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Article

Impact of Different Emergency Treatment Methods on Prognosis of Patients with Acute Myocardial Infarction Undergoing Percutaneous Coronary Intervention: Retrospective Study

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Abstract

Purpose: This study aimed to investigate the impact of different emergency treatment methods on the prognosis of patients with acute myocardial infarction (AMI) undergoing percutaneous coronary intervention (PCI). **Methods**: A retrospective study was conducted involving 114 patients admitted to the hospital between January 2022 and December 2022. The patients were divided into two groups based on their emergency treatment methods: First Transport and Then Treatment Group (n = 56) and Treatment Before Transport Group (n = 58). Baseline characteristics, biomarker levels, echocardiographic findings, curative effects, and 1-year follow-up outcomes were compared between the two groups. **Results**: Biomarker levels and echocardiographic parameters differed significantly between the two groups, thus indicates potential variations in disease severity and prognosis. Moreover, the 1-year follow-up outcomes showed higher rates of all-cause mortality (16.07% *vs*. 3.45%, $p = 0.022$), recurrent myocardial infarction (19.64% *vs*. 5.17%, $p = 0.019$), rehospitalization for cardiovascular causes (25.05% *vs*. 8.62%, $p = 0.019$), and PCI for new lesions (23.21% *vs*. 6.92%, $p = 0.014$) in the First Transport and Then Treatment Group compared with the Treatment Before Transport Group. **Conclusion**: The timing of emergency treatment methods in patients with AMI undergoing PCI appeared to significantly impact clinical outcomes, echocardiographic parameters, and 1-year follow-up outcomes. Immediate administration of treatment before transport showed potential benefits in mitigating myocardial damage and improving long-term prognosis compared with the approach of transporting the patient to the healthcare facility before initiating treatment.

Keywords

emergency treatment methods; prognosis; acute myocardial infarction; percutaneous coronary intervention

Introduction

Acute myocardial infarction (AMI) remains a major contributor to global morbidity and mortality [1–3]. AMI is a condition caused by the sudden occlusion of the coronary arteries, which leads to extensive myocardial ischemia and necrosis [4–6]. This unique pathophysiology determines the urgency and complexity of its treatment [7–9]. In addition, the complications and sequelae associated with AMI greatly impact patient prognosis and healthcare resource utilization, which makes it a major global public health concern [10–12].

Percutaneous coronary intervention (PCI), which is a minimally invasive procedure involving the insertion of a catheter with a deflated balloon into the blocked coronary artery, followed by balloon inflation to restore blood flow, has revolutionized revascularization in the setting of AMI [13–15]. While PCI has significantly improved clinical outcomes and reduced mortality rates, the optimal approach to emergency treatment methods, particularly the timing of intervention in relation to transport to the healthcare facility, remains an area of active investigation and debate [16–18]. In the prehospital setting, different strategies are used to manage patients with AMI, which range from initiating treatment at the site of the medical emergency before transport to administering treatment upon arrival at the healthcare facility following transportation. The choice of the approach may impact various aspects of patient care.

This study innovatively explores the optimal emergency response protocols for individuals with AMI, a topic that has been scarcely addressed in previous research. Emergency care is crucial for AMI patients; however, there is a lack of research focusing on the sequence of transfer and emergency interventions. The primary aim of this study is to bridge this knowledge gap by elucidating the impact of two distinct emergency response protocols on the post-treatment prognosis of AMI patients undergoing PCI.

This retrospective study aimed to investigate the impact of different emergency treatment methods on the prog-

nosis of patients with AMI undergoing PCI. By comparing outcomes between the First Transport and Then Treatment Group and the Treatment Before Transport Group, we sought to elucidate potential associations between the timing of emergency treatment and a range of clinical endpoints.

Materials and Methods

Study Population

This retrospective study included 114 patients who were admitted to our hospital from January 2022 to December 2022 and who underwent PCI for AMI. Based on the different emergency treatment methods, the patients were divided into the First Transport and Then Treatment Group (n = 56) and the Treatment Before Transport Group (n = 58). The First Transport and Then Treatment Group comprised 42 males and 14 females with a mean age of 59.13 ± 5.11 years. The Treatment Before Transport Group composed of 42 males and 16 females with a mean age of 60.18 ± 6.56 years. All participants included in this study gave informed consent. This study has been approved by the ethics committee of Hubei No.3 People's Hospital of Jianghan University, approval No. 2024LW2024009.

Inclusion and Exclusion Criteria

Inclusion Criteria: Patients diagnosed with AMI [19], patients who underwent PCI as a primary reperfusion strategy for AMI for the first time, adult patients aged 18 years or older, and patients who completed one year follow-up.

Exclusion Criteria: Patients with a previous history of coronary artery bypass grafting; patients with missing or incomplete medical records; patients with a history of severe comorbidities such as end-stage renal disease, liver failure, or malignancy, which may significantly impact prognosis and confound the analysis; patients who underwent fibrinolysis or other reperfusion strategies as the initial treatment for AMI prior to subsequent PCI; patients with a diagnosis of an alternative cardiac condition mimicking AMI, such as myocarditis or Takotsubo cardiomyopathy; patients with a history of significant drug or alcohol abuse; patients who failed to undergo PCI due to anatomical or technical limitations; and missing data.

Methods

Two groups of patients were dispatched by a centralized command center consisting of 120 dispatchers, with the requirement for emergency responders to react within 4 minutes upon receiving instructions. Upon receiving distress calls from patients, the emergency dispatch center promptly connected on-site emergency physicians for initial assessment and self-care guidance. The emergency response team comprised of physicians, nurses, and drivers, each with distinct roles: physicians responsible for diagnosis and treatment, nurses for patient monitoring and immediate care, and drivers for safe transport of the ambulance to the accident site. Additionally, a qualified psychologist was included to provide psychological support and assist in managing psychological trauma during emergencies.

Treatment before Transport

This group consists of patients who, based on their medical condition, family consent, and the situation at the scene, were able to receive pre-hospital emergency interventions following the protocol of treatment before transportation. In the Treatment Before Transport protocol, emergency medical procedures are initiated on-site as soon as a patient experiences a medical emergency. Only once the patient's vital signs have stabilized and their condition has improved, are they transported to an ambulance. The emergency process involves the immediate collection of medical history and assessment of the patient's vital signs upon arrival of the medical team. Within 10 minutes, standard emergency measures are applied, such as positioning the patient in a head-elevated or seated position, closely monitoring dynamic changes in the patient's vital signs, administering high-flow oxygen via a mask or nasal cannula, maintaining an open airway, ensuring smooth breathing, and conducting comprehensive monitoring of vital signs, electrocardiogram evaluation, oxygen therapy, sublingual nitroglycerin (Beijing Yimin Pharmaceutical Co., Ltd., Beijing, China; 0.5 mg; catalog number: H11021022) as needed based on symptoms, and making an initial diagnosis based on the electrocardiogram results. In cases where acute myocardial infarction is suspected without treatment contraindications, dual antiplatelet therapy is promptly administered, typically comprising a chewable 300 mg clopidogrel tablet (Sanofi Winthrop Industrie; Hangzhou, Zhejiang, China; 75 mg; catalog number: HJ20171237) and a 300 mg aspirin tablet (Bayer HealthCare Manufacturing S.r.l., Leverkusen, Germany; 100 mg; catalog number: HJ20160685). The patient is immediately instructed to cease all voluntary activities, provided with oxygen, an intravenous access is established to maintain effective circulation, complications are managed, and family members are informed about the patient's condition and the transfer process. Communication with family members is vital, alerting the designated hospital's chest pain center through WeChat for early warning. Psychological intervention is implemented for conscious patients to alleviate anxiety and fear, while maintaining a patent airway for those with altered consciousness. The decision to proceed to further medical intervention is made only when the patient's vital signs, including but not limited to heart rate, blood pressure, respiratory rate, and oxygen saturation, are deemed stable

Table 1. Baseline Characteristics of the Study Population.

Parameter	First Transport and Then Treatment Group (n = 56)	Treatment Before Transport Group (n = 58)	χ^2/t	*p* value
Age (years)	59.13 ± 5.11	60.18 ± 6.56	0.960	0.339
Gender (Male/Female)	42 (75.00)/14 (25.00)	42 (72.41)/16 (27.58)	0.098	0.754
BMI (kg/m^2)	20.34 ± 3.12	21.07 ± 4.79	0.961	0.339
Diabetes (%, n)	17 (30.36)	16 (27.59)	0.106	0.704
Hypertension (%, n)	25 (44.64)	24 (41.38)	0.124	0.725
Family history of AMI	13 (23.21)	12 (20.69)	0.106	0.745
Smoking	21 (37.50)	23 (39.66)	0.056	0.813
Alcohol intake	40 (71.43)	45 (77.59)	0.570	0.450
Time from symptom onset to emergency medical personnel arrive (min)	21.26 ± 5.12	22.61 ± 6.94	1.179	0.241
Door to balloon time (min)	73.48 ± 3.41	72.37 ± 3.87	1.623	0.108
The type of AMI			0.486	0.486
ST elevation myocardial infarction	15 (26.79%)	19 (32.76%)		
Non-ST elevation myocardial infarction	41 (73.21%)	39 (67.24%)		

Note: BMI, body mass index; AMI, acute myocardial infarction.

and optimized. Throughout the transportation in the ambulance, the patient is positioned appropriately, vital signs are continuously monitored, high-flow oxygen is provided if necessary, and measures to keep the airway open and breathing smooth are upheld.

First Transport and Then Treatment

This group comprises patients whose medical conditions, situational factors at the scene, and family opinions necessitated emergency interventions that prioritized transportation over immediate on-site treatment. Consequently, emergency measures involved transporting these patients before administering treatment. First Transport and Then Treatment group implemented a prehospital emergency medical care approach that combines transportation with treatment. At the onset of symptoms, patients underwent electrocardiogram (ECG) monitoring, blood oxygen saturation monitoring, oxygen therapy, and sublingual nitroglycerin administration. Following initial emergency interventions, patients were transported to an ambulance, where further emergency medical care was provided using ambulance facilities. The emergency procedures in this process mirrored those of the Treatment Before Transport group. Patients were placed in a Trendelenburg or sitting position with head elevated and feet lowered, with continuous monitoring of vital signs. They were administered oxygen through a face mask or nasal cannula with high flow rates to maintain open airways and ensure smooth breathing.

Obervational Indexes

Relevant data, including baseline characteristics, biomarker levels, echocardiographic findings, curative effects, and 1-year follow-up outcomes, will be extracted from electronic medical records. Data extraction will be conducted by trained personnel in accordance with data protection and patient confidentiality regulations.

Statistical Analysis

This study conducted a standardized data cleansing process prior to data analysis to identify and rectify inconsistencies, errors, and missing values in the dataset. The process involved a comprehensive dataset examination, removal of duplicate entries, correction of data entry errors, and addressing missing values. Missing values were imputed using deep neural networks through the data wig and pandas libraries in Python 3.6.0 (Centrum Wiskunde & Informatica, Amsterdam, Holland), which ensures that the percentage of missing data was kept below 5% to mitigate potential selection bias. Furthermore, sensitivity analyses were performed by calculating outcomes for cases lost to follow-up using both worst-case and best-case scenarios. If the results showed no significant difference, then the loss to follow-up had minimal impact on the conclusions of the study, which makes them reliable. The final results were reported after imputing missing values.

Data analysis was performed using SPSS 29.0 (SPSS Inc, Chicago, IL, USA). Categorical data were presented as n (%). The chi-square test was employed when the sample size was $\geq$40 and the expected count T $\geq$5, or a corrected chi-square test was applied for samples $\geq$40 with 1 $\leq$ T $<$ 5. Fisher's exact test was used for sample sizes $<$40 or when expected counts were T $<$1. The Shapiro–Wilk test was utilized to assess normal distribution in continuous variables. Normally distributed variables were presented as $\bar{x} \pm$ s and analyzed using the *t*-test with corrected variance. Non-normally distributed data were expressed as median

Table 2. Pre-hospital Vital Signs of Patients in Both Groups.

Parameter	First Transport and Then Treatment Group (n = 56)	Treatment Before Transport Group (n = 58)	t	*p* value
Heart rate (bpm)	82.44 ± 5.36	80.88 ± 6.13	1.452	0.149
Systolic BP (mmHg)	130.68 ± 10.98	132.45 ± 12.22	0.815	0.417
Diastolic BP (mmHg)	78.22 ± 8.55	76.68 ± 7.98	0.993	0.323
SpO_2 (%)	95.57 ± 2.21	95.14 ± 3.64	0.755	0.452
Respiratory rate (bpm)	18.35 ± 2.54	18.23 ± 3.25	0.223	0.824

Note: BP, blood pressure; SpO_2, saturation of peripheral oxygen.

Table 3. Biomarker Levels after Admission in Both Groups.

Parameter	First Transport and Then Treatment Group (n = 56)	Treatment Before Transport Group (n = 58)	t	*p* value
Troponin I (ng/mL)	10.99 ± 2.37	10.01 ± 2.19	2.272	0.025
CK-MB (ng/mL)	37.42 ± 5.55	32.33 ± 4.77	5.244	< 0.001
NT-proBNP (pg/mL)	478.89 ± 50.18	460.02 ± 45.97	2.091	0.039
CRP (mg/L)	5.61 ± 1.15	5.08 ± 1.35	2.264	0.026

Note: CK-MB, creatine kinase, MB form; NT-proBNP, N-terminal pro-brain natriuretic peptide; CRP, C-reactive protein.

(25th percentile, 75th percentile) and analyzed using the Wilcoxon rank-sum test. A two-tailed $p < 0.05$ was considered statistically significant.

Results

Baseline Characteristics

Based on the baseline characteristics, no statistically significant differences existed between the First Transport and Then Treatment Group and the Treatment Before Transport Group (Table 1). The age was 59.13 ± 5.11 years for the First Transport and Then Treatment Group and 60.18 ± 6.56 years for the Treatment Before Transport Group, with no significant difference (p = 0.339). Moreover, gender, body mass index (BMI), diabetes prevalence, hypertension prevalence, family history of AMI, time from symptom onset to emergency medical personnel arrive door to balloon time and the type of AMI did not show significant differences between the two groups. Therefore, at baseline, the two groups were well matched in terms of demographics and cardiovascular risk factors.

Pre-Hospital Vital Signs

The analysis of pre-hospital vital signs showed no significant differences between the First Transport and Then Treatment Group and the Treatment Before Transport Group (Table 2). They had comparable mean heart rate (p = 0.149), systolic and diastolic blood pressure (p = 0.417; 0.323), oxygen saturation levels (p = 0.452), and respiratory rates (p = 0.824). These findings suggest comparable pre-hospital vital signs in both groups.

Biomarker Levels

Biomarker levels after admission differed significantly between the First Transport and Then Treatment Group and the Treatment Before Transport Group, including Troponin I, creatine kinase, MB form (CK-MB), N-terminal pro-brain natriuretic peptide (NT-proBNP), and C-reactive protein (CRP) levels (Table 3). Troponin I levels were 10.99 and 10.01 ng/mL in the first and second groups, respectively, which shows a statistically significant difference (p = 0.025). Similarly, CK-MB, NT-proBNP, and CRP levels also differed significantly between the two groups, with p values of less than 0.001, 0.039, and 0.026, respectively, which implies distinct biomarker profiles post-admission.

Curative Effects

The curative effects of the two patient groups were compared, which revealed notable differences (Table 4). The Treatment Before Transport Group exhibited a significantly higher rate of partial response than the First Transport and Then Treatment Group (48.28% *vs*. 17.86%, p = 0.001). Moreover, the Treatment Before Transport Group demonstrated a higher rate of stable disease than the First Transport and Then Treatment Group (60.34% *vs*. 39.29%, p = 0.025). Conversely, the First Transport and Then Treatment Group showed a higher incidence of progressive disease than the Treatment Before Transport Group (35.71% *vs*. 12.07%, p = 0.003). Interestingly, complete response rates did not significantly differ between the groups (1.79% *vs*. 0%, p = 0.491). These findings suggest that the timing of treatment in relation to transport may influence the curative effects in patients.

Table 4. Curative Effect of the Two Groups of Patients.

Response	First Transport and Then Treatment Group (n = 56)	Treatment Before Transport Group (n = 58)	Fisher/χ^2	p value
Complete response	1 (1.79)	0 (0)		0.491
Partial response	10 (17.86)	28 (48.28)	11.863	0.001
Stable disease	22 (39.29)	35 (60.34)	5.054	0.025
Progressive disease	20 (35.71)	7 (12.07)	8.813	0.003

Table 5. 1-year Follow-up Outcomes of the Two Groups of Patients.

Parameter	First Transport and Then Treatment Group (n = 56)	Treatment Before Transport Group (n = 58)	χ^2	p value
All-cause mortality (%)	9 (16.07)	2 (3.45)	5.207	0.022
Recurrent MI (%)	11 (19.64)	3 (5.17)	5.538	0.019
Rehospitalization for cardiovascular causes (%)	14 (25.05)	5 (8.62)	5.503	0.019
PCI for new lesions (%)	13 (23.21)	4 (6.92)	5.979	0.014

Note: MI, myocardial infarction; PCI, percutaneous coronary intervention.

1-Year Follow-up Outcomes

In the 1-year follow-up outcomes of the two patient groups, notable differences were observed between the First Transport and Then Treatment Group (n = 56) and the Treatment Before Transport Group (n = 58) (Table 5). The all-cause mortality rate was significantly higher in the First Transport and Then Treatment Group than in the Treatment Before Transport Group (16.07% *vs*. 3.45%, p = 0.022). Similarly, the incidence of recurrent myocardial infarction was more prevalent in the First Transport and Then Treatment Group than in the Treatment Before Transport Group (19.64% *vs*. 5.17%, p = 0.019). In addition, rehospitalization for cardiovascular causes occurred at a significantly higher rate in the First Transport and Then Treatment Group than in the Treatment Before Transport Group (25.05% *vs*. 8.62%, p = 0.019). Moreover, PCI for new lesions was performed more frequently in the First Transport and Then Treatment Group than in the Treatment Before Transport Group (23.21% *vs*. 6.92%, p = 0.014). These findings underscore potential differences in 1-year clinical outcomes between the two groups.

Discussion

The impact of different emergency treatment methods on the prognosis of patients with AMI undergoing PCI is a crucial area of investigation in cardiovascular medicine. In this retrospective study, we aimed to compare outcomes between the First Transport and Then Treatment Group and the Treatment Before Transport Group to elucidate potential associations between the timing of emergency treatment and a range of clinical endpoints. The discussion will delve into the key findings of this study and their implications, the potential mechanisms underlying the observed differences, and the implications for future research and clinical practice to guide healthcare providers in optimizing emergency treatment strategies for patients with AMI undergoing PCI.

The baseline characteristics of the study population revealed no significant differences in demographic and cardiovascular risk factors between the First Transport and Then Treatment Group and the Treatment Before Transport Group. This finding indicated that the two groups were well matched in terms of baseline characteristics, which minimizes potential confounding factors that could influence the study outcomes. This condition was essential to ensure that any observed differences in outcomes between the groups can be more confidently attributed to the differences in emergency treatment methods rather than underlying demographic or clinical disparities.

The observed differences in clinical endpoints between the two groups may be attributed to several potential factors. Firstly, the immediate administration of emergency treatment at the site of the medical emergency in the Treatment Before Transport Group may lead to more rapid restoration of coronary blood flow, which reduced the extent of myocardial injury and preserves cardiac function. Egorova *et al*.'s study [20] also discovered that promptly restoring coronary artery blood flow significantly improves the severity of AMI in patients. By contrast, the delay in initiating treatment in the First Transport and Then Treatment Group may prolong the ischemic time, which leads to larger infarct size, impaired myocardial function, and increased incidence of adverse remodeling. Prasad *et al*.'s study [21] also found that prolonging ischemic time increases myocardial damage, which significantly impacts the occurrence of myocardial infarction at a later stage. In addition, differences in pre-hospital interventions such as the use of antiplatelet agents, antithrombotic therapy, and analgesia at the site of the medical emergency in the Treatment Before Transport Group could potentially improve microvas-

cular perfusion, mitigate ischemia-reperfusion injury, and alleviate patient discomfort. All these factors are critical in influencing long-term outcomes. Ott *et al.*'s study [22] also found that certain drug therapies have a mitigating effect on microvascular perfusion in patients with AMI. Furthermore, psychological stress and anxiety associated with the delay in treatment initiation in the First Transport and Then Treatment Group could trigger sympathetic overactivity, exacerbate inflammatory responses, and contribute to maladaptive cardiac remodeling, which ultimately impact 1-year follow-up outcomes. Graham *et al.* [23] found that, when the duration of excessive sympathetic nervous system activity is longer, the impact on the heart is greater. By comprehensively evaluating physiological, interventional, and psychological implications, these latent reasons provided a multifaceted understanding of the complex interplay between treatment timing and patient prognosis in the context of AMI undergoing PCI. Zhou *et al.*'s study [24] also found that early emergency treatment can improve the hemodynamics of AMI patients undergoing PCI, reduce perioperative mortality, and increase the success rate of ventilator weaning. Moreover, a reasonable lying position can reduce the oxygen consumption of the myocardium, and sufficient oxygen provides a longer treatment time for later surgical treatment, significantly improving the survival rate of patients and prolonging their survival period.

The impact of stress and anxiety associated with the delay in treatment initiation in the First Transport and Then Treatment Group should be considered. Prolonged transport times without active intervention may lead to heightened psychological stress, which can negatively impact physiological responses and patient outcomes. Chen *et al.*'s study [25] also found that positive interventions have potential benefits for patients' stress and anxiety. Understanding the potential psychological and emotional impacts of delayed treatment initiation is crucial in comprehensively evaluating the implications of different emergency treatment methods on patient prognosis.

While this retrospective study provides valuable insights into the potential impact of different emergency treatment methods on the prognosis of patients with AMI undergoing PCI, several limitations should be acknowledged. The retrospective design of the study may have introduced some uncontrolled inherent bias and potential confounding factors. In addition, the relatively small sample size and single-center nature of the study may limit the generalizability of the findings to broader patient populations and healthcare settings. Furthermore, the retrospective nature of the study may have introduced selection biases and limitations in data availability, which potentially impact the robustness of the results. Moreover, the imputation of data in this study was not very well validated and may have introduced bias. Besides, this experiment in the follow-up time is one year, not enough to understand this experiment the continued effects of the treatment. Therefore, future prospective studies with larger, multi-center cohorts and comprehensive data collection are warranted to validate the findings and further elucidate the mechanisms underpinning the observed differences.

Conclusion

The findings of this retrospective study suggest that the timing of emergency treatment in patients with AMI undergoing PCI may significantly influence clinical outcomes, echocardiographic parameters, and 1-year follow-up outcomes. The immediate administration of treatment before transport showed potential benefits in terms of mitigating myocardial damage, reducing in-hospital complications, and improving long-term prognosis compared with the approach of transporting the patient to the healthcare facility before initiating treatment.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Author Contributions

FX and ZP designed the research study. LC and FS performed the research. FS, FX, LC, ZP collected and analyzed the data. FX and ZP participated in drafting the manuscript, all authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This study, conforming to the Declaration of Helsinki (2013), has been approved by the ethics committee of Hubei No.3 People's Hospital of Jianghan University, approval No. 2024LW2024009. This study was a retrospective analysis; all patients included had informed consent and signed relevant agreements.

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Conflict of Interest

The authors declare no conflict of interest.

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