Original Article
Study of emergency disposal model on acute myocardium infarction-inverse transportation between county hospital and regional health center

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Abstract: Objective: To explore the emergency treatment model for interventional treatment of acute myocardium infarction in county hospital, and evaluate the safety, effectiveness and feasibility of emergency percutaneous coronary intervention (PCI). Methods: From September 2002 to September 2008, there were a total of 126 cases of acute myocardial infarction for the local PCI treatment by interventional cardiologist (transport doctor). In these cases, 69 men and 57 women with the mean age of 66.3±3.5 years old (ranging from 28 to 83 years old), meanwhile, 83 cases anterior wall myocardial infarction and 43 cases inferior wall myocardial infarction (15 cases with right ventricular infarction) with onset time of 2-12 h and the mean time of 5.8±1.1 h. Results: There were 126 cases accepted CAG, of which 3 cases triple vessel lesion were suggested for CABG, 1 case extensive anterior wall myocardial infarction with Tako-tsubo ardiomyopathy as final diagnosis, without vascular lesions but cuttlefish ball-like occurred in left ventriculography. 3 cases presented thrombosis autolysis, and another 2 cases of surgical failure. The rest 117 cases were all treated with PCI, and the success rate reached 98.3%. There were 8 cases suffered surgery peri operative period cardiac events, and 4 cases deaths (3.4%) occurred after the procedure. Conclusions: Inverse transportation model is significantly effective to treat acute myocardium infarction, which can provide support for the organization and technology for acute heart interventional treatment during the initial period in county hospital.

Keywords: Acute myocardium infarction, percutaneous transluminal coronary angioplasty, heart intervention model, inverse transportation

Introduction

Acute myocardium infarction is one of the most common causes of sudden death which can result in sudden chest pain. 10%-20% patients die outside the hospital, and the natural death rate of 15%-20% for those go to hospital [1]. The key procedures of decreasing mortality are pre-hospital care and timely and effective revascularization, that early intravenous thrombolytic and/or emergency coronary angiography, and primary stent implantation (PCI). In 2007, American ACC/AHA acute myocardium infarction guide reported that, the ideal time to reperfusion therapy was within 2 h after the onset of disease [2]. FAST-MI and the latest meta-analysis indicated that, it is most effective to take coronary angiography and PCI after 2-24 h receiving thrombolytic treatment for

STEMI patients [3, 4]. Meta-analysis found that if the transport time from receiving medical treatment to sending the patient to the cath lab was less than 290 min, the mortality of PCI treatment could fell to 3.3%, and the incidence of the long-term heart events could drop to 7%, such as the death, nonlethal myocardium infarction, stroke, etc. However, when D2B time prolonged to 91-120 min, 121-150 min and more than 150 min, the mortality in hospital stays was 4.2%, 5.7% and 7.4%, respectively. After adjusting characteristic difference of the patients, per 15 min reduction of D2B time can reduce the death of 6.3 cases for per 1000 cases STEMI patients that receive treatment. It is more significant in the patients who are hospitalized within 1 h of the beginning of symptom and high-risk [5]. Intervention operation on cardiovascular disease was started in early 2002

Table 1. Comparison between two groups in general clinical data

Items	PCI group (n=126)	Control group (n=116)	P value
Age	66.3±3.4	67.3±4.2	0.057
Male	69	61	0.735
Onset time	5.9±1.7	6.3±2.0	0.074
Risk factors			
Diabetes	38	35	0.998
Hypertension	72	67	0.923
Abnormal blood fats	79	37	0.000
Smoking	43	41	0.842
History of myocardial infarction	1	0	0.521
History of cerebral infarction	4	2	0.685

in our hospital, but is not capable yet to take independently emergency PCI, or directly transport patients to the superior hospital for emergency PCI. First aid equipment and medicine are not prepared entirely on the ambulance, emergency services professionals are lack of special training, traffic condition is not sure, all of which increase the risk of the patients in transportation. The case transported to the superior hospital for emergency PCI within 90 min is less than 4%, which has great impact on the quality of long-term survival of the patients. Therefore, this study aimed to explore the effective emergency disposal model on acute myocardium infarction in county hospital and increase the survival rate of the patients.

Materials and methods

General materials

The general information of the patients are shown in **Table 1**. The AMI cases admitted to our hospital from September 2002 to September 2008, presented within 2 h to 12 h of symptom onset received thrombolysis and PCI with all patients and their relatives provided the informed consents were collected to the study. AMI diagnosis was all applied for the WHO standard (1). In 126 cases, 69 men and 57 women were with the mean age of 66.3±3.5 years old (ranging from 28 to 83 years old), meanwhile, 83 cases anterior wall myocardial infarction and 43 cases inferior wall myocardial infarction (15 cases with right ventricular infarction). There were 46 cases with hypertension, 38 cases with diabetes. The control group was the 116 cases of acute myocardium infarction from March 1998 to 2002 in our hospital, and

these cases only received drug treatment because it was impossible to carry out emergency coronary angiography, and primary stent implantation then. There were no statistical differences in the age, sex, AMI time range, left ventricular ejection fraction, merged hypertension and diabetes, medication treatment between these two groups.

Emergency disposal model

When the patient was diagnosed with acute myocardium infarction in our Emergency Room, the treatment model, inverse transportation experts, should be started immediately. Call the experts from regional health center in Suzhou or Shanghai etc. by telephone to rush to our hospital for emergency PCI. Meanwhile, 300 mg aspirin and 300-450 mg clopidogrel were given for STEMI patients immediately. Intravenous thrombolytic therapy was taken for the patients less than 3 hours after thrombosis. During the experts rushing to our hositel, the patient was directly sent to cardiac catheterization laboratory and made good preparations for the PCI. 80% patients were prior treated with coronary angiography when time permits, then treated with PCI immediately after the experts arrived.

Observation indexes

The mortality rates, hospital staying time and ischemia and related events during the hospital stay and follow-up period were observed, including cardiac death of cardiac failure, reassuring myocardial infarction, target-vessel revascularization and malignant arrhythmias.

Operation methods

The operation were just given routinely care, and 2000 u unfractionated heparin was firstly injected through blood vessel for patients of coronary angiography. If PCI was taken, the patients should be given 100 u/kg heparin by intravenous, and per hour prolonging, 2000 u heparin was added. After the operation, 100 u/kg low molecule heparin was given by skin injections, twice per day, and 3-5 days for all. Clopidogrel should be taken for at least 12 months with a dose of 75 mg per day, and aspirin with 100 mg per day for long-term use. PCI

Table 2. Detailed Numbers of patients with CAG and PCI

	CAG	PCI	The reason do not undergo PCI
Left anterior descending branch (LAD)	64	61	2 cases of autolysis, on case suggested to take CAG
Left main (LM)	3	3	
Circumflex (LCX)	15	14	One case of severely stenotic, balloon inflation cannot go through
Right coronary arterial (RCA)	43	39	The failure of one case of autolysis, one case of vascular malformation. 2 cases suggested to take CABG
Tako-tsubo cardiomyopathy	1		Cuttlefish ball-like occurred in left ventriculography
Total	126	117	9

was operated or guided by the experts to treat IRA for common processing, choosing the proper stent for the stenting of IRA, according to the angiography results. Success criteria for the operation: TIMI blood flow more than Level 3, and residual stenosis less than 20%.

36 cases with the indications were treated with intravenous thrombolysis therapy in all 116 cases for control group. 15 mg r-tPA was infused intravenously, and another dose of 35 mg was given through an intravenous drip within 30 min. For routine therapy, 100 mg aspirin and 75 mg clopidogrel were given per day with oral. 100 u/kg low molecule heparin was given by skin injections, twice per day, and 3-5 days for all.

Results

The procedure and results of operation

For 126 cases the mean time between the onset and in hospital was 5.8 h (2-12 h), in these 14 cases were treated with ACG after intravenous thrombolytic. In 126 cases, 125 cases presented IRA after CAG, that 3 cases of LM, 64 cases of LAD, 15 cases of LCX, and 43 case of RCA; after Coronary angiography, 114 cases of Level 0 of TIMI blood flow, 8 cases of Level I, 3 cases of Level II, one case of Level III; 104 cases of single vessel disease, 18 cases of two vessel disease, 4 cases of three vessel diseases, and in these 3 cases were suggested to take coronary artery bypass surgery. One case of 83 years old, IRA was far-end lesions of RCA, accompanying by severe calcium, Level I of TIMI blood flow, and guide wire was not able to go through balloon, which led to the failure of PCI. One case was failed because of opening deformities of right coronary and the catheter cannot go through. TIMI blood flow of 3 cases recovered to Level 3 after thrombus aspiration and the separate intracoronary injecting of

10-15 mL tirofiban. But without stent insertion, one famale patient extensive anterior wall myocardial infarction with Tako-tsubo ardiomyopathy as final diagnosis, without vascular lesions but cuttlefish ball-like occurred in left ventriculography, combining with the history of excessive grief.

As shown in **Table 2**, in all 126 cases with CAG surgery, 117 cases were taken with PCI surgery, with the immediate success rate of 117/119=98.30%, the time stay of D2B 1.8±0.5 h from being hospitalized for emergency to the first balloon inflation, IRA residual stenosis less than 20% and Level 3 of TIMI blood flow.

8 cases (6.35%) developed cardiac events in the time period surrounding the surgery

4 cases died (mortality rate of 3.4%), and another 4 cases survived. Foe the death cases, case 1 was extensive anterior myocardial infarction complicated with cardiac shock, IRA was seen in coronary angiography, with 99% disease in proximal lesion of LAD, 95% disease in middle lesion of RCA and thrombosis appearances were seen. One Fiberd holder of 3.5×28 mm and 3.5×23 mm were placed respectively, after the operation, Level of II-III of IRA TIMI were immediately seen by arteriography, without residual stenosis. However, patient's shock was not cured after operation, with a blood pressure less than 60/30 mmHg steadily, ventricular tachycardia occurred 30 minutes after operation, followed by ventricular fibrillation. After the treatments of electrical defibrillation and cardiopulmonary resuscitation etc., the patient died. Case 2 with cardiac arrest in the emergency room, was treated with CAG after cardiopulmonary resuscitation. 100% occlusion of left main was found, treated with PCI then, one Taxus stent of 4.0 mm×8 mm was

Table 3. Comparison between ischemic related events in two groups during the follow-up period

Items	PCI group	Control group	*P* value
Mace events			
Heart failure	9	25	0.001
Malignant arrhythmias	9	21	0.010
Cardiac death	6	15	0.024
Total	24	61	<0.001

placed, but without reflow of the blood, the patient cannot be rescued successfully. Case 3 was inferior wall myocardial infarction complicated with right ventricular infarction. Because the blood pressure remained low steadily, the patient was treated with expansion and inter aortic ballon pump. However, sharp pain on lower back occurred 6 h after the operation, aggravated as counterpulsation and spread to neck, and the patient was thought to die from aortic dissection. Case 4 was suffered from left main disease, and one sent of 4.0×23 mm was placed. After the operation, acute pulmonary edema postoperatively was developed, and the condition eased with such treatments pf positive pressure respiratory and Intra aortic balloon pumping etc. However, the patient died from emergency antitachycardi and fibrillation after 20 days.

In 4 survivors cases who developed cardiac events in the time period surrounding the surgery, case 1 was extensive anterior wall myocardial infarction, was treated with PCI after thrombolytic therapy. One holder of 3.5×28 mm was placed in LAD. 24 h after the operation, the patient developed chest pain again, and electrocardiogram indicated that corresponding ST segment increased again in the original infarcted areas that acute balloon occlusion. After then followed by acute left heart failure, because the patient refused to take reoperation, the treatments such as medical treatment and mechanical ventilation were used and out of danger a week later. Six months later, CAG was taken, Level III of IRA TIMI blood flow was seen and without residual stenosis. Case 2 with CAG was found that IRA was the middle block of LAD, and RCA stenosis reached up to 90%. 24 h after the patient only treated with PCI to LAD, ventricular tachycardia or fibril-

lation were developed, and $ST_{II, III, avF}$ was elevated after cardioversion. That was diagnosed with inferior wall myocardial infarction, and it is effective to take intravenous thrombolytic therapy with 150 million u urokinase. Temporary pacemaker was placed in Case 3, because of inferior wall myocardial infarction and III AVB. 5 days after the operation, persistent chest pain occurred, without dynamic change presented in electrocardiogram, and the serum myocardial enzyme spectrum returned to normal levels. Chest x-ray indicated that temporary pacemaker electrodes of right ventricle perforated, and the pain passed off after removed. Case 4 presented cardiac tamponade, and symptoms are relieved after pericardiocentesis and drainage.

Hospital stay

The average hospital stay was 9.1 days, which is fitting in with the clinical requirements of the Ministry. In 112 cases of crotrol group, 36 cases were treated with thrombolytic therapy and with the average hospital stay of 11.2 days.

Follow-up

In PCI group, all patients were suggested to take clopidogrel (75 mg per day) for one year at least and long-term use of the oral of aspirin (0.1 per day) after they left the hospital. In the first month, patients were followed up for every week, once every month later. For that after one year or living far away, the body activity inconvenient, took telephone inquiries once every 3 months. For control group, patient clinic, returning visit or telephones follow-up were taken every 3 months. The average follow-up time of the two groups was 32-86 months. As shown in **Table 3**, in 117 cases of PCI group, 8 cases died, with 6 cases of cardiogenic death. There were 4 cases (3.4%) cardiogenic death in the time period surrounding the surgery, and 2 cases of sudden cardiac deaths in follow-up period, which occurred 14 and 22 months after getting out of hospital, respectively. One case died from esophageal cancer 3 months after the operation, another one case died from lung cancer. The rest 16 cases developed cardiac related events (13.6%). In these cases, 9 cases of heart failure, 7 cases of malignant arrhythmias. In these 7 cases, 3 cases placed ICD because of repeated ventricular tachycardia and fibrillation. The control group was followed up for 32-86 months. In this group, 20 cases

died, with 9 cases during their hospital stay (7.76%), 6 cases of cardiac death during the follow-up period, 3 cases of non-cardiogenic death and 2 cases that the cause was unknown. Cardiac events occurred in 46 cases (40%), heart failure in 25 cases and arrhythmia in 21 cases. In these cases, there were 19 cases of heart failure accompanying by arrhythmia, 8 cases of ventricular tachycardia or fibrillation, and only one case to receive ICD.

Discussion

For such medical institutions can not directly carry out emergency PCI, there are three kinds of effective treatment of AMI model, namely, local thrombolysis, transfer to take direct PCI, and transfer to take PCI after local thrombolysis [6-8]. However, it also has certain difficulies in treatment of AMI with transportation model. For example, the equipment on ambulance and hospital staff are limited, transportation traffic conditions are not clear, social health insurance in our country cannot pay universal among different areas, the patients are usually troubled with raise money quickly, all of which delay the rescue of patients, and limited to transport patients from different areas. The practice, invitating experts from medical centers in other places to emergency support for direct PCI (Inverse transportation experts), are appreciated in its clinical application in recent years. It is suggested that in Guides in percutaneous coronary intervention in China in 2012 that, if the patients are sent to the hospital with emergency PCI facility but lack of qualified doctors, the hospital can invite doctors quickly from the superior hospital to take PCI, namely strategies for transportation doctors. In this way, it needs not to transport the patient to another hospital, which can save time and reduce transportation risk. The study of PTEVERSE-STEMI prospectively compared the efficacy of the transportation of patients and doctors. In 334 STEMI patients, DTB time delay in doctor transportation group was significantly reduced than patients transportation group (95±27 min and 147±29 min ($P<0.001$). The ratio of acute heart event in 30 days was also obviously declined (8.9% and 17.2%, P=0.03) [8], and the incidence of adverse events happened also improved significantly (84.8% and 74.6%, P=0.019) [9]. Our hospital is a country medical center, and receives hundreds patients of acute myocardial infarction every year. In the early years, we were unable to take emergency PCI independently influenced by interventional qualifications, so the emergency disposal model of inverse transportation was adopted for AMI patients. The emergency model has the following characteristics: (1) Implement the organizational structure of inverse transportation, and make it programed. Make D2B time delay (from patients reaching the emergency department to ball bag expansion) generally satisfy the request of the guide. (2) Set up culture information and communication management in this model. Feed back the relevant information that includes outpatient data, patients' conditions changes, and postoperative recovery condition of patients to the experts by telephone and network. Experts correct scheme timely and guide local first aid and perioperative period management. (3) Broke the previous model of single doctor further studies and personal professional level improvement, that transportation experts not only cure the patients in local, but also export technology for local. It is according to the demands of strengthening the building for county hospital by the Ministry of Health, and has trained an innovative young and professional team for the local medical institutions. It assures the proper operation of 24/7 d PCI, and set up the foundation for the green channel to AMI emergency treatment. (4) Those patients with acute myocardial infarction in a critical condition or complex lesions, should be transported to the cath lab of superior regional medical center timely to avoid second surgical visit in hospitalemergency room of third-party hospital after transportation. The green channel to AMI emergency treatment was extended, and the former repeated transfer turn into simple one-time treatment, so effectively reduced the key times for AMI emergency treatment. (5) According to the application of the emergency disposal model, inverse transportation, on acute myocardium infarction, technical collaboration among different degree hospitals was improved, also applied in coequals hospitals, and good economic and social benefits have been achieved. (6) This model is also conducive to cultivate a team including the nurses, and technology learning curve was obviously shortened.

Our preliminary experimentation demonstrates that, the average time of AMI reperfusion was 1.8±0.5 h, which was close to the guidelines require (1.5 h). This model was feasible to shorten the time window of reperfusion, and the success rate of immediate operation reached 98.3%, which was similar to those that have been well documented [10-12].

For control group, the majority of patients had no thrombolysis sign when admitted, it was noly 36 cases with thrombolysis (31%), and many cases could not be taken reperfusion effectively. During the follow-up period, it was significantly increased in heart failure and arrhythmia. Inverse Transportation Experts opens up a new reference model of emergency disposal model on acute myocardium infarction in county hospitals. It is safer to transport experts than patients, which can obviously shorten the delay time to direct PCI [13]. D2B time delay is at most shortened to 56 min, and can greatly increase the survival rate of patients.

The model of Reverse transportation for the treatment of myocardial infarction is significantly effective, which extends the thought for treatment in those basic general hospital without direct PCI, shortens the mortality during transferring and follow-up period and the incidence of major adverse cardiac events. It cultivates a useful, well-qualified team of emergency treatment talents for the local, enhances the medicine technology of the county hospitals, conforms to the guidelines of the Planning Committee of the country, and is an effective clinical skill. However, the study is still in a preliminary exploratory stage, and has some disadvantages of the deficient number of cases and no randomize etc. It is essential to explore massive randomized control trials in the medical institutions where conditions permit, and seek further evidence to the feasibility and effectiveness of the treatment model of AMI.

Disclosure of conflict of interest

None.

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