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Investigating the Impact of Establishing Chest Pain Units in Rural Areas on the Treatment and Prognosis of Patients with Acute ST-Segment Elevation Myocardial Infarction

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Abstract

Objective

To investigate the effects of rural chest pain units (CPU) on treatment timelines, clinical outcomes, and prognosis in patients with acute ST-segment elevation myocardial infarction (STEMI).

Methods

This retrospective study enrolled 562 rural STEMI patients (May 2021–June 2023, Suining County People's Hospital) who underwent successful primary percutaneous coronary intervention (PPCI). Patients were stratified into CPU transport (Group A, n = 166) and non-CPU (Group B, n = 396) cohorts. Post-discharge follow-up (1/3/6/12 months, endpoint: all-cause mortality) and comparisons of clinical data, major adverse cardiac events (MACE) were performed.

Results

Median follow-up: 12 months. Group A exhibited shorter SO-to-FMC, FMC-to-ECG, emergency-to-catheterization, door-to-wire (D-to-W) times, and hospital stay (all $P < 0.001$). MACE incidence was lower in Group A (13.86% vs. 29.29%, $P < 0.001$). MACE group had longer timelines, older age, higher female proportion, lower LVEF (all $P < 0.05$). Group ($OR = 2.247$), gender ($OR = 4.940$), age, Killip class, D-to-W, SO-to-FMC were independent MACE predictors (all $P < 0.05$); these factors also had MACE predictive value.

Conclusion

Rural standardized CPU reduce pre-hospital delays and improve STEMI prognosis.

Clinical trial number: not applicable.

1. Introduction

Acute chest pain, a common symptom in emergency departments, accounts for 5%-30% of emergency visits[1], with a significant proportion of high-risk chest pain cases being due to acute coronary syndrome (ACS)[2]. Among the types of ACS, acute ST-segment elevation myocardial infarction (STEMI) is a leading cause of mortality[3]. Studies from multiple centers have demonstrated[4–6]that the treatment time for STEMI is critical to patient prognosis, as every minute of delay in treatment can increase myocardial cell necrosis, thereby elevating the risk of death and disability for patients[7]. Therefore, establishing efficient and standardized chest pain centers (CPC) is crucial for reducing reperfusion time and enhancing the treatment efficiency for patients with STEMI[8, 9].

According to the latest data from the "Report on Cardiovascular Health and Diseases in China 2022"[10]: the mortality rate of cardiovascular diseases (CVD) in rural areas has exceeded and remained higher than that in urban areas since 2009. The mortality rate from acute myocardial infarction has significantly increased since 2012 and has been higher than urban levels since 2013. The cardiovascular health issue in rural China is not only severe but also worsening, making rural areas a critical zone for cardiovascular diseases[11, 12]. It is essential to shift more attention to rural areas, focus on patients with chest pain in these regions, and improve the treatment level for chest pain patients in rural areas.

Currently, the diagnosis and treatment of chest pain in rural areas of China face several challenges. First, resource limitations, such as a shortage of professional personnel and inadequate medical facilities, lead to difficulties in diagnosis or misdiagnosis. Second, residents may lack awareness of the severity of chest pain and emergency knowledge. Third, the referral system is underdeveloped, making it difficult for acute chest pain patients to be quickly transferred to centers or hospitals with better facilities.

To address these issues in rural chest pain treatment, we proposed to build a treatment network between municipal hospitals and have achieved initial results[13–15], but the network has not sunk into rural areas. In order to solve the problem of treating patients with chest pain in rural areas, the China CPC Alliance proposed a strategy in October 2019 to establish CPU in township hospitals and community health service centers. These units are a vital component of the regional collaborative treatment system for CPC[16], integrating medical resources from higher and lower levels and creating green channels. Although some regions have established CPU in rural areas, there is still insufficient evidence to support whether they can genuinely reduce mortality rates and improve the prognosis for rural patients. This study aims to investigate the impact of establishing CPU in rural areas on the diagnosis, treatment, and prognosis of patients with STEMI.

2. Materials and Methods

2.1. Patient recruitment

Patient Cohort and Study Criteria: Figure 1 presents the cohort of patients with STEMI consecutively selected 631 rural patients diagnosed, who were admitted to the CPC of Suining County People's Hospital between May 13, 2021, and June 25, 2023, and who underwent PPCI within 12 hours of symptom onset. Among these patients, 75 (11.89%) were lost to follow-up. After verification with the population registry, 6 were confirmed deceased, and the remaining 69 patients, though alive, could not be contacted and were excluded from the study. Ultimately, 562 patients (including the 6 deceased) were successfully followed up. Of these, 166 patients were transported by the chest pain treatment unit (Group A), and 396 patients were not (Group B)

. **Inclusion Criteria**: Age over 18 years. Meeting the diagnostic criteria for STEMI[17]: chest pain lasting more than 30 minutes, with surface ECG showing ST-segment elevation of more than 0.2 mV in two contiguous leads and dynamic ST-segment changes, and newly detected regional wall motion abnormalities on cardiac ultrasound. Onset of symptoms occurred in rural areas of Suining County. Successfully underwent PPCI. **Exclusion Criteria**: Unwilling to participate in the study. Life expectancy less than 1 year. Did not undergo PPCI treatment.

This study protocol was approved by the Ethics Committee of Suining County People's Hospital (Ethics Approval Number: LL-2022-24).

2.2 Study Methods

Treatment Requirements: The initial treating physician was required to perform the first ECG and cardiac enzyme tests according to the chest pain unit's timeline. The ECG was then uploaded to a WeChat contact group, where the on-duty physician of our hospital at the CPC would interpret the ECG in real-time, providing guidance for initial treatment and transportation.

Collected indicators included age, gender, time from SO-to-FMC, and time from FMC to emergency department visit. For patients undergoing PPCI treatment, the time from emergency reception to transfer to the catheterization room (recorded as 0 minutes if bypassing the emergency and Coronary Care Unit (CCU), D-to-W, and total PPCI time were recorded. Post-procedure Thrombolysis in Myocardial Infarction (TIMI) flow and admission Killip classification were also noted. Bedside cardiac ultrasound was performed within 1-3 days post-surgery, and in-hospital MACE were documented. Follow-ups were conducted via outpatient visits and telephone at 1, 3, 6, and 12 months post-discharge to record the occurrence of MACE, with all-cause mortality as the follow-up endpoint.

Definitions

() Admission Blood Pressure: Upon admission to the emergency department or catheterization room, the patient's blood pressure was measured using a standardized and calibrated blood pressure monitor. Two measurements were taken, with a 1-2minute interval between each. All readings were recorded, and the average of the two readings was used.

() MACE: This includes all-cause mortality, recurrent acute myocardial infarction, unplanned revascularization, and newly onset acute heart failure or acute exacerbation of chronic heart failure.

2.3 Statistical Analysis

Data were analyzed using SPSS version 27.0 software. For Groups A and B, normally distributed continuous variables were expressed as mean ± standard deviation ($\bar{x}\pm s$) and compared using the independent samples *t*-test. Non-normally distributed continuous variables were analyzed using non-parametric tests and presented as median (Q2-Q3). Categorical data were expressed as frequency (%) and compared using the χ^2 test. Graphs were created using GraphPad Prism software. Logistic regression analysis was used to identify risk factors for the occurrence of MACE events. $P < 0.05$ was considered statistically significant.

3. Results

3.1 Comparison of General Data of Enrolled Patients

As is shown in Table 1the pre-hospital antiplatelet use rate in Group A was significantly higher than in Group B, with a statistically significant difference (99.40% *vs.* 91.41%, *P*<0.001). The SO-to-FMC and FMC-to-first ECG times in Group A were shorter than those in Group B, with statistically significant differences [170.00 (140.00-240.00) *vs.* 188.50 (152.00-300.00) minutes, 6.00 (4.00-7.00) *vs.* 6.00 (4.00-10.00) minutes, *P*=0.001, *P*<0.001]. The establishment of CPU had a significant impact on reducing the treatment time for patients.

Patients in the MACE group had a higher average age [78.5 (62.00-85.00) *vs.* 69.00 (59.00-76.00) years, *P*<0.001], higher proportion of females (56.83% *vs.* 22.46%, *P*<0.001), and longer SO-to-FMC time [245.50 (160.00-369.25) *vs.* 180.00 (145.00-258.00) minutes, *P*<0.001] compared to the non-MACE group. The proportion of patients with a smoking history in the MACE group was lower than in the non-MACE group (22.30% *vs.* 33.57%, *P*=0.013), with all differences being statistically significant.

Table 1 General Data of 562 Patients Undergoing PPCI Treatment

category	Group A（n=166）	Group B（n=396）	$t/\chi^2/Z$	*P*	MACE group （n=139）	non-MACE group （n=423）	$t/\chi^2/Z$	*P*
Age (years)	71.50 （61.75~79.00）	70.00 （59.00~78.00）	-1.749	0.080	78.5 （62.00~85.00）	69.00 （59.00~76.00）	-6.096	**<0.001**
Female (%)	58（34.94%）	116（29.29%）	1.745	0.187	79（56.83%）	95（22.46%）	57.839	**<0.001**
History of smoking (%)	42（25.30%）	131（33.08%）	3.322	0.068	31（22.30%）	142（33.57%）	6.234	**0.013**
History of hypertension (%)	58（34.94%）	145（36.62%）	0.142	0.706	52（37.41%）	151（35.70%）	0.133	0.715
History of hyperlipidemia（%）	14（8.43%）	38（9.60%）	0.188	0.664	14（10.07%）	38（8.98%）	0.148	0.701
Heart rate (times/min)	77.58±14.14	75.40±15.65	1.550	0.122	76.50±16.13	75.89±14.95	0.406	0.685
Admission systolic pressure（mmHg）	132.00 （117.00~149.25）	134.00 （115.00~151.25）	-0.628	0.530	134.50（113.75-153.25）	133.00（116-150）	-0.006	0.995
Admission diastolic pressure（mmHg）	79.00 （70.00~90.00）	80.00 （70.00~95.00）	-0.567	0.571	78.00 （69.00~90.00）	80.00 （70.00~94.00）	-1.483	0.138
Prehospital antiplatelet（%）	165（99.40%）	362（91.41%）	11.435	**<0.001**	129（92.81%）	398（94.09%）	0.295	0.587
SO-to-FMC（min）	170.00 （140.00~240.00）	188.50 （152.00~300.00）	-3.179	**0.001**	245.50 （160.00~369.25）	180.00 （145.00~258.00）	-4.323	**<0.001**
Time from FMC to first ECG（min）	6.00（4.00~7.00）	6.00（4.00~10.00）	-3.424	**<0.001**	6.00（4.75~8.00）	6.00（4.00~8.00）	~0.055	0.956

Abbreviation：D-to-W: door-to-wire; FMC: first medical contact; SO-to-FMC: symptom onset to first medical contact; PPCI: primary percutaneous coronary intervention; ECG: electrocardiogram.

3.2 Comparison of Clinical Data of Patients Undergoing PPCI Treatment

A total of 562 patients received PPCI treatment (166 in Group A and 396 in Group B). The emergency reception to catheterization room time [17.50 (7.50-23.00) *vs.* 25.00 (16.00-35.00) minutes, *P*<0.001], D-to-W time [67.00 (47.00-82.00) *vs.* 78.00 (64.75-98.00) minutes, *P*<0.001], and hospital stay [7.00 (5.00-8.00) *vs.* 8.00 (6.00-9.00) days, *P*<0.001] in Group A were significantly shorter than those in Group B, with statistically significant differences.

In the MACE group, the time from emergency reception to catheterization room [25.00 (15.00-35.00) *vs.* 22.00 (13.00-31.00) minutes, *P*=0.007], D-to-W time [85.00 (68.75-111.25) *vs.* 72.00 (55.00-88.00) minutes, *P*<0.001], and total PPCI time [60.00 (49.75-70.25) *vs.* 55.00 (48.00-66.00) minutes, *P*=0.043] were all longer than those in the non-MACE group. The LVEF [56.00 (45.00-62.00%) *vs.* 59.00 (50.00-65.00%), *P*<0.001] was lower in the MACE group compared to the non-MACE group. These differences were all statistically significant (Table 2).

Table 2 Comparison of Clinical Data of 562 Patients Undergoing PPCI Treatment

category	Group A（n=166）	Group B（n=396）	$t/\chi^2/Z$	*P*	MACE group（n=139）	non-MACE group （n=423）	$t/\chi^2/Z$	*P*
The emergency reception to catheterization room time （min）	17.50（7.50~23.00）	25.00（16.00~35.00）	-7.868	**<0.001**	25.00（15.00~35.00）	22.00（13.00~31.00）	-2.687	**0.0**
D-To-W（min）	67.00（47.00~82.00）	78.00（64.75~98.00）	-5.915	**<0.001**	85.00（68.75~111.25）	72.00（55.00~88.00）	-5.442	**<0.**
Total PPCI time（min）	58.00（49.00~68.00）	57.50（47.75~68.00）	-0.477	0.634	60.00（49.75~70.25）	55.00（48.00~66.00）	-2.021	**0.0**
Convict vessel								
LAD（%）	69（41.57）	153（38.64）	2.882	0.410	55（39.57）	167（39.48）	1.741	0.6
LCX（%）	23（13.86）	43（10.86）			16（11.51）	50（11.82）		
RCA（%）	63（37.95）	160（40.40）			59（42.45）	164（38.77）		
LM（%）	11（6.62）	40（10.10）			9（6.47）	42（9.93）		
Number of Stents Implanted	1.00（1.00~1.00）	1.00（1.00~2.00）	-0.889	0.375	1.00（1.00~1.00）	1.00（1.00~2.00）	-0.234	0.8
Cardiac ultrasound-related data								
left atrial diameter（mm）	34.00（31.00~38.00）	34.00（31.00~37.00）	-0.914	0.361	35.00（31.00~38.00）	34.00（31.00~37.00）	-1.509	0.1
right atrial diameter（mm）	33.00（29.00~35.00）	32.00（30.00~35.00）	-0.380	0.704	32.00（29.00~35.00）	32.00（30.00~35.00）	-0.036	0.9
left ventricular end-diastolic diameter（mm）	46.00（43.75~50.00）	46.00（42.00~50.00）	-0.738	0.461	46.00（42.00~50.25）	46.00（43.00~50.00）	-0.580	0.5
LVEF（%）	58.00（49.00~64.00）	58.00（49.75~65.00）	-0.463	0.643	56.00（45.00~62.00）	59.00（50.00~65.00）	-3.200	**0.0**
hospitalization expenses （CNY）	25667.44 （22447.16~32664.77）	24809..99 （21985.02~31765.76）	-1.355	0.175	24818.49 （21985.02~30935.96）	25161.17 （21985.02~32336.12）	-0.172	0.8
hospitalization days	7.00（5.00~8.00）	8.00（6.00~9.00）	-6.025	**<0.001**	7.00（6.00~9.00）	7.00（6.00~9.00）	-0.572	0.5

Abbreviation：CNY=Chinese Yuan；D-To-W: Time from entry to guide wire passage；LAD: left anterior descending artery; LCX: left circumflex artery; RCA: right coronary artery; LM: left main artery; LVEF: left ventricular ejection fraction；PPCI：Primary Percutaneous Coronary Intervention.

3.3 Comparison of MACE Incidence Between Two Patient Groups

We can see from Figure 2，the incidence of in-hospital MACE was recorded for patients undergoing PPCI. In Group A (166 patients), 23 patients (13.86%) experienced MACE, including 3 cases of cardiogenic shock, 5 cases of all-cause mortality, 7 cases of heart failure, and 8 cases of malignant arrhythmias. In Group B (396 patients), 116 patients (29.29%) experienced MACE, comprising 23 cases of all-cause mortality, 19 cases of cardiogenic shock, 44 cases of new-onset heart failure, and 30 cases of malignant arrhythmias. The incidence of MACE in Group A was significantly lower than in Group B (13.86% *vs.* 29.29%, χ^2 = 14.975, P<0.001), indicating a statistically significant difference.

3.4 Factors Influencing the Occurrence of MACE During the Follow-Up Period

As is shown in Table 3, univariate analysis revealed that group (non-chest pain unit), gender (female), age, Killip classification, LVEF%, D-to-W, SO-to-FMC, total PCI time, and time from emergency department admission to the catheterization laboratory were associated with the occurrence of MACE during the follow-up period. Further multivariate logistic regression analysis, adjusting for other variables, indicated that group [*OR* = 2.247, 95% *CI* (1.230, 4.105), *P* = 0.008], gender [*OR* = 4.940, 95% *CI* (3.083, 7.916), *P* < 0.001], age [*OR* = 1.039, 95% *CI* (1.018, 1.061), *P* < 0.001], Killip classification [*OR* = 1.242, 95% *CI* (1.020, 1.512), *P* = 0.031], D-to-W [*OR* = 1.017, 95% *CI* (1.009, 1.026), *P* < 0.001], and SO-to-FMC [*OR* = 1.003, 95% *CI* (1.001, 1.004), *P* = 0.002] remained independent factors associated with the occurrence of MACE during the follow-up period.

Table 3 Factors influencing the long-term occurrence of MACE

Variables	Univariate Analysis	*P*	Multivariate Analysis	*P*
	OR（95% *CI*）		*OR*（95% *CI*）	
Non-chest pain unit group	2.576（1.577-4.207）	**<0.001**	2.247（1.230-4.105）	**0.008**
Female	4.546（3.029-6.822）	**<0.001**	4.940（3.083-7.916）	**<0.001**
Age	1.053（1.034-1.072）	**<0.001**	1.039（1.018-1.061）	**<0.001**
Heart rate	1.003（0.990-1.015）	0.684		
Killip classification	1.352（1.149-1.591）	**<0.001**	1.242（1.020-1.512）	**0.031**
LVEF	0.970（0.953-0.987）	**<0.001**	0.972（0.951-0.993）	**0.011**
D-to-W time	1.020（1.013-1.027）	**<0.001**	1.017（1.009-1.026）	**<0.001**
SO-to-FMC time	1.003（1.002-1.004）	**<0.001**	1.003（1.001-1.004）	**0.002**
FMC-to-ECG time	0.998（0.953-1.044）	0.919		
Total PCI time	1.017（1.006-1.029）	**0.003**	1.011（0.998-1.024）	0.096
Post-procedural TIMI flow	0.367（0.135-1.001）	0.050		
Number of stents implanted	1.014（0.712-1.444）	0.937		
Time from emergency department arrival to catheterization laboratory	1.023（1.009-1.037）	**<0.001**	1.010（0.993-1.027）	0.244

Abbreviation：LVEF=Left ventricular ejection fraction；SO-to-FMC：Symptom onset to first medical contact time；D-To-W=Door-to-wire；PPCI：Primary Percutaneous Coronary Intervention.

3.5 Impact of Different Arrival Methods on MACE

Follow-up concluded when patients either experienced all-cause mortality or successfully completed a 12-month follow-up period. The last follow-up time (in months) for each patient was recorded. There was no statistically significant difference in follow-up time between Group A and Group B [Z = -1.398, P = 0.162]. However, Kaplan-Meier survival analysis showed that the survival rate in Group B was lower compared to Group A (Figure 3).

3.6 ROC Analysis of Factors Associated with MACE During Follow-Up

The Receiver Operating Characteristic (ROC) curves were plotted for the relevant factors identified. The Area Under the Curve (AUC) values for each variable were as follows: Killip classification (0.564), group (0.586), LVEF (0.590), SO-to-FMC (0.622), D-to-W (0.654), and both gender and age (0.672). These factors demonstrated varying degrees of predictive value for the occurrence of MACE (Figure 4, Table 4).

Table 4 Factors Associated with MACE During Follow-Up

Variables	AUC	*P*	95% *CI*	
			lower limit	upper limit
Group	0.586	0.002	0.534	0.638
Gender	0.672	0.000	0.618	0.726
Age	0.672	0.000	0.614	0.730
Killip	0.564	0.023	0.507	0.622
LVEF	0.590	0.001	0.536	0.645
D-to-W	0.654	0.000	0.601	0.706
SO-to-FMC	0.622	0.000	0.568	0.677

Abbreviation：LVEF=Left ventricular ejection fraction；SO-to-FMC：Symptom onset to first medical contact time；D-To-W=Door-to-wire；AUC：Area under the curve.

4. Discussion

This study investigates the impact of establishing CPU in rural areas on the diagnosis, treatment, and prognosis of patients with STEMI. The findings are as follows:

The pre-hospital antiplatelet use rate in the chest pain unit group (Group A) was significantly higher than in the non-chest pain unit group (Group B). Additionally, both the SO-to-FMC time and the time from FMC to the first ECG were significantly shorter in Group A compared to Group B.

2. Group A demonstrated greater efficiency during PPCI, with shorter times from emergency department admission to the catheterization laboratory, D-to-W, and overall hospital stay. 3. The incidence of MACE in Group A (13.86%) was significantly lower than in Group B (29.29%).

Multiple studies[18, 19] have shown that shortening pre-hospital treatment time can reduce the mortality rate of patients with STEMI. Pre-hospital delays limit early reperfusion in patients[20, 21]. Research[20, 22] identified advanced age, lower educational levels, and female gender as independent risk factors for delayed presentation in STEMI patients. Pre-hospital delays are a prominent issue in STEMI management[23], and despite various measures, this problem has not been effectively resolved[24, 25].

Germany has established a network of CPU that has played a certain effect to improve the treatment of ACS patients[26]. The 2019 Guidelines for the Diagnosis and Treatment of Acute ST-Segment Elevation Myocardial Infarction also proposed establishing a regional collaborative treatment network. The goal of the network is to extend to more community health service centers and township hospitals, creating a three-tiered linkage system at the city, county, and township levels. CPU are a crucial component of the regional collaborative chest pain treatment system, integrating modern development features to provide better medical services to grassroots populations.

This study found that treatment times (SO-to-FMC, time to first ECG, emergency department admission to catheterization laboratory, D-to-W, and hospital stay) were significantly lower in Group A than in Group B. This is consistent with previous studies on CPC. Studies[26] have shown that the time to complete the first ECG was better after the establishment of CPC. Davis *et al*.[27] also concluded that the hospital stay duration was shorter after the establishment of CPC compared to before. This indicates that the establishment of CPC or CPU ensures timely and accurate diagnosis and treatment during patient visits, improving diagnostic and treatment efficiency and reducing hospital stay duration.

Factors such as group, gender (female), age, Killip classification, D-to-W, and SO-to-FMC were identified as independent factors associated with MACE events. Among these, gender, age, and D-to-W showed notable predictive value for MACE events. Compared with young and middle-aged people, elderly patients with STEMI generally have a poorer prognosis due to significantly weaker sensitivity and self-repair ability. Previous studies[28, 29] have established that advanced age is a critical factor influencing the occurrence of MACE in STEMI patients. Research[30, 31] has also indicated that female STEMI patients are at a higher risk of MACE compared to males. The reason[32] is that female STEMI patients have diverse manifestations and fewer typical chest pain symptoms, resulting in delays in pre-hospital time. Treatment delays, such as prolonged reperfusion time, significantly impact the prognosis of STEMI patients[33]. A high Killip classification is not only an independent risk factor for MACE after PCI treatment in STEMI patients[34] but also a strong predictor of composite endpoint events in the long term[35].

There were no significant differences in age and gender between Groups A and B. The differences in MACE incidence and survival rates between the two groups were primarily attributed to the treatment times. Wei, TF *et al*.[36] also confirmed that shortening SO-to-FMC time significantly reduces treatment time, short-and long-term mortality, and the incidence of MACE in patients with STEMI. Our study found that the treatment times SO-to-FMC, time to first ECG, emergency department admission to catheterization laboratory, D-to-W were significantly shorter in Group A than in Group B. Previous research[37] has suggested that longer emergency visits and higher Killip classifications are associated with higher treatment times. In our study, the chest pain unit transport group significantly reduced treatment times, which not only helped lower Killip classifications but also improved patient prognosis.

Standardized Chest Pain Unit are effective means to shorten pre-hospital treatment time. Our study showed that age, SO-to-FMC, and D-to-W time were not only independent factors associated with MACE during the follow-up period but also had predictive value for MACE events during follow-up. Group A significantly reduced SO-to-FMC and D-to-W times, resulting in a lower incidence of MACE compared to Group B, highlighting the importance of CPU in improving clinical outcomes. Additionally, this study found that the average age and proportion of females in the MACE group were significantly higher than in the non-MACE group, demonstrating the high diagnostic value of age and gender in predicting MACE events. Focusing on elderly and female patients, optimizing treatment processes, and improving treatment efficiency are crucial for reducing MACE incidence.

Previous studies[38-40] have shown that establishing a regional collaborative chest pain treatment system helps shorten ischemia-reperfusion treatment times for STEMI patients and reduce hospitalization costs[41, 42]. However, our study did not find a statistically significant difference in hospitalization costs between Groups A and B, which is similar to the conclusions of Asher, E. *et al*[18], possibly due to the similar vascular conditions and treatment measures (*e.g.*, stent implantation, medication).

5. Study Limitations

This study has several limitations. First, it is focused on Suining rural areas, which may not fully represent all rural regions. Although the sample size of 562 cases is substantial, larger-scale studies might provide more generalizable results. Second, this study only included STEMI patients who underwent PPCI, so the findings may not be applicable to other types of myocardial infarction. Future research should expand the scope to cover more rural areas and different types of myocardial infarction to explore the effectiveness of CPU in various settings.

6. Conclusion

The construction and standardized implementation of CPU in rural areas are of significant importance in shortening treatment times, improving patient outcomes, and enhancing long-term prognosis.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Suining County People's Hospital, and the ethics number is: LL-2022-24. All methods were conducted in accordance with relevant guidelines and regulations and informed consent was obtained from all participants.

Consent for publication

Not applicable.

Availability of data and materials

The raw data supporting the conclusions of this article will be made available upon reasonable request to the corresponding author.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

QZ was involved in designing the study and drafting the manuscript. YL contributed to the study design and supervised the work. RW and WC revised the manuscript and were involved in the study design. HW and YQ collected and analyzed the data. XY assisted with data organization and interpretation of results. TM revised the manuscript and performed the final proofreading. All authors read and approved the final manuscript.

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Figures

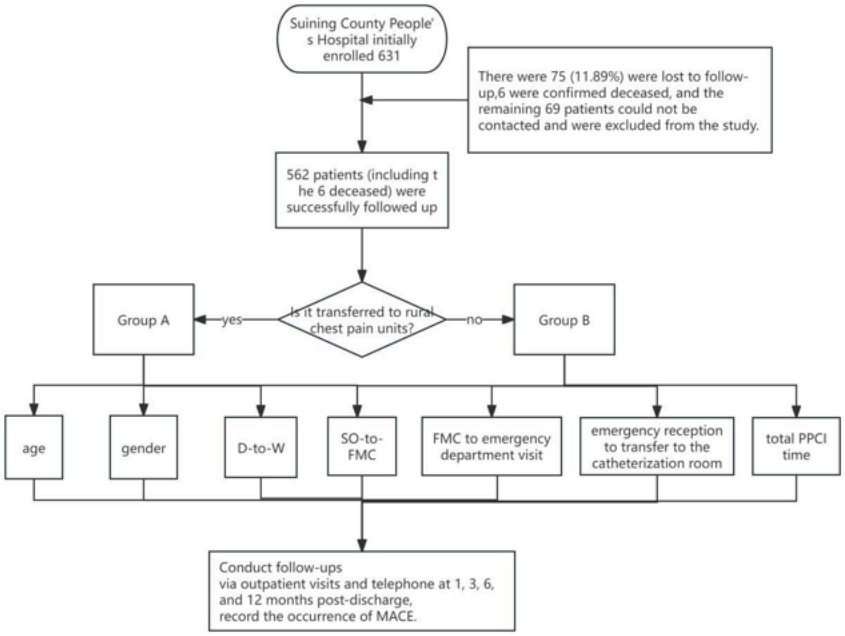


Figure 1

Research flow chart.

Abbreviations: D-to-W: door-to-wire; SO-to-FMC: symptom onset to first medical contact; PPCI: primary percutaneous coronary intervention.

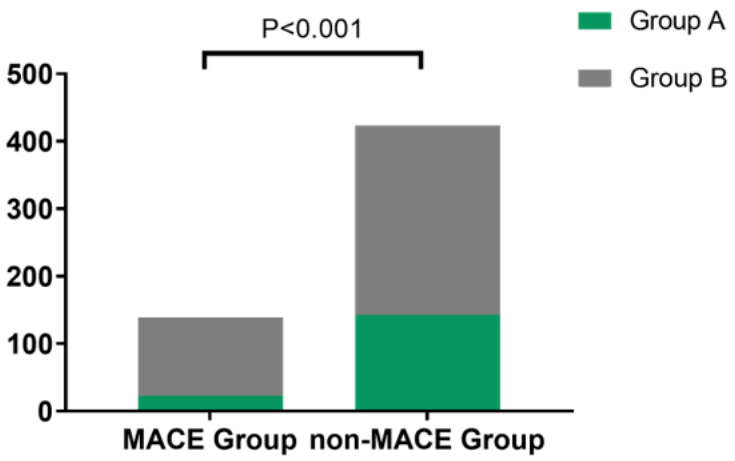


Figure 2

Comparison of MACE Incidence Between Two Patient Groups

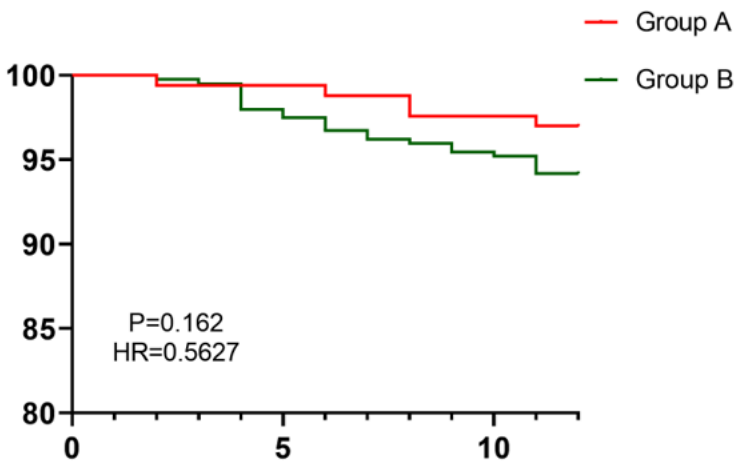


Figure 3

Kaplan-Meier survival curves of patients in groups A and B

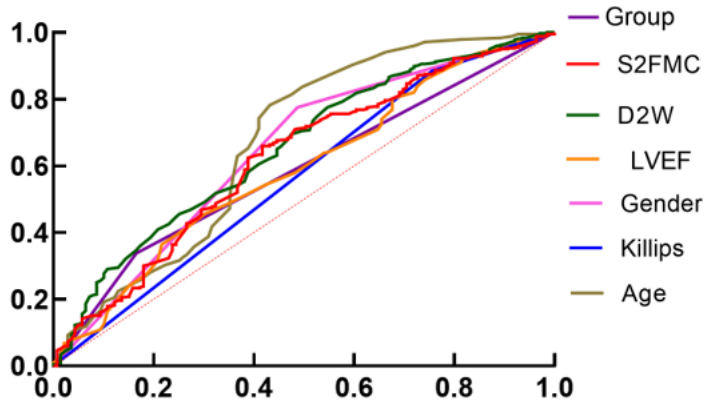


Figure 4

ROC Analysis of Factors Associated with MACE During Follow-Up

Abbreviation：LVEF=Left ventricular ejection fraction；SO-to-FMC：Symptom onset to first medical contact time；D-To-W=Door-to-wire