ORIGINAL ARTICLE

Pre-hospital Delays Among Patients with Acute Coronary Syndrome in the Central Region of Malaysia and Their Associated Factors

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ABSTRACT

Introduction: Early arrival at the hospital and initiation of reperfusion treatment are critical for improving patient outcomes during cardiac events. Pre-hospital delays remain the most significant barrier to the effective management of acute coronary syndrome (ACS). However, there is a lack of data on pre-hospital delays in Malaysia. Therefore, the study aimed to identify the factors contributing to pre-hospital delays. **Materials and methods:** This cross-sectional study was conducted in two government hospitals. Patients who developed ACS outside the hospital and had their time of symptom onset and time of arrival at the hospital recorded were recruited using universal sampling. Multiple logistic regression was utilised to determine the factors associated with pre-hospital delays of more than 2 hours. **Results:** A total of 390 patients were included in this study. The median pre-hospital delay time was 3 (interquartile range=1.72) hours, with 77.2% of the patients experiencing delays. Pre-hospital delays of more than 2 hours were significantly associated with atypical chest pain (adjusted odds ratio [AOR]=3.33; 95% confidence interval [CI]=1.73, 6.41; P<0.001), no history of hyperlipidaemia (AOR=2.03; 95% CI=1.09, 3.80; P= .027), transportation sent by another person (AOR=17.11; 95% CI=8.44, 34.71; P<0.001) and self-driven transportation (AOR=16.93; 95% CI=5.09, 56.30; P<0.001). **Conclusion:** The majority of the patients with ACS experienced pre-hospital delays of more than 2 hours. Interventions aimed at increasing public awareness about the symptoms of ACS and available modes of transportation are important for improving emergency cardiac care in Malaysia.
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Keywords: Treatment delay, Emergency medical services, Cardiovascular diseases, Myocardial ischaemia, Low- and middle-income country

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INTRODUCTION

Over the last decade, circulatory diseases, such as acute coronary syndrome (ACS), have remained the principal causes of mortality and morbidity both worldwide and in Asia–Pacific countries, including Malaysia (1,2). Early arrival at the hospital and initiation of reperfusion treatment are critical for improving patient outcomes (3). Research has shown that pre-hospital delays are one of the predictors of in-hospital complications, including recurrent ischaemia, arrhythmia, heart failure and longer hospital stay (4).

The pre-hospital delay time (PDT) is defined as the interval between the time of symptom onset and the time of arrival at the emergency department of a hospital (5,6). The advantages of treatments such as thrombolysis and primary angioplasty are inversely related to the delay time (7,8). It has been suggested that for every half-hour delay in the administration of thrombolysis or angioplasty, the 1-year mortality rate increases by 7.5% (9). Therefore, clinical practice guidelines have emphasised the importance of keeping the total cardiac ischaemic time within a maximum of 2 hours and ideally within 1 hour for optimal results (10,11).

Previous literature has demonstrated that delays in seeking care for cardiac events are a problem both internationally and in Malaysia. The time taken to seek care for ACS events varies across countries. In Europe, the median PDT ranges from 2.0 to 4.0 hours (12,13). In the United States, the mean PDT spans from 1.9 to 3.3 hours (14–16). In Asia, the PDT varies from 1.8 to

4.0 hours, with Japan reporting 3.5 hours (17); China, 4 hours (18); and India, 4.8 hours (19). According to the Thailand Acute Coronary Syndrome Registry, the median delay time is 4.0 hours in Southeast Asia (20). Conversely, a local study conducted in two tertiary hospitals in Kelantan and Terengganu found a median PDT of 2.2 hours (21).

Prior studies performed in different countries have reported various factors associated with pre-hospital delays, including older age, female sex, low socio-economic status, low educational level, co-morbidities (e.g. diabetes and hypertension), cognitive function and symptom interpretation (6,22–24). Furthermore, some studies have shown that cognitive and psychological factors such as feelings, emotions, behaviours and reactions towards symptoms contribute to delays in hospital arrival (25–27). Nevertheless, these studies have not consistently identified the factors influencing pre-hospital delays. This inconsistency may be attributed to differences in methodology, including variable choice, sample selection and research setting.

Malaysia is a middle-income country situated in the Asia–Pacific region. It comprises 13 states and three federal territories. Cardiac care services are provided by both the government and private health sectors (28). Government health facilities are highly subsidised by the Ministry of Health, making them more affordable for the public (29). Consequently, the majority of the population utilises government services.

In Malaysia, limited studies have evaluated pre-hospital delays and their associated factors among patients with ACS. Only one study has been found, conducted at a government hospital in the states of Kelantan and Terengganu, which are situated on the east coast of Peninsular Malaysia (21). This study revealed that the factors associated with pre-hospital delays were female sex, atypical symptoms and a private clinic as the first medical contact (21). However, the factors influencing pre-hospital delays among patients with ACS vary, and many research findings regarding clinical status, medical history and certain demographic variables are contradictory. Thus, the results of the study may not be generalisable to other regions of Malaysia due to the diversity of cultural practices and socio-economic development across the country.

Our study aimed to identify the factors associated with pre-hospital delays among patients with ACS in the Klang Valley, the central region of Peninsular Malaysia. This area is experiencing rapid socio-economic development with urbanised cities, where the population is at a high risk for stress and a sedentary lifestyle, which contribute to ACS. Thus, identifying the factors affecting pre-hospital delays could help healthcare practitioners develop appropriate patient-targeted educational interventions to promote early arrival at the hospital for timely treatment and raise awareness about cardiovascular diseases.

MATERIALS AND METHODS

Study design and settings

This cross-sectional study was conducted from 15 January 2022 to 31 July 2023 in two tertiary care government hospitals: Serdang Hospital and Kuala Lumpur Hospital. Serdang Hospital is a dedicated cardiac referral centre for cardiovascular disease treatment for the central region and across the country. Kuala Lumpur Hospital is the largest government hospital in Malaysia and serves as a tertiary care hospital. These two hospitals were purposely selected due to the substantial amount of ACS cases available.

Sample size

The sample size was calculated using the single-proportion formula, based on the study conducted by Lim et al. (21). This study found that the median PDT was 2.2 hours, with 36% of patients arriving late. The estimated sample size was 354, and the minimum sample size was 386, accounting for a non-response rate of 10%.

Sampling method

All patients who were admitted to the cardiology ward with a diagnosis of ACS within the study period were screened for eligibility for the study. Universal sampling was used to recruit all patients who met the inclusion criteria. Specifically, patients who were diagnosed with ACS, were aged 18 years and above, had developed cardiac symptoms outside the hospital, were haemodynamically stable (confirmed by stable vital signs), had no chest pain and/or discomfort and were alert and oriented to person, place and time at the time of interview were included in the study. Patients who were unable to provide the time of symptom onset or had another serious and life-threatening illness, including terminal illness, or cognitive impairment were excluded from the study.

Data collection

Patients with ACS were identified from hospital records upon admission to the cardiology ward. They were approached once their conditions were stabilised and they were pain-free, ensuring no interference with the standard of care. Informed written consent was obtained before data collection. Data were collected using a structured data collection form through face-to-face interviews. The data collection form consisted of three sections. Section I assessed sociodemographic information (i.e. age, sex, ethnicity, educational level, monthly household income and marital status) and clinical profile (i.e. current diagnosis; family history of coronary artery disease; history of comorbidities including hypertension, diabetes mellitus and hyperlipidaemia; and history of smoking). Section II evaluated the symptoms at presentation (i.e. previous

experience with chest pain and characteristic of chest pain) and situational factors (i.e. location of the incident, self-medication, mode of transportation, presence of a bystander and first medical contact). Section III captured the time of arrival at the hospital and the time of symptom onset. This information was obtained from patients and then verified with their medical records.

Data analysis

Data were entered and analysed using the IBM Statistical Package for the Social Sciences version 27. The dependent variable for this study was the PDT, which was calculated from the time of symptom onset to the time of arrival at the emergency department for treatment. The PDT was categorised into within 2 hours and more than 2 hours. These 2-hour cut-off times were chosen, as the current national clinical practice guidelines for the management of acute ST-segment elevation myocardial infarction (STEMI) recommend appropriate medical interventions to be administered within 2 hours of symptom onset for maximum reperfusion to occur (10). Furthermore, these cut-off times have been used in previous larger-scale landmark studies (24,30–32). The independent variables were the factors influencing pre-hospital delays (i.e. sociodemographic characteristics, cardiovascular risk factors, clinical symptoms and situational factors).

Descriptive statistics were used to present the profile of the study population. Categorical variables were described as frequencies and percentages, whereas continuous variables were presented as means and standard deviations for normally distributed data and medians and interquartile ranges (IQRs) for non-normally distributed data.

The factors associated with pre-hospital delays were assessed using the chi-square test, simple logistic regression and multiple logistic regression (MLR). The factors with P-values less than 0.25 in the simple logistic regression analysis were included in the MLR analysis (33). The enter method was applied for the MLR analysis. Adjusted odds ratios (AORs) were calculated, with P-values less than 0.05 considered statistically significant. The multicollinearity of the independent variables was examined using the variance inflation factor (VIF). A VIF value below 10 indicated no collinearity within the data. The fitness of the MLR model was assessed using the Hosmer–Lemeshow goodness-of-fit test, with P-values more than 0.05 indicating an adequate model fit.

Ethical Clearance

This study received ethical board approval from the Medical Research Ethics Committee of the Ministry of Health Malaysia (NMRR-20-2153-54157 [IIR]).

RESULTS

A total of 400 patients were approached, among whom 390 were recruited for this study, yielding a response rate of 97.5%. The median age of the participants was 56 (IQR = 14) years, and the age ranged from 34 to 72 years. The majority of the participants were men (75.1%, n = 293), received education up to secondary school (60%, n = 234) and were married (82.8%, n = 323). Half of the participants were Malay (54.4%, n = 212) and had a low monthly household income (53.3%, n = 208). Most were diagnosed with STEMI (59.3%) based on their ECG findings. Approximately 49.7%, 40.3% and 41.5% had hypertension, diabetes mellitus and hyperlipidaemia, respectively, while 53.3% had a history of smoking. One-third of the participants had a family history (34.9%) of cardiac diseases (Table I). The overall median PDT was 3 (IQR = 1.72) hours. Among all participants, 301 (77.2%) arrived late (more than 2 hours), while 89 (22.8%) arrived early (within 2 hours). Regarding the presentation of ACS, two-thirds of the participants experienced their first chest pain (65.6%), and only half presented with typical chest pain (54.1%). A large proportion of the participants self-medicated to reduce their symptoms (81.3%), and the majority began to experience the symptoms of ACS at home (62.8%). Nearly 90% of the participants had a bystander present during symptom onset. Only 22.6% arrived at the hospital by ambulance, while the others used their own transportation. Further, less than half of the participants visited the emergency department (47.2%) after symptom onset, while the remaining participants decided to visit a private clinic or health clinic (Table II). The bivariate analysis using the chi-square test showed that the characteristic of chest pain, mode of transportation, presence of a bystander and first medical contact were significantly associated with pre-hospital delays (Table III).

Table I: Sociodemographic and clinical profiles of the participants (N = 390)

Characteristic	Median (IQR)	n (%)
Age, year	56 (14)	
Sex		
Male		293 (75.1)
Female		97 (24.9)
Ethnicity		
Malay		212 (54.4)
Chinese		113 (29.0)
Indian		57 (14.6)
Others		8 (2.1)
Educational level		
Primary education		60 (15.4)
Secondary education		234 (60.0)
Tertiary education		96 (24.6)
Monthly household income		
B40 (<RM 4,850)		208 (53.4)
M40 (RM 4,851–10,970)		128 (32.8)
T20 (>RM 10,970)		54 (13.8)
Marital status		
Married		323 (82.8)
Single/widowed		67 (17.2)
Pre-hospital delay time		
≤2 hours		89 (22.8)
>2 hours		301 (77.2)
Diagnosis		
STEMI		231 (59.3)
NSTEMI		109 (27.9)
Unstable angina		50 (12.8)
Family history of CAD		
No		254 (65.1)
Yes		136 (34.9)
Hypertension		
No		196 (50.3)
Yes		194 (49.7)
Diabetes mellitus		
No		233 (59.7)
Yes		157 (40.3)
Hyperlipidaemia		
No		228 (58.5)
Yes		162 (41.5)
Smoking		
No		182 (46.7)
Yes		208 (53.3)

CONTINUE

Table II: Profile of the acute coronary syndrome cases at presentation

Symptoms at presentation	n (%)
Previous experience with chest pain	
No	256 (65.6)
Yes	134 (34.4)
Characteristic of chest pain	
Typical	211 (54.1)
Atypical	179 (45.9)
Situational variables	
Location of the incident	
Home	245 (62.8)
Workplace	75 (19.2)
Public place	70 (18)
Self-medication	
No	73 (18.7)
Yes	317 (81.3)
Mode of transportation	
Ambulance	88 (22.6)
Sent by another person	246 (63.0)
Self-drive	56 (14.4)
Presence of a bystander	
No	48 (12.3)
Yes	342 (87.7)
First medical contact	
Emergency department	184 (47.2)
Health clinic	81 (20.8)
Private clinic	125 (32.0)

Table III: Chi-square test of the association between the study factors and pre-hospital delays (N = 390)

Variable	≤2 hours n = 89	>2 hours n = 301	χ^2	P
Sociodemographic data				
Sex				
Male	62 (21.2)	231 (78.8)	1.84	0. 175
Female	27 (27.8)	70 (72.2)		
Ethnicity				
Malay	47 (22.2)	165 (77.8)	1.16	0.764
Chinese	29 (25.7)	84 (74.3)		
Indian	12 (21.1)	45 (78.9)		
Others	1 (12.5)	7 (87.5)		
Educational level				
Primary education	10 (16.7)	50 (83.3)	2.85	0.241
Secondary education	60 (25.6)	174 (74.4)		
Tertiary education	19 (19.8)	77 (80.2)		
Monthly household income				
B40 (<RM 4,850)	50 (24.0)	158 (76.0)	0.42	0.809
M40 (RM 4,851–10,970)	28 (21.9)	100 (78.1)		
T20 (>RM 10,970)	11 (20.4)	43 (79.6)		
Marital status				
Married	70 (21.7)	253 (78.3)	1.41	0.235
Single/widowed	19 (28.4)	48 (71.6)		
Clinical profile				
Diagnosis				
STEMI	59 (25.5)	172 (74.5)	4.33	0.114
NSTEMI	24 (22.0)	85 (78.0)		
Unstable angina	6 (12.0)	44 (88.0)		
CAD risk factors				
Family history of CAD				
No	59 (23.2)	195 (76.8)	0.69	0.793
Yes	30 (22.1)	106 (77.9)		
Hypertension				
No	41 (20.9)	155 (79.1)	0.81	0.368
Yes	48 (24.7)	146 (75.3)		
Diabetes mellitus				
No	53 (22.7)	180 (77.3)	0.002	0.966
Yes	36 (22.9)	121 (77.1)		
Hyperlipidaemia				
No	47 (20.6)	181 (79.4)	1.52	0.218
Yes	42 (24.2)	120 (74.1)		
Smoking				
No	48 (26.4)	134 (73.6)	2.45	0.118
Yes	41 (19.7)	167 (80.3)		
Symptoms at presentation				
Previous experience with chest pain				
No	56 (21.9)	200 (78.1)	0.38	0.539
Yes	33 (24.6)	101 (75.4)		

CONTINUE

Table III: Chi-square test of the association between the study factors and pre-hospital delays (N = 390) (CONT.)

Variable	≤2 hours n = 89	>2 hours n = 301	χ^2	P
Characteristic of chest pain				
Typical	66 (31.3)	145 (68.7)	18.68	<0.001*
Atypical	23 (12.8)	156 (87.2)		
Situational variables				
Location of the incident				
Home	58 (23.7)	187 (76.3)	2.83	0.244
Workplace	12 (16.0)	63 (84.0)		
Public place	19 (27.1)	51 (72.9)		
Self-medication				
No	14 (19.2)	59 (80.8)	0.68	0.411
Yes	75 (23.7)	242 (76.3)		
Mode of transportation				
Ambulance	57 (64.8)	31 (35.2)	11ƻ23.67	<0.001*
Sent by another person	27 (11.0)	219 (89.0)		
Self-drive	5 (8.9)	51 (91.1)		
Presence of a bystander				
No	3 (6.3)	45 (93.8)	8.53	0.003*
Yes	86 (25.1)	256 (74.9)		
First medical contact				
Emergency department	59 (32.1)	125 (67.9)	22.90	<0.001*
Health clinic	19 (23.5)	62 (76.5)		
Private clinic	11 (8.8)	114 (91.2)		

*P < 0.05

Table IV presents the results of the simple logistic regression and MLR analyses. The variables with P-values less than 0.25 in the simple logistic regression analysis were sex, marital status, current diagnosis of ACS, hyperlipidaemia, smoking, characteristic of chest pain, location of the incident, mode of transportation, presence of a bystander and first medical contact. These variables were included in the MLR model. Pre-hospital delays of more than 2 hours were significantly associated with atypical chest pain (AOR = 3.33; 95% confidence interval [CI] = 1.73, 6.41; P < 0.001), no history of hyperlipidaemia (AOR = 2.03; 95% CI = 1.09, 3.80; P = 0.027), transportation sent by another person (AOR = 17.11; 95% CI = 8.44, 34.71; P < 0.001) and self-driven transportation (AOR = 16.93; 95% CI = 5.09, 56.30; P < 0.001).

Table IV: Simple and multiple logistic regression analyses of the factors associated with pre-hospital delays of more than 2 hours among the patients with ACS (N = 390)

Variable	Simple logistic regression		Multiple logistic regression	
	Crude OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Sociodemographic data				
Sex				
Male	1.437 (0.850, 2.430)	0.176	0.866 (0.407, 1.843)	0.709
Female	1			
Marital status				
Married	1.431 (0.790, 2.590)	0.237	1.345 (0.633, 2.856)	0.441
Single/widowed	1			

CONTINUE

Table IV: Simple and multiple logistic regression analyses of the factors associated with pre-hospital delays of more than 2 hours among the patients with ACS (N = 390) (CONT.)

Variable	Simple logistic regression		Multiple logistic regression	
	Crude OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Clinical profile				
Diagnosis				
STEMI	1			
NSTEMI	1.215 (0.707, 2.087)	0.481	1.303 (0.652, 2.604)	0.453
Unstable angina	2.516 (1.020, 6.204)	0.045	2.472 (0.780, 7.832)	0.124
Hyperlipidaemia				
No	1.348 (0.838, 2.169)	0.219	2.030 (1.086, 3.795)	**0.027***
Yes	1			
Smoking				
No	1			
Yes	1.459 (0.908, 2.346)	0.119	1.555 (0.788, 3.069)	0.203
Symptoms at presentation				
Characteristic of chest pain				
Typical	1			
Atypical	3.087 (1.825, 5.222)	<0.001	3.333 (1.733, 6.411)	**<0.001***
Situational variables				
Location of the incident				
Home	1.201 (0.657, 2.196)	0.552	0.946 (0.429, 2.087)	0.890
Workplace	1.956 (0.869, 4.403)	0.105	1.504 (0.516, 4.390)	0.455
Public place	1			
Mode of transportation				
Ambulance	1			
Sent by another person	14.914 (8.23, 26.97)	<0.001	17.11 (8.438, 34.709)	**<0.001***
Self-drive	18.755 (6.78, 51.87)	<0.001	16.93 (5.096, 56.30)	**<0.001***
Presence of a bystander				
No	5.039 (1.527, 16.629)	0.008	2.762 (0.687, 11.108)	0.153
Yes	1			
First medical contact				
Emergency department	1			
Health clinic	1.540 (0.845, 2.806)	0.158	0.603 (0.275, 1.324)	0.207
Private clinic	4.892 (2.449, 9.771)	<0.001	1.849 (0.795, 4.305)	0.154

CI = Confidence interval, OR = Odds ratio, *P < 0.05
The enter method was applied for the multiple logistic regression analysis.
Multicollinearity and interactions were not found among the independent variables. The VIF value ranged from 1.014 to 1.302.
The Hosmer–Lemeshow test (P = 0.154), a classification table (overall correctly classified percentage = 86.4%) and areas under the ROC curve (86.6%) were applied to check the model fitness.

DISCUSSION

Summary of findings

The median symptom-to-door time was 3 (IQR = 1.72) hours. More than three-quarters of the patients (77.2%) experienced delayed arrivals at the hospital of more than 2 hours. The factors associated with pre-hospital delays were atypical chest pain, no history of hyperlipidaemia and private transportation to the hospital.

Comparison with other studies

The median PDT in our study (3 hours) is longer than the results reported in developed countries such as the United States (2.7 hours) (24), Australia (2.2 hours) (34), China (2.3 hours) (35) and Korea (2.5 hours) (36). However, the median time is shorter in this study than in some developing countries such as India (6 hours) (19), Bangladesh (9 hours) (37) and Indonesia (5 hours) (38). This variation in the delay times across different countries may relate to the social and cultural contexts of each society that play a role in people's responses to the symptoms of cardiac events. In addition, the differences in the healthcare system and access to ambulance services and emergency care may have an impact on the healthcare-seeking behaviour of patients with ACS.

We found that a large proportion of the patients (77.2%) experienced pre-hospital delays of more than 2 hours. This finding is worrying, as maximum reperfusion for

better outcomes requires medical interventions to be administered within 2 hours of symptom onset (39).

In the present study, the patients experiencing atypical symptoms had higher odds of delayed hospital admission than those presenting with typical symptoms. This factor was also reported as a predictor for pre-hospital delays in previous studies (34,40,41). Some patients experienced atypical symptoms such as body weakness, shortness of breath, abdominal discomfort and sweating during cardiac events, and these presentations were associated with substantially longer pre-hospital delays (24,34,42). The current society may still lack knowledge and awareness regarding atypical presentations, contributing to the lack of urgency in seeking hospital treatment early. Our study showed that the patients with no history of hyperlipidaemia had 2.03 times higher odds of delayed hospital arrival than those with a history of hyperlipidaemia. This finding is consistent with a previous local report indicating that patients with hyperlipidaemia tended to seek treatment early (21). Patients with hyperlipidaemia might have received health information from their healthcare providers, making them more aware of their risk for developing cardiovascular diseases and better able to recognise the symptoms of ACS that prompt early medical attention.
Our analysis revealed that using private transportation increased the risk of pre-hospital delays of more than 2 hours. This finding is consistent with some reports showing that patients who used an ambulance had a shorter delay than those who used private transportation (38,42). However, other previous studies reported contrasting findings (41). Our findings showed that most patients (63.0%) were sent to the hospital by another person, while only 22.6% were transported by an ambulance. One of the reasons private transportation was preferred over an ambulance could be that the public is still not well familiarised with the procedures for accessing ambulance services.

Implications for practice

There is a need to increase public awareness regarding the importance of seeking immediate and timely definitive treatment for ACS in the hospital. Interventions such as educational programmes for the public and high-risk patients regardless of their hyperlipidaemia status should focus on the atypical symptoms of ACS. Promoting the use of ambulance services as a mode of transportation may help shorten the PDT in seeking hospital treatment for ACS.

Strengths and limitations

To the best of our knowledge, this study is the first local research to provide insights into the extent of 2-hour pre-hospital delays, highlighting that nearly 80% of the patients presented to the hospital more than 2 hours after symptom onset. We also identified potential areas to target when developing educational programmes for the public and high-risk patients.

There are several limitations of this study. The survey questions used were close-ended and standardised. The use of variable choices in the survey questionnaire may not cover all factors influencing pre-hospital delays, such as cognitive and psychological factors. This study also did not recruit patients with ACS who were not stable enough to be interviewed during data collection, patients who did not seek medical care and patients who died outside the hospital. Thus, the results might not apply to these groups of patients. Further, patients may have recall bias regarding the time of symptom onset. To mitigate this limitation, we initiated the interviews as soon as the patients were stabilised. Finally, the distance from the site of the incident to the hospital could be a potential factor contributing to pre-hospital delays. However, we did not capture this distance in our study.

CONCLUSION

More than three-quarters of the patients (77.2%) experienced delayed arrivals of more than 2 hours. Atypical chest pain, no history of hyperlipidaemia and private transportation were associated with an increased risk for pre-hospital delays among patients with ACS. These findings may serve as a reference for healthcare professionals to raise awareness about pre-hospital delays and guide the development of health education content aimed at reducing these delays in ACS management.

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