) (n = 100)	69.0 (59.3–99.0) (n = 115)	0.883
Door to balloon time (within 180 min data only), min	69.0 (57.0–93.0) (n = 201)	69.0 (54.5–85.5) (n = 91)	68.5 (58.8–97.5) (n = 110)	0.427
Final PCI Procedure				0.260
POBA, n (%)	10 (4.5) (n = 220)	4 (4.0) (n = 101)	6 (5.0) (n = 119)	
Thrombectomy, n (%)	1 (0.5) (n = 220)	1 (1.0) (n = 101)	0 (0) (n = 119)	
Thrombectomy and POBA, n (%)	2 (0.9) (n = 220)	0 (0) (n = 101)	2 (1.7) (n = 119)	
Drug-coated balloon, n (%)	2 (0.9) (n = 220)	0 (0) (n = 101)	2 (1.7) (n = 119)	
Drug eluting stent, n (%)	197 (89.5) (n = 220)	94 (93.1) (n = 101)	103 (86.6) (n = 119)	
Bare-metal stent, n (%)	5 (2.3) (n = 220)	2 (2.0) (n = 101)	3 (2.5) (n = 119)	
Wire did not cross the lesion, n (%)	3 (1.4) (n = 220)	0 (0) (n = 101)	3 (2.5) (n = 119)	
IABP support, n (%)	33 (13.9)	12 (11.3)	21 (15.9)	0.309
VA-ECMO support, n (%)	25 (10.5)	4 (3.8)	21 (15.9)	0.002
Temporary pace maker support, n (%)	15 (6.3)	8 (7.5)	7 (5.3)	0.479

Data were expressed as median (interquarter range) or numbers (percentages). A Mann–Whitney U test was used for abnormally distributed continuous variables. A Chi-square test was used for categorical variables

CAG coronary angiography, *CTO* chronic total occlusion, *IABP* intra aortic balloon pumping, *PCI* percutaneous coronary intervention, *POBA* plain old balloon angioplasty, *VA –ECMO* veno-arterial extracorporeal membrane oxygenation

Table 3 Comparison of clinical outcome between the secondary emergency group and the tertiary emergency group

All events	All ($n=238$)	Secondary emergency ($n=106$)	Tertiary emergency ($n=132$)	p value
Peak CK, U/L	1943 (984–3753) ($n=237$)	1873 (889–3632) ($n=106$)	1983 (1151–4078) ($n=131$)	0.724
Peak CK-MB, U/L	187.0 (71.5–382.5) ($n=237$)	180.5 (72.8–343.8) ($n=106$)	197.0 (69.0–402.0) ($n=131$)	0.605
Length of hospital stay, day	6.0 (4.0–10.0)	6.0 (4.0–9.3)	6.0 (4.0–10.0)	0.694
Length of CCU stay, day	2.0 (1.0–3.0)	1.0 (1.0–2.0)	2.0 (1.0–4.0)	0.143
In-hospital death, n (%)	24 (10.1)	5 (4.7)	19 (14.4)	0.014

Data were expressed as median (interquarter range) or numbers (percentages). A Mann–Whitney U test was used for abnormally distributed continuous variables. A Chi-square test was used for categorical variables

CCU cardiac care unit, *CK* creatine kinase

Table 4 Multivariate logistic regression model to find the association between the tertiary emergency and in-hospital death

Dependent variable: In-hospital death	Odds ratio	95% confidence interval	p value
Independent variables			
Tertiary emergency (reference: secondary emergency)	3.52	1.24–10.02	0.018
Age (1-year increase)	1.03	0.99–1.07	0.065
Male gender (reference: female gender)	0.43	0.17–1.13	0.087

All variables were simultaneously adjusted in one step

Compliance with ethical standards

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