MEDICAL SCIENCE MONITOR

CLINICAL RESEARCH

e-ISSN 1643-3750
© Med Sci Monit, 2017; 23: 1055-1063
DOI: 10.12659/MSM.902466

Received: 2016.11.21
Accepted: 2017.01.02
Published: 2017.02.27

Improved Survival of Patients with ST-Segment Elevation Myocardial Infarction 3–6 Hours After Symptom Onset Is Associated with Inter-Hospital Transfer for Primary Percutaneous Coronary Intervention (PCI) at a Large Regional ST-Segment Elevation Myocardial Infarction (STEMI) Program *vs.* In-Hospital Thrombolysis in a Community Hospital

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
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Source of support: Departmental sources

Background: This study sought to compare the 30-day and 1-year survival of patients diagnosed with ST-segment elevation myocardial infarction (STEMI), whose symptom onset to in-hospital first medical contact (IHFMC) was 3–6 h, who received either in-hospital thrombolysis (IHT) in the nearest county hospital or direct transfer to a larger hospital in Henan province, China for primary percutaneous coronary intervention (PPCI).

Material/Methods: Patients were allocated into 2 groups: one group received IHT in the local county hospital, whereas the other group were transferred to the PCI centers to receive PPCI. Patient demographic data, baseline characteristics, and time between different stages of patient contact to the initiation of treatment for IHT or PPCI were recorded for analysis.

Results: No significant difference was identified between the 2 groups with the baseline characteristics and demographic data. The all-cause mortality was not significantly different between the IHT and PPCI group at 30 days (13.0% *vs.* 9.9%, p=0.386). However, a significant difference in mortality between the IHT and PPCI group was observed at 1 year (23.4% *vs.* 14.1%, p=0.035). Inter-hospital transfer time for PPCI tended to be the independent predictor for survival (OR: 4.4 CI 95%: 1.9–14.5, p 0.001). Overall, the patients undergoing PPCI in inter-hospital transfer had a higher survival rates for 1 year compared with patients receiving IHT.

Conclusions: Despite the delay associated with inter-hospital transfer for PPCI, patients with STEMI 3–6 h after symptom onset have improved survival with PPCI over patients treated locally with IHT.

MeSH Keywords: **Percutaneous Coronary Intervention • Survival Rate • Thrombolytic Therapy**

Full-text PDF: http://www.medscimonit.com/abstract/index/idArt/902466

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Background

Coronary heart disease is the leading cause of death globally, with myocardial infarction a common manifestation of this disease. It is estimated that there are about 230 million people in China with cardiovascular disease, including 200 million with hypertension, 7 million with stroke, 2 million with myocardial infarction, and 4.2 million with heart failure. A study in China in 2008 indicated that the mortality rate of coronary heart disease in urban residents was about 91.41 per 100 000, compared with 51.89 per 100 000 in rural residents [1]. In recent years, advanced therapies for coronary heart disease have been developing continuously. Patients with ST-segment elevation myocardial infarction (STEMI) require urgent revascularization as well as aggressive antiplatelet and antithrombotic pharmacotherapy [2]. If these most appropriate treatments are offered within the shortest possible time from symptom onset, it will dramatically improve clinical outcome compared with conservative treatment strategies. Unfortunately, only a minority of patients receive all guideline-indicated therapies within the recommended timeframes, which leads to some unacceptably long delays to treatment reported in real-world registries [3].

Primary percutaneous coronary intervention (PPCI) is the preferred reperfusion strategy for STEMI when performed within 90–120 min from the first medical contact and performed by a person skilled in the procedure [4,5]. However, many hospitals do not have resources to provide PPCI for patients, thus a large proportion of STEMI patients are transferred for PPCI in bigger hospitals, which leads to substantial time delays to reperfusion compared with the patients who receive on-site fibrinolytic therapy [6–8]. Transferring for PPCI involves a longer delay to treatment, which leads to a potential loss of benefit, compared with receiving IHT in the local county hospital. From the patient's perspective, the delay between symptom onset and provision of reperfusion therapy (either starting fibrinolysis or transferring for PPCI) is possibly the most important, since it reflects total ischemic time. It should be reduced as much as possible.

Thus, there is a need to understand the effect of treatment delays associated with duration of transfer from inpatient contact through inter-hospital transfer for PPCI with respect to patient survival. As for the geographical and traffic limitations in our area, the STEMI patients with time from symptom onset to IHFMC 3–6 h accounts for approximately 40% of STEMI patients in our hospitals. Research on treatment and prognosis of these STEMI patients has received little attention. Therefore, the primary objective of this study was to investigate differences in 30-day and 1-year mortality of STEMI patients whose time from symptom onset to in-hospital first medical contact (IHFMC) was 3–6 h who received IHT in a local county hospital *vs.* those treated with PPCI via inter-hospital transfer to the Emergency Cardiac Center of Henan Province People's Hospital.

Material and Methods

Study design and patient population

The study was designed to compare the prognosis and survival of STEMI patients who received IHT with those who declined IHT and opted for inter-hospital transfer for PPCI and thus having longer time to treatment. From January 2012 to January 2013, 998 patients were identified as STEMI patients after screening from 6 county hospitals affiliated to Zhengzhou city. Of these, STEMI patients with symptom onset to IHFMC beyond 3 h but within 6 h were enrolled in the study. These patients either received IHT in the local county hospital or they rejected IHT and were brought to the PCI center within 3 h for PPCI (Figure 1). A total of 653 patients were excluded from the study because symptom onset to IHFMC was less than 3 h or more than 6 h. In total, 332 patients met the 3–6 h criterion, of whom 13 were excluded because they had contraindications for IHT or refused to receive IHT and were transferred for PPCI. A total of 333 STEMI cases were taken up for the analysis, comprising 192 patients in the IHT group and 141patients in the transferred PPCI group.

Definitions

Patients with STEMI were defined as having continuous ischemic symptoms for at least 30 min with the following electrocardiographic changes: ST-segment elevation ≥2 mm in 2 continuous precordial leads or ≥1 mm in 2 limb leads, extensive ST-segment depression in the precordial leads representing posterior myocardial infarction with confirmatory posterior circulation infarction, and subsequent cardiac enzyme (troponin or CK-MB) elevation >2-fold of the normal upper limit [8]. Symptom onset was defined as the time observed by the patient or bystanders of the onset of the presenting symptoms (e.g., chest pain, dyspnea, cardiac arrest). First medical contact (FMC) was defined as when the paramedics arrived. In-hospital first medical contact (IHFMC) was defined as the time when in-hospital doctors were at the patient's side.

Time intervals

We identified several time points during the process: symptom onset, first medical contact, IHFMC, diagnosis, providing consent, start of therapy, and reperfusion time. Five time periods were recorded: time from symptom onset to first medical contact was recorded as Period 1; time from first medical contact to diagnosis was recorded as Period 2; time from

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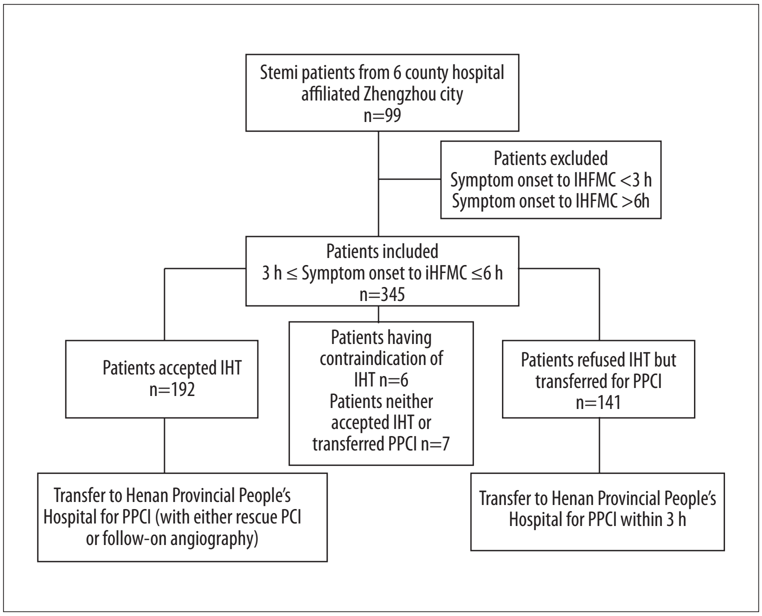

Figure 1. Study population. STEMI – ST-segment elevation myocardial infarction; PCI – percutaneous coronary intervention; IHFMC – in-hospital first medical contact; IHT – in-hospital thrombolysis; PPCI – primary percutaneous coronary intervention.

diagnosis to providing consent was recorded as Period 3; time from providing consent to beginning of treatment was recorded as Period 4; and time from beginning time of treatment to patency was recorded as Period 5. The times of each enrolled patient were recorded for further analyses.

Data collection

The demographic data, transfer modality, time segments, clinical status, and in-hospital outcomes in both patient groups were prospectively recorded. Details related to reperfusion procedures and 30-day and 1-year survival were tracked prospectively in all the referring county hospitals and the Emergency Cardiac Registry of Henan Provincial People's Hospital. All patients provided written informed consent. This study was conducted after approval from the Ethics Committee of Henan Province People's Hospital.

Statistical analysis

Categorical data are represented with frequencies and percentages and were analyzed by chi-square tests. Continuous variables are described as mean ±SD or median and interquartile range, and were analyzed by the *t* test or Wilcoxon rank-sum test. To examine the association of treatment strategy and mortality, multivariate logistic regression was used to assess its relation with 30-day mortality, and its relation with 1-year mortality was assessed by the Cox proportional hazards model. Covariates significantly associated with mortality in univariate analysis were considered in the multivariable logistic regression analysis and the Cox proportional hazards model. All p values were 2-tailed, and a p value <0.05 was considered significant. All data were analyzed using SPSS 16.0 software (SPSS Inc., Chicago, USA).

Results

The baseline characteristics and demographic data (age, sex, smoking, hypertension, diabetes, and dyslipidemia) of the 2 groups are presented in Table 1. Although the patients in the inter-hospital transfer group tended to be older and male with a past history of transient ischemic attack or stroke, the differences were not statistically significant. Similar patterns with regard to cardiovascular risk factors, diabetic status, cardiovascular history, territory of STEMI, and number of diseased vessels were observed in both groups. No significant difference was observed in the number of patients complicated with cardiac arrest requiring ventilation, congestive heart failure, or cardiogenic shock.

Time intervals

No significant difference was observed between the 2 groups in the symptom-to-IHFMC time (265±52 *vs.* 271±52 min, p=0.288) and diagnosis time (15.0±3.0 *vs.* 14.9±3.1 min, p=0.713) (Table 2). In the IHT group, time of providing consent, preparation time, and time from beginning of IHT to patency were 68±17 min, 23±5 min, and 60±8 min, respectively. The mean transport time from the primary county to the key hospital for PPCI was 124±36 min. In the inter-hospital transfer group, the time from admission to consent for PPCI, PPCI preparation time, and time from beginning of PPCI to patency were 30±11 min, 20±6 min, and 45±15 min, respectively. No significant difference was seen in the total ischemic time between the inter-hospital transfer group (452±63 min) and the IHT group (483±67 min).

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Table 1. The baseline characteristics and demographic data of the two groups.

Characteristics	IHT group (n=192)		Inter-hospital transfer group (n=141)		P value
Age, yrs	59.4±11.0		61.3±11.6		0.58
Male	118	(61.4%)	95	(67.4%)	0.27
Systolic blood pressure, mm Hg	130	(105–150)	132	(108–151)	0.33
Serum creatinine, mmol/l (IQR)	88	(74–110)	94	(71–113)	0.46
Current smoker	80	(41.7%)	61	(43.3%)	0.77
Hypertension	117	(60.9%)	88	(61.9%)	0.79
Diabetes mellitus	47	(24.4%)	32	(22.7%)	0.71
Hypercholesterolemia	90	(46.9%)	67	(47.5%)	0.91
Prior MI	27	(14.1%)	22	(15.6%)	0.70
Prior PCI	21	(10.9%)	18	(12.8%)	0.61
Prior CABG	9	(4.7%)	4	(2.8%)	0.57
History of TIA/stroke	17	(8.9%)	15	(10.6%)	0.59
Peripheral arterial disease	7	(3.6%)	6	(4.3%)	0.78
Pre-hospital arrest requiring ventilation	15	(7.8%)	8	(5.8%)	0.45
Congestive heart failure	7	(3.6%)	6	(4.3%)	0.78
Cardiogenic shock at presentation	10	(5.2%)	8	(5.7%)	0.85
LVEF < 40%	35	(18.2%)	27	(19.1%)	0.83
Anterior MI	87	(45.3%)	55	(39.0%)	
Number of diseased vessels					
1-vessel disease	72	(37.5%)	52	(36.9%)	0.91
2-vessel disease	61	(31.8%)	47	(33.3%)	0.76
3-vessel disease	45	(23.4%)	31	(22.0%)	0.76
Left main disease	8	(4.2%)	6	(4.3%)	0.68
No disease	6	(3.1%)	5	(3.5%)	0.82

Survival

Reperfusion was achieved in 139 patients (139/192, 72.4%) in the IHT group, while in the PPCI group, 136 patients achieved reperfusion (136/141, 96.5%). The complications of patients in the 2 groups were as follow. Among 192 patients in the IHT group, 4 patients had fatal bleeding symptoms (2 were cerebral hemorrhage and 2 were upper gastrointestinal bleeding), 2 patients had stroke symptom (cerebral bleeding), and 2 patients had reinfarction symptom. Among 141 patients in the PPCI group, 3 patients had fatal bleeding symptoms (1 was retroperitoneal hemorrhage, 1 was cerebral bleeding, 1 was upper gastrointestinal bleeding), 1 patient had stroke (cerebral bleeding), 1 patient had stent thrombosis symptoms, 1 patient had coronary dissection tear symptoms, and no patients had reinfarction symptoms. The all-cause mortality in the IHT group and inter-hospital transfer group with PPCI at 30 days (13.0% *vs.* 9.9%, p=0.386) were not significantly different. However, mortality in the IHT group and inter-hospital transfer group with PPCI at 1 year showed a significant difference (23.4% *vs.* 14.1%, p=0.035) (Figure 2). Survival curves between the IHT group and inter-hospital transfer group with PPCI for 30 days showed no significant difference because the divergence level was low (Figure 3). However, differences in survival curves between the IHT group and inter-hospital transfer group with PPCI for 1 year showed significant differences,

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Table 2. Time interval of the two groups from symptom onset to receiving IHT or PPCI.

Time interval (mins)	IHT group (n=192)	Inter-hospital transfer group (n=141)	P value
Symptom-to-IHFMC time	265±52	271±52	0.288
IHFMC – Needle time	158±26		
Diagnosis time	15.0±3.0	14.9±3.1	0.713
Providing consent time	68±17		
Thrombolysis preparation time	23±5		
Time from the beginning of IHT to the patency	60±8		
IHFMC – balloon time	179±85		
Transport time		124±36	
Time from admission to permission of PPCI		30±11	
PPCI preparation time		20±6	
Time from the beginning of PPCI to the patency		45±15	
Total ischemic time	452±63	483±67	0.373

IHFMC – in-hospital first medical contact; PPCI – primary percutaneous coronary intervention; STEMI – ST-segment elevation myocardial infarction; IHT – in-hospital thrombolysis.

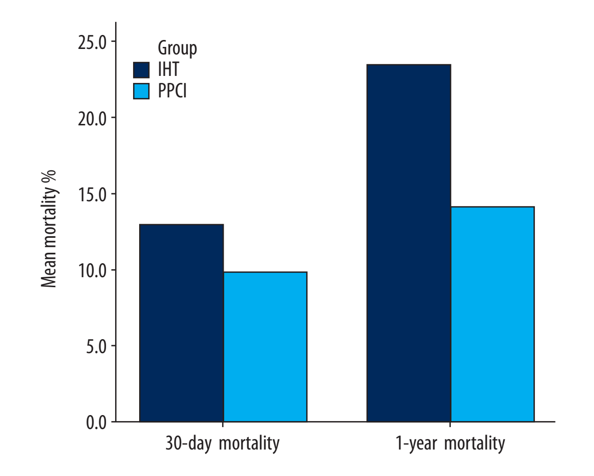

Figure 2. Mortality level in the IHT group and inter-hospital transfer group with PPCI at 30 days and 1 year.

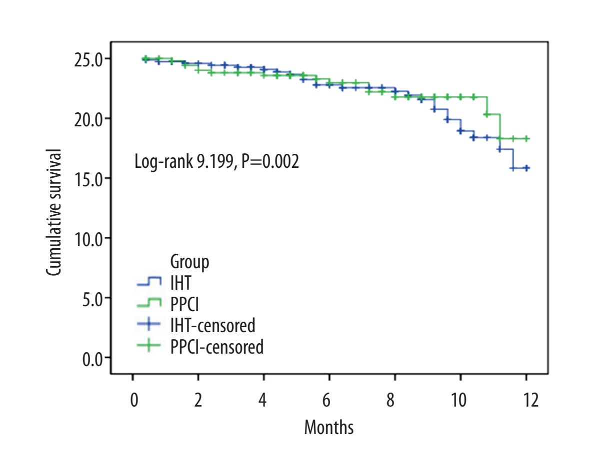

Figure 3. Thirty-day survival curves in the IHT group and inter-hospital transfer group with treated with PPCI.

with higher divergence level (Figure 4). Overall, the patients undergoing PPCI, even with inter-hospital transfer, had higher survival rate for 1 year compared with patients receiving IHT.

Analysis of the predictors for 30-day and 1-year mortality

Multivariate analysis of the factors associated with the mortality at 30-day and 1-year mortality are shown in Tables 3 and 4. According to the results of the multivariate analysis, we used univariate analysis to reveal univariate predictors for 30-day and 1-year mortality after ST-Segment Elevation MI (Tables 5 and 6). Cardiogenic shock and cardiac arrest requiring ventilatory support were the 2 strongest predictors for mortality in this population at 30 days and 1 year. Importantly, prior TIA or stroke remained a significant factor associated with mortality at 30 days (OR: 8.8, 95% CI: 2.9–26.7, p<0.001) and at 1 year (OR: 14.2, 95% CI: 3.3–39.7, p=0.000). Left ventricular ejection fraction (40%) (OR: 4.3, 95% CI: 2.1–11.4, p=0.004) and prior history of myocardial infarction (OR: 1.7, 95% CI: 1.0–3.2, p<0.001) were still independent predictors for lower

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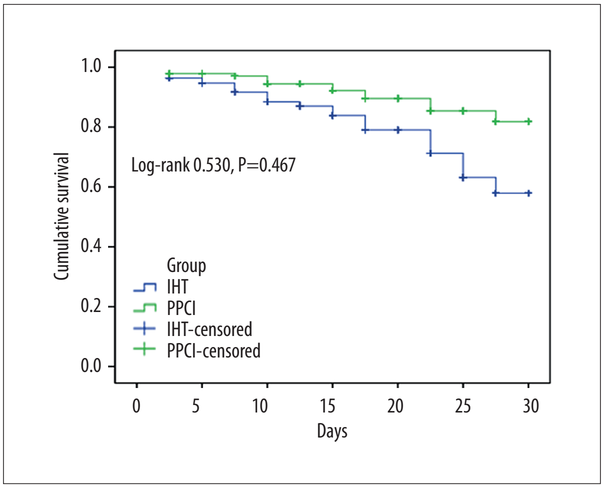

Figure 4. One-year survival curves in the IHT group and inter-hospital transfer group treated with PPCI.

Table 3. Results of separate age, gender, coronary risk factor and stent type adjusted logistic regression models with 30-day mortality after ST-segment elevation MI.

Variable	OR (95%CI)	P value
Group	0.96 (0.32–2.81)	0.467
Age (years)	0.84 (0.81–1.06)	0.227
Gender (male)	1.79 (0.58–9.21)	0.513
Hypertension	1.52 (1.18–3.03)	0. 430
Diabetes mellitus	1.90 (1.11–3.36)	0.037
Hypercholesterolemia	2.01 (1.30–4.40)	0.280
Serum creatinine, mmol/l (IQR)	1.21 (1.06–2.42)	0.143
Current smoking	1.42 (0.56–2.14)	0.516
Prior MI	1.33 (1.08–1.68)	0.112
Prior CABG	0.75 (0.43–2.12)	0.075
History of TIA/stroke	1.10 (1.06–2.47)	0.005
PAD	2.3 (2.0–3.2)	
Pre-hospital arrest requiring ventilation	1.6 (1.4–2.5)	0.005
Cardiogenic shock at presentation	3.6 (3.4–4.2)	0.017
LVEF <40%	1.5 (1.2–2.0)	0.009
Anterior MI	0.8 (0.76–0.85)	0.451
Multivessel or left main diseases	1.9 (1.0–3.7)	0.003

Table 4. Results of separate age, gender, coronary risk factor and stent type adjusted logistic regression models with 1-year mortality after ST-segment elevation MI.

Variable	OR (95%CI)	P value
Group	1.73 (1.69–1.86)	0.020
Age (years)	0.97 (0.91–1.55)	0.525
Gender (male)	1.35 (0.42–4.21)	0.626
Hypertension	2.50 (2.21–3.12)	0.912
Diabetes Mellitus	1.78 (1.42–3.44)	0.886
Hypercholesterolemia	0.51 (0.48–0.77)	0.108
Serum creatinine, mmol/l (IQR)	2.33 (2.30–3.02)	0.713
Current smoking	1.11 (0.93—2.37)	0.667
Prior MI	2.56 (2.52—3.38)	0.540
Prior CABG	0.88 (0.83–1.12)	0.108
History of TIA/stroke	1.37 (1.22–2.01)	0.025
PAD	2.30 (2.0–3.2)	
Pre-hospital arrest requiring ventilation	2.96 (2.91–3.24)	0.000
Cardiogenic shock at presentation	2.89 (2.77–3.66)	<0.001
LVEF <40%	4.01 (3.98–4.13)	0.018
Anterior MI	0.61 (0.57–0.89)	0.153
Multivessel or left main diseases	2.38 (2.22–3.18)	<0.001

mortality at 30 days but not at 1 year. Inter-hospital transfer time for PPCI was an independent predictor for survival (OR: 4.4, CI 95%: 1.9–14.5, p=0.001).

Discussion

Previous studies demonstrated that PPCI was superior to thrombolysis in terms of reinfarction, stroke, and death. However, these advantages may be lost due to the delay of treatment when transporting patients to a primary percutaneous coronary intervention center. Time to treatment is a key factor for survival, not only for thrombolysis therapy but also for primary angioplasty. In this study, we retrospectively analyzed STEMI patients with symptom onset to IHFMC beyond 3 h but within 6 h who received IHT in the local county hospital and compared them to those who accepted inter-hospital transfer for PPCI in Henan Province, China. Patients who received IHT in the local county hospital or PPCI after inter-hospital transfer

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Table 5. Univariate predictors for 30-day mortality after ST-segment elevation MI.

	OR (95%CI)		P value
Prior TIA or stroke	8.8	(2.9–26.7)	<0.001
Pre-hospital arrest requiring ventilation	7.9	(2.4–25.4)	0.001
Cardiogenic shock at presentation	7.7	(2.1–19.4)	0.000
Multivessel or left main disease	4.4	(1.6–11.8)	0.003
LVEF <0.40	4.3	(2.1–11.4)	0.004
Anterior MI	2.1	(1.2–3.7)	0.029
Diabetes mellitus	1.9	(1.1–3.3)	0.037
Prior MI	1.7	(1.0–3.2)	<0.001
Hypertension	1.5	(1.1–3.0)	0.043
Age(per year)	1.06	(1.02–1.08)	0.021

had similar patterns of cardiovascular risk factors, past cardiovascular history, diabetic status, number of diseased vessels, and territory of STEMI. There were no differences in number of cases complicated by cardiac arrest requiring ventilatory support, congestive heart failure, and cardiogenic shock between the 2 groups. The bleeding complication rate was higher in the IHT group than in the PPCI group. In the IHT group, there were 4 patients with fatal bleeding and 13 patients with nonfatal bleeding (e.g., gums bleeding, small hemoptysis, nasal bleeding, and urinary and reproductive tract bleeding), and in the PPCI group there were 4 patients with fatal bleeding and 4 patients with nonfatal bleeding; the rate was 8.9% in the IHT group and 5.0% in the PPCI group. Patients undergoing PPCI in the inter-hospital transfer group had a higher survival rate at 1 year compared with patients receiving IHT, but no significant difference was found at 30 days. The outcome of the 2 treatment strategies had no significant difference at 30 days, mainly because complications in the 2 groups were similar. In addition, both treatments guarantee blood perfusion, and the patients were mostly convalescing and resting, so the survival outcomes were not significantly different. However, with increasing activity over time, patients who received PPCI treatment had better activity endurance than the patients treated with IHT. The recurrence rate of angina pectoris or myocardial infarction of patients in the PPCI group was lower than that in the IHT group. Thus, 1-year outcomes in the PPCI treatment group were better than in the IHT group. To the best of our knowledge, this is the first time that PPCI involving inter-hospital transfer has been shown to be an independent predictor for survival after STEMI.

Table 6. Univariate predictors for 1-year mortality after ST-segment elevation MI.

Variable	OR (95%CI)		P value
Pre-hospital arrest requiring ventilation	18.0	(5.2–62.7)	0.000
Cardiogenic shock at presentation	15.6	(3.3–39.7)	0.000
Prior TIA or stroke	14.2	(4.4–45.9)	0.000
PAD	8.6	(1.6–47.4)	0.013
LVEF <0.40	8.0	(2.7–23.4)	0.007
Multivessel or left main disease	6.6	(2.6–16.5)	0.000
Inter-hospital transferred PPCI	4.4	(1.9–14.5)	0.001
Anterior MI	3.7	(1.5–11.8)	0.044
Diabetes mellitus	2.4	(1.1–6.7)	0.004
Hypertension	1.9	(1.0–5.8)	0.003
Prior MI	1.4	(1.0–3.8)	0.005
Age (per year)	1.04	(1.02–1.06)	0.017

In treating patients with STEMI, PPCI is more commonly used than IHT. According to North American and European guidelines (Class IA), primary PCI should be preferred to thrombolysis, provided that patients undergo PCI within 120 min of first medical contact [9,10]. A prospective cohort study reported that, compared with IHT and PHT, PPCI was associated with reduced duration of hospital stay, reinfarction, and mortality in 26 205 patients with STEMI [11]. Similar results have also been reported in other studies [12], although not in all registry studies [13–15]. These results are also consistent with the results of other studies [16,17] and the Danish Trial in Acute Myocardial Infarction [18], showing that PPCI has a better outcome than thrombolysis in terms of delay times of up to at least 3–4 h. Consistent with the results of several previous reports, our study found that the effects of reperfusion treatment depend on the treatment delay, but the loss in benefit with longer delay is less obvious and appears later with PPCI than with thrombolysis. In some cases, post-procedural bleeding events were associated with an increased risk of in-hospital mortality in PCI, and an estimated 12.1% death rate related to bleeding complications occurs in the U.S. [19] New antithrombin therapy has been shown to reduce periprocedural bleeding after PPCI, and the radial approach in PPCI was associated with a significantly lower incidence of major bleeding [20,21].

Although patients in the inter-hospital transfer group were older (61.3±11.6 years), more likely to be male, and have a history

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of transient ischemic attack or stroke, the overall 1-year survival rate for PPCI was higher than with IHT. In the Senior PAMI trial, 481 patients who were older than 70 years and who had STEMI (>12 h of symptoms) were randomly divided to PCI versus fibrinolytic therapy. Results demonstrated a 36% reduction in death or nonfatal stroke (11.3% PCI *vs.* 13% thrombolytic therapy, p=0.57), while a significant 55% reduction in death, stroke, or reinfarction favoring PCI (11.6% PCI *vs.* 18% thrombolytic therapy, p<0.05) was observed [22]. PPCI tends to be more effective for older patients in terms of survival [23].

Inter-hospital transfer time for PPCI was an independent predictor for survival (OR: 4.4 CI 95%: 1.9–14.5, p 0.001) in the present study, and shows that PPCI is a better treatment for these patients. However, other studies in which STEMI patients with a treatment strategy of emergency aggressive reperfusion therapy with primary PCI showed that more patients in the traditional inter-hospital transfer died during the first year after the event, and this may be related to the long symptom-to-balloon time [24,25]. In another regional STEMI program using a contemporary primary PCI strategy, patients who were transferred directly to the PCI center via pre-hospital triage strategy had a significantly lower mortality at 30 days and at 1 year when compared with inter-hospital transfer patients. The authors indicated that a direct transfer strategy is an independent predictor for 1-year survival after STEMI when considering other important risk factors, including patient age, left ventricular ejection fraction, pre-hospital cardiac arrest, and cardiogenic shock [26]. Our study confirms that cardiogenic shock, cardiac arrest requiring ventilation, and prior TIA or stroke were the strongest predictors for mortality in this population at 30 days and 1 year. Another 2 factors – prior history of myocardial infarction and left ventricular ejection fraction – are also independent predictors for lower mortality at 30 days but not at 1 year. This was similar to earlier reports [26].

Findings of our study suggest that, in the present economic and medical circumstances in Henan Province, China, patients with STEMI generally arrive at local hospitals without a PCI center after a relatively long time, so transfer PPCI would be a better alternative. However, persistent improvement is needed to shorten the reperfusion time. To achieve this, we recommend reinforcing public health education, expanding scientific knowledge, enhancing medical skill and technique of medical staff, and setting up extensive emergency rescue systems. Establishing and maintaining interactive affiliations among the county hospitals, municipal hospitals, and provincial hospitals through mobile networks or interactive communication equipment will help provide better patient care. The physician's communication skills play a key role in shortening reperfusion time. All these problems should be solved through deepening the healthcare reform and improving the doctor-patient relationships and the quality of medical technology. Thus, based on China's national conditions, it is not currently possible to use the door-to-balloon time. Therefore, some revisions of China's STEMI guidelines should be made to improve actual working conditions in various aspects, including the clinical, research, and policy formulation in this field, just to meet the requirements of this specialty.

Study limitations

As this was not a randomized controlled study, there could have been selection bias in patient assignment to groups. This study aimed to investigate the reperfusion time of patients with STEMI in a definite time period only performed in a few county hospitals in Henan Province. Our results may have been affected by cultural, geographical, medical resources, and economic conditions. Overall, the primary percutaneous coronary intervention time of STEMI patients was likely to be longer than that in developed countries, mainly due to pre-hospital delay, inter-hospital transfer time, consent delay, and medical cost delay.

Conclusions

In summary, patients undergoing PPCI for STEMI with symptom onset to IHFMC times of 3–6 h via inter-hospital transfer had better 1-year survival than those with IHT in the regional STEMI program. Our study also provides insights into the challenges in caring for STEMI patients in rural areas. It is important to create more PCI centers in smaller hospitals to improve the overall health of patients in the region.

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