RESEARCH ARTICLE

Influence of pre-hospital to post-hospital delay factors on MI complications: a prospective cohort study

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Abstract

Objective: To identify factors contributing to delays in in the initiation of treatment among ST elevation myocardial infarction patients.

Method: The prospective cohort study was conducted at the National Institute of Cardiovascular Disease, Karachi, from December 2020 to June 2021, and comprised ST elevation myocardial infarction patients of either gender aged at least 18 years. Time delay categories were 1st and 2nd delays that were patient-related, and 3rd delay that was system-related), with thresholds of ≤90 minutes and ≤120 minutes. Those who experienced delays were placed in group A, while the rest were in group B. Socio-demographic factors, co-morbidities, reasons of delay and in-hospital complications were recorded. Data was analysed using SPSS (version 21).

Results: Of the 348 patients, 174(50%) were in group A; 129(74.1%) males and 45(25.9%) females with overall mean age 57.52±10.59 years. The remaining 174(50%) were in group B; 148(85.1%) males and 26(14.9%) females with overall mean age 54.4±12.1 years. The delays were associated with male gender, education level and employment status (p<0.05). Factors contributing to 1st delay included lack of cardiac symptom awareness 77(77%), belief in symptom resolution 38(38%), attributing symptoms to gastric issues 30(30%), and dependency 14(14%). Transportation issues 4(66.7%), indirect commutation 3(50%) and distance 82(47.1%) caused the 2nd delay, while improper referrals 2(50%) and decision delays of more than an hour 1(25%) were common in the 3rd delay. Moreover, 150(86.2%) experienced in-hospital complications, and 88(50.6%) encountered both pre- and post-percutaneous coronary intervention complications (p=0.01).

Conclusions: Pre-hospital and post-hospital delaying factors had an impact on ST elevation myocardial infarction complications, highlighting the need for improved patient education on recognising cardiac symptoms and seeking timely medical attention to reduce ST elevation myocardial infarction complications.

Keywords: Delay factors, ST elevation myocardial infarction, STEMI, Percutaneous coronary intervention, PCI, three delay model, Myocardial infraction complications. (JPMA 75: 19; 2025)

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Introduction

The coronary heart disease (CHD) burden is escalating rapidly in South Asia, with Pakistan witnessing 240,720 CHD-related deaths in 2020, representing 16.49% of the total deaths.[1] The recognised treatment for ST segment elevation myocardial infarction (STEMI) is the timely administration of reperfusion therapy that is percutaneous coronary intervention (PCI).[2] According to the American Heart Association (AHA) guidelines, a patient with STEMI needs emergent catheterisation and PCI in <90 minutes from door to procedure initiation.[3] The prompt administration of the therapy leads to a reduction in complications and better survival.

Extensive research exists on the benefits of the timely administration of PCI.[4] The benefit to the mortality reduction by 50% was greatest when the PCI was administered within 4 hours from the onset of symptoms.[5] On the contrary, the reduction in mortality declines after 6 hours from the onset of symptoms, hence increasing in-hospital complications.[6] However, the coronavirus disease-2019 (COVID-19) pandemic led to a 40% rise in in-hospital mortality of PCI patients.[7]

The identification of factors responsible for the delay is crucial in preventing the complications of STEMI.[8] Despite the improvement in transportation services and the educational status of the individual, pre-hospital delay remains a substantial problem.[9] Factors related to lack of knowledge of acute MI (AMI) symptoms, presentation with atypical symptoms, misinterpretation of symptoms, delayed hospital admission, unusual symptom onset timings, and lack of access to cardiac hospital have also been reported.[10] Cardiovascular risk factors, which are a major contributor to morbidity and mortality in Pakistan, are on the rise in relation to AMI.

During the COVID-19 pandemic, the healthcare system faced significant strain, leading to reduction in AMI

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admissions by 47.1%.[11] This delay in seeking medical help contributes to the burden of cardiovascular disease (CVD) in Pakistan, highlighting the need to address these factors. The current study was planned to identify factors contributing to delays in AMI-related hospital admissions that are crucial for preventing in-hospital complications.

Patients and Methods

The prospective cohort study was conducted at the National Institute of Cardiovascular Disease (NICVD), Karachi, from December 2020 to June 2021. After approval from the institutional ethics review committee, the sample size was calculated using the OpenEpi calculator[12] with 95% confidence interval (CI), 5% margin of error, power 80%, and prevalence among the exposed group 34.3%, with the ratio between the exposed and unexposed group 1:1.[13] Assuming the odds ratio (OR) of 1.5 times, the sample size was inflated by 10%. The sample was divided equally between exposed group A and unexposed group B. Those included were adult participants of either gender aged >18 years who diagnosed with AMI on electrocardiogram (ECG) on the basis of elevation of ST segment of >2mm in 2 chest leads along with the ST-segment depression in leads opposite to the leads showing ST-segment elevation.[14] The sample was restricted to residents of Karachi who were undergoing primary PCI. Patients who were already diagnosed with other diseases, like valvular heart disease (VHD), atrial septal defect (ASD), ventricular septal defect (VSD) and cardiomyopathies, as well as pregnant women were excluded. The sampling method used in the study is convenience sampling. The participant's selection was based on the time of onset of the symptom to the time at the presentation of the hospital. The 6-hour time period was targetted because thrombolytic therapy's benefits decrease after this period.[15] The time delay in presentation at the hospital was calculated from the time of onset of symptoms to the arrival at the catheterisation laboratory (Cath lab) of more than 6 hours, and it was categorised into 3 types of delay. The 1st and 2nd delays accounted for patient-related delays, while the 3rd delay accounted for the system delay.[16] The time variables were categorised into 3 types; 1st delay ≤90 minutes,[17] 2nd delay ≤120 minutes[18] and 3rd delay from the arrival at the emergency department (ED) till arrival at the Cath lab arrival of ≤90 minutes.[19] The time delay of 1st and 2nd categories was recorded on the basis of accounts furnished by patients or their attendants. (Figure 1)

All data was collected after taking informed consent from the patients using a structured proforma that was calibrated and validated by clinical experts. The proforma included socio-demographic factors, smoking history and co-morbidities along with delay factors. Smoking status was considered active in those consuming >10 cigarettes per day. At the first level, factors such as lack of knowledge of cardiac symptoms, dependency, misinterpretation, and the belief that symptoms would resolve with time were considered. The second level focussed on transportation services utilised, distance from the residence to hospital, and whether the participants sought treatment from local practitioners or directly from some cardiac hospital. The third level examined proper referral processes and delays in decision-making for PCI. The data was collected from the different departments of the hospital. The principal investigator first met the patient at the ED, and then the patient was observed for in-hospital complications throughout the stay.

Data was analysed using SPSS (version 21). Data was expressed as mean ± standard deviation for continuous variables, and as frequencies and percentages for categorical variables. Chi-square test was used for categorical variables, and independent sample t-test was applied for continuous variables. For the variables of sparse data of cell count <5, fishers test was used. A 95% CI was taken into account with p<0.05 with 5% margin of error.

Results

Of the 348 patients, 174(50%) were in group A; 129(74.1%) males and 45(25.9%) females with overall mean age 57.52±10.59 years. The remaining 174(50%) were in group B; 148(85.1%) males and 26(14.9%) females with overall mean age 54.4±12.1 years. The delays were associated with male gender, education level and employment status (p<0.05) (Table 1).

Smoking history (Table 2) and co-morbidities (Table 3) were not significantly different between the groups (p>0.05).

Factors contributing to 1st delay included lack of cardiac symptom awareness 77(77%), belief in symptom resolution 38(38%), attributing symptoms to gastric issues 30(30%), and dependency 14(14%). Transportation issues 4(66.7%), indirect commutation 3(50%) and distance 82(47.1%) caused the 2nd delay, while improper referrals 2(50%) and decision delays of more than an hour 1(25%) were common in the 3rd delay (Table 4).

Moreover, 150(86.2%) experienced in-hospital complications, and 88(50.6%) encountered both pre- and post-PCI complications (Table 5).

Discussion

The primary aim of the current study was to examine the

Table-1: Socio-demographic characteristics of the Exposed and Unexposed participants

Socio-demographic Variable	Exposed Group (n=174)	Unexposed Group (n=174)	*p*-value
Gender			
Male	129 (74.1 %)	148 (85.1 %)	0.011*
Female	45(25.9 %)	26 (14.9 %)	
Age (In Years)	57.52 S. D ±10.59	54.4 S. D ±12.1	2.494
Marital Status			
Un Married	05 (2.9%)	07 (4%)	0.557
Ever Married	169 (97.1%)	167 (96.0%)	
Distance from the Residence to the health facility			
Less than 90 minutes	92(52.9%)	101 (58.0%)	0.332
More than 90 minutes	82 (47.1%)	73 (42.0 %)	
Education			
Educated	96 (55.2 %)	114 (65.5 %)	0.049*
Uneducated	78 (44.8 %)	60 (34.5%)	
Educational Status			
Uneducated	78(44.8%)	60 (34.5%)	0.114
Primary (1-5)	15 (8.6%)	12 (6.9%)	
Middle (6-8)	20 (11.5%)	22 (12.6%)	
Secondary (9-12)	41 (23.6%)	44 (25.3%)	
Graduation (12 +)	20 (11.5%)	36 (20.6%)	
Employment Status			
Unemployed	61 (35.1%)	40 (23.0%)	0.045*
Retired	23 (13.2%)	26 (14.9%)	
Employed	90 (51.7%)	108 (62.1%)	
Job type	n=90	n=108	
Blue collar	52 (57.7%)	55(50%)	0.071
White collar	38 (42.2%)	55(50%)	

Table-2: History of smoking among Exposed and Unexposed patients.

Smoking	Patients with Delay (n=174)	Patients without Delay (n=174)	*p*-value
Active Smoker			0.127
Yes	45(25.9%)	58 (33.6%)	
No	129 (74.1%)	116 (66.7%)	
Passive Smoker			0.894
Yes	35(20.1%)	36 (20.7%)	
No	139 (79.9%)	138 (79.3%)	
Ex-smoker			0.237
Yes	17 (9.8%)	11(6.3%)	
No	157 (90.2%)	163(93.7%)	

Table-3: Co-morbidities associated with myocardial infarction in Exposed and Unexposed patients.

Co-morbidities	Patients with Delay (n=174)	Patients without Delay (n=174)	*p*-value
Co-morbid			0.186
Yes	151 (86.8%)	142 (81.6%)	
No	23 (13.2%)	32 (18.4%)	
Hypertension			0.193
Yes	106 (60.9%)	94 (54.0%)	
No	68 (39.1%)	80 (46.0%)	
Diabetes Mellitus			0.046
Yes	74 (42.5%)	56 (32.2%)	
No	100 (57.5%)	118 (67.8%)	
History of Ischaemic Heart Disease			0.881
Yes	27 (15.5%)	26 (14.9%)	
No	147 (84.5%)	148 (85.1%)	

Table-4: Statistical stratification of delays, causal factors and complications.

Total time delay from the onset of symptoms to the Cath lab arrival			
Total Delay	**Exposed (n=174)**	**Unexposed (n=174)**	
Less than 6 hours	57(32.8%)	174 (100%)	
More than 6 hours	117 (67.2%)	00	
Combination of 1st, 2nd and 3rd delays & Its Factors among exposed group (n=174)			
1st delay Factors	**Exposed (n=100)**	**1st + 2nd (n=47)**	**1st +3rd (n=9)**
Timing of Onset of Symptoms			
Morning	24(24%)	01 (11.1%)	09 (19.1%)
Afternoon	22 (22%)	02 (22.2%)	10 (21.3%)
Evening	20 (20%)	02 (22.2%)	09 (19.1%)
Night	24 (24%)	04 (44.4%)	17 (36.2%)
Do not remember the time	10 (10%)	XX	02 (4.3%)
Knowledge of cardiac symptoms			
Yes	23 (23%)	01 (11.1%)	08 (17%)
No	77 (77%)	08 (88.9%)	39 (83%)
Reason seeking medical care			
Persistence of Symptom	12 (12%)		09 (19.1%)
Worsening of Symptom	88 (88%)	09 (100%)	38 (80.9%)
Reason for 1st delay			
Thought symptoms would resolve with time	38(38%)	XX	16 (34%)
Didn't know where to seek care	08 (8%)	03 (33.3%)	04 (8.5%)
Dependency	14 (14.0%)	03 (33.3%)	08 (17%)
Self-medication	07 (7%)	01 (11.1%)	04 (8.5%)
Gastric Interpretation	30 (30%)	02 (22.2%)	11 (23.4%)
Symptoms Resolved	01 (01%)	XX	Xx
Lack of financial resources	Xx	XX	01 (2.1%)
2nd Delay Factors	**Exposed (n=6)**	**1st+2nd delay (N=9)**	**2nd +3rd delay (n=2)**
Type of Transport			
Hospital Ambulance	01(16.7%)	04 (44.4%)	02(100%)
Self-Transport	04 (66.7)	02 (22.2%)	
Public Transport	01 (16.7%)	03 (33.3%)	
Direct Commutation to Cardiac Hospital			
Yes	03(50.0%)	03 (33.3%)	01(50%)
No	03 (50.0%)	06 (66.7%)	01(50%)
3rd Delay factors	**Exposed (n=4)**	**1st +3rd Delay (n=2)**	**2nd +3rd Delay (n=47)**
Referral			
Yes	02 (50%)	21 (44.69%)	02 (100%)
No	02 (50%)	26 (55.31%)	
Decision making			
Instantly	Xx	18 (38.2%)	02 (100%)
Less than 30 min	03 (75%)	23 (48.93%)	
More than 1 hour	01(25%)	06 (12.76%)	
Comparison of Complications between Exposed & Unexposed			
	Exposed (n=174)	**Unexposed (n=174)**	**P-Value**
In-Hospital Complications			
Yes	150 (86.2%)	33(19%)	0.00
No	24(13.8%)	141(81%)	
Timing of Complications			
Pre PCI	03(1.7%)	00	0.00
Post PCI	59 (33.9%)	15 (8.6%)	
Both	88 (50.6%)	18 (10.3%)	

Table-5: Stratification of complications at each level of delay between Exposed and Unexposed patients

Details	Total Delays 1st delay	2nd delay	3rd delay	Comparison of total delays 1st +2nd	1st +3rd	2nd +3rd	1st +2nd +3rd	*p*-value
	(n=100)	(n=6)	(n=4)	(n=9)	(n=47)	(n=2)	(n=6)	
In-Hospital Complications								
Yes	86(86%)	05 (83.3%)	04(100%)	07 (77.8%)	41(87.2%)	02(100%)	05 (83.3%)	0.00
No	14 (14%)	01 (16.7%)	xx	02 (22.2%)	06(12.8%)	XX	01 (16.7%)	
Timing of Complications								
Pre PCI	02 (2.32%)	xx	xx	01(14.28%)	XX	XX	XX	0.00
Post PCI	41 (47.67%)	02 (40%)	02 (50%)	05 (71.43%)	09(%)	XX	xx	
Both	43 (50%)	03 (60%)	02(50%)	01 (14.29%)	32(68.1%)	02(100%)	05 (83.3%)	

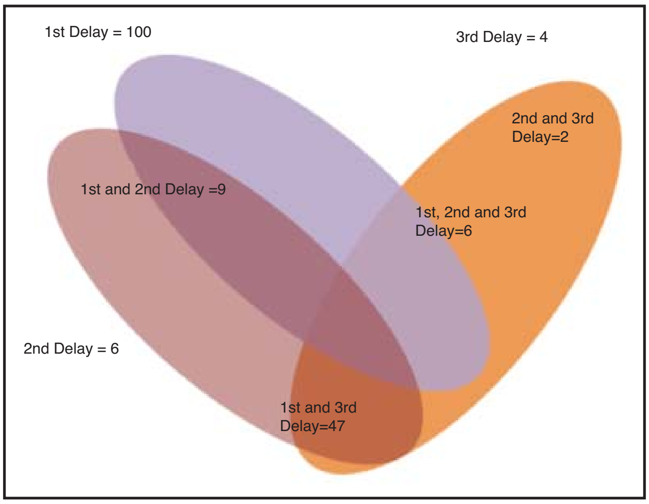

Figure-1: Venn diagram showing the overlap of different types of delay in ST segment elevation myocardial infraction (STEMI) patients.

factors contributing to pre-intervention delays that occurred at 3 levels from the onset of symptoms to the arrival at Cath lab for Primary PCI (PPCI) and their association with in-hospital complications, ultimately increasing morbidity and mortality rates.

There were clear variations between the genders; men were more likely to arrive at the hospital late because they were unaware of their symptoms or because they were unemployed or retired. On the other hand, 25.9% of women experienced delays as a result of cultural norms, dependence on male family members, or marital status being single, widower, or divorced. These results are consistent with earlier studies showing elderly women have longer pre-hospital delays than older men.[20-21]

Educational background also played a significant role. Uneducated individuals were more likely to develop in-hospital complications compared to their educated counterparts (p<0.015) mainly because they were not aware of cardiac symptoms. Consistent with the findings, a Pakistani study revealed that just 6% of individuals identified 2-3 symptoms of AMI, and 81% were unaware they were suffering with a potentially fatal condition.[22-23]

Smoking emerged as a major risk factor for CVD. The current study indicated that, in comparison to passive or ex-smokers, smokers' reckless behaviour (25.9%) contributed considerably to pre-hospital delays and subsequent in-hospital complications, even though they were aware of the harmful effects. This was in line with literature.[09]

One important risk factor for in-hospital problems linked to pre-hospital delays was found to be hypertension. Moser et al. also noted that hypertension, the female gender, and insufficient knowledge of MI symptoms were key contributors to delays (p=0.041).[24]

Pre-hospital delays were substantially correlated with a previous history of MI. It is difficult to distinguish between AMI and chronic pain in patients with a history of MI because they frequently have unusual symptoms and persistent pain (OR 1.35, p=0.006).[25]

Patient misinterpretation of symptoms and pain-resistant behaviour were major factors at the first level of delay. After adjusting for other variables, these factors remained independent predictors of pre-hospital delays at the first level (p<0.000), with ORs of 3.514 (95% CI: 2.589-5.276) and 4.488 (95% CI: 2.537-5.730), respectively. Similar findings were reported by Fukuoka et al. in 2005.[26]

The current findings are also supported by recent research, which shows that pre-hospital delays are strongly associated with the location of symptom onset, first medical contact with a private physician, distance from symptom onset to first medical contact, hospitalisation decision, symptom ignorance, and mode of transportation.[27]

The strength of the current study lies in its comprehensive examination of factors from pre-hospital to post-hospital delays. As a prospective cohort study, it provides robust data on events occurring both pre-PCI and post-PCI, with clinical data obtained from medical records to minimise recall bias. The study effectively highlights multiple causes of pre-hospital delays at all three levels, offering valuable insights into improving patient outcomes.

However, the current study has its limitations as the sample related to a single hospital. Also, as the data related to the time and symptom relies on the patient's statement, there is a possibility of recall bias. The study only focussed on in-hospital complications, not the complications that occurred after discharge from the hospital. In addition, the study did not include data related to patients who died outside the hospital. Traffic status and infrastructure of the roads also can lead to the 2nd level of delay, and the delay that occurred due to the current pandemic was not considered, which is another limitation of the study.

Conclusion

About two-third of the patients of STEMI presented after 6 hours from the onset of symptoms. There are various pre-determinants of delay divided into modifiable and non-modifiable factors. There is a need to develop strategies to reduce the delay at all levels from the onset of symptoms to the presentation at the Cath lab. Increased knowledge of the symptoms, awareness of atypical symptoms, ban on cigarette smoking, focus on the importance of exercise, training of the medical professionals regarding prompt AMI diagnosis, and screening of the individuals who are at a higher risk of AMI are some of the strategies that may decrease in-hospital complications and the mortality rate.

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Author Contribution:

JA: Concept, data analysis and interpretation.

KN: Revision and final approval.

SA: Supervision, drafting and revision.