

Management Delays in NSTEMI-ACS at a Moroccan Tertiary Care Center: Patterns and Factors Associated with Late Presentation

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DOI: <https://doi.org/10.36347/sasjm.2026.v12i10.007>

| Received: 09.08.2026 | Accepted: 05.10.2026 | Published: 07.10.2026

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Abstract

Original Research Article

Non-ST-segment elevation acute coronary syndrome (NSTEMI-ACS) requires timely diagnosis and treatment, yet Moroccan data on delayed hospital presentation remain limited. This retrospective, observational, single-center study included 120 consecutive adults with NSTEMI-ACS who underwent coronary angiography at Ibn Sina University Hospital in Rabat between January 2024 and May 2026. Prolonged prehospital delay was defined as a symptom-to-door time of more than 24 hours, and associated factors were identified using multivariable logistic regression. Left ventricular functional recovery was assessed by the change in left ventricular ejection fraction (LVEF) from baseline to three months. Median symptom-to-door time was 24 hours [IQR, 12-72], and 54 patients (45.0%) presented more than 24 hours after symptom onset. Median door-to-angiography time was 24 hours [IQR, 24-72], and median symptom-to-angiography time was 73 hours [IQR, 48-144]. Greater distance from the tertiary care center (OR, 1.009; 95% CI, 1.001-1.017), an abnormal ECG (OR, 3.957; 95% CI, 1.203-13.013), lower admission troponin levels (OR, 0.934; 95% CI, 0.873-0.998), and lower baseline LVEF (OR, 0.959; 95% CI, 0.924-0.994) were independently associated with prolonged prehospital delay. Among 31 patients assessed at three months, median LVEF increased from 55% to 58% ($p=0.003$), but recovery was not significantly associated with prehospital delay. Prolonged prehospital delay was common and was related to both patient- and healthcare system-related factors. Improving symptom recognition, access to medical care, and regional referral pathways may help reduce delayed presentation.

Keywords: NSTEMI-ACS; prehospital delay; late presentation; coronary angiography; Morocco.

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INTRODUCTION

Non-ST-segment elevation acute coronary syndrome (NSTEMI-ACS), including non-ST-segment elevation myocardial infarction and unstable angina, represents a large proportion of acute coronary syndrome admissions [1,2]. These two conditions differ according to the presence or absence of acute myocardial injury, but both require prompt diagnosis, risk stratification, and appropriate management [3,4].

Delays can occur at different stages of care. Prehospital delay refers to the time between symptom onset and hospital arrival, while in-hospital delay includes the time from admission to coronary angiography. These delays may be related to patient factors, particularly poor symptom recognition or delayed medical consultation. They may also be related to healthcare system factors, including long travel distances, interhospital transfer, and limited access to specialized cardiac care [5–7]. Understanding these

factors is important for identifying where delays occur and how the care pathway may be improved.

Most studies on delays in acute coronary syndrome care have focused on ST-segment elevation myocardial infarction, while data on NSTEMI-ACS remain more limited, particularly in low- and middle-income countries [5,8,9]. In Morocco, available studies have reported long delays before medical consultation and access to coronary angiography [10–12]. Specific evidence concerning NSTEMI-ACS remains scarce. A recent Moroccan single-center study of 140 patients with NSTEMI reported a mean time of approximately 48 hours from symptom onset to medical consultation and a mean time of 18 hours to coronary angiography [12]. However, the different time intervals along the care pathway and the factors associated with delayed arrival at the tertiary care center remain poorly characterized in Morocco. To the best of our knowledge, few Moroccan studies have specifically investigated the determinants of

Citation: Hassani, A., El Khaboté, O., El Ghali, T., Oukerraj, L., & Cherti, M. (2026). Management Delays in NSTEMI-ACS at A Moroccan Tertiary Care Center: Patterns and Factors Associated with Late Presentation. *SAS J Med*, 12(10), 1045-1055. <https://doi.org/10.36347/sasjm.2026.v12i10.007>

symptom-to-door delay among patients presenting with NSTEMI-ACS. The present study was therefore designed to address this gap.

The primary objective of this study was to identify the independent predictors of prolonged prehospital delay in patients presenting with NSTEMI-ACS. The secondary objective was to evaluate the association between prehospital delay and left ventricular functional recovery at 3 months.

MATERIALS AND METHODS

Study Design and Population

This retrospective, observational, single-center study was conducted at the Cardiology B Department of Ibn Sina University Hospital, a tertiary referral center in Rabat, Morocco, between January 2024 and May 2026.

A total of 120 consecutive adult patients were included.

Patients were eligible for inclusion if they met all of the following criteria:

- Age ≥ 18 years;
- Diagnosis of NSTEMI-ACS, including non-ST-segment elevation myocardial infarction (NSTEMI) or unstable angina, according to the 2023 European Society of Cardiology (ESC) Guidelines;
- Coronary angiography performed during the index hospitalization.

Patients meeting any of the following criteria were excluded:

- ST-segment elevation myocardial infarction (STEMI);
- Incomplete medical records or missing data required for the study analyses.

Data Collection

Data were retrospectively collected from the GreenCube electronic medical record system and the CardioReport catheterization laboratory database. Demographic characteristics, cardiovascular risk factors, medical history, clinical presentation, electrocardiographic findings, laboratory parameters, echocardiographic data, coronary angiographic findings, treatment strategies, management delays, and in-hospital outcomes were collected using a predesigned standardized data collection form.

To evaluate short-term left ventricular functional recovery, patients were contacted by telephone and invited for a follow-up visit approximately three months after discharge. During this visit, a standardized clinical interview was conducted to document the occurrence of major adverse cardiovascular events (MACE) and rehospitalization. A transthoracic echocardiography examination was then performed to reassess left ventricular ejection fraction (LVEF). 31 patients completed the three-month follow-up.

Study Outcomes

The primary outcome was late presentation, defined as a symptom-to-door delay (STD) >24 hours. Independent factors associated with prolonged symptom-to-door delay were identified using multivariable logistic regression analysis.

The secondary outcome was short-term left ventricular functional recovery, measured as the change in left ventricular ejection fraction (LVEF) between baseline and the three-month follow-up evaluation.

Definitions

- Symptom-to-door delay (STD) was defined as the time interval between symptom onset and the patient's arrival at Ibn Sina University Hospital.
- Door-to-angiography delay (DTA) was defined as the time interval between the patient's arrival at Ibn Sina University Hospital and the initiation of coronary angiography.
- Symptom-to-angiography delay (STA) was defined as the time interval between symptom onset and the initiation of coronary angiography.
- Early and late presentation: Patients were categorized according to symptom-to-door delay as early presenters (≤ 24 h) or late presenters (>24 h). The 24-hour cutoff corresponded to the median symptom-to-door delay observed in the study population.
- Patient-related contributing factors included delayed medical consultation due to symptom neglect and temporary medical conditions requiring stabilization or specific management before coronary angiography.
- System-related contributing factors included interhospital transfer and admission during off-hours (nights, weekends, or public holidays).
- Known coronary artery disease (CAD) was defined as a history of acute coronary syndrome, documented coronary artery disease, or previous coronary revascularization (percutaneous coronary intervention or coronary artery bypass grafting).
- Single-vessel disease was defined as the presence of $\geq 70\%$ stenosis in one major epicardial coronary artery. Multivessel disease was defined as the presence of $\geq 70\%$ stenosis in two or more major epicardial coronary arteries. Left main coronary artery stenosis was considered significant when $\geq 50\%$.
- Geographic zones: Patients were classified into three geographic zones according to their administrative area of residence: [1] the Rabat–Salé–Temara area, [2] the remaining Rabat–Salé–Kénitra (RSK) region, and [3] outside the RSK region.

- GRACE (Global Registry of Acute Coronary Events) risk score was calculated at admission according to the original GRACE risk model, which is based on eight clinical variables to estimate the risk of in-hospital and six-month mortality.
- Major adverse cardiovascular events (MACE) were defined as a composite endpoint including all-cause death, non-fatal myocardial infarction, and stroke occurring during the index hospitalization or within the three-month follow-up period.

Statistical Analysis

Statistical analyses were performed using Jamovi software (version 2.6.45). Continuous variables were expressed as mean $\pm$ standard deviation (SD) or median [interquartile range (IQR)], according to the distribution assessed using the Shapiro–Wilk test. Categorical variables were expressed as frequencies and percentages.

Comparisons between early and late presenters were performed using Student's t-test or the Mann–Whitney U test for continuous variables, and the chi-square test or Fisher's exact test for categorical variables, as appropriate.

Variables with a p-value <0.20 in univariate analysis were entered into a multivariable binary logistic regression model to identify independent factors associated with prolonged symptom-to-door delay. To avoid multicollinearity, variables reflecting the same

clinical construct were not entered simultaneously into the model. Adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were reported.

Spearman's rank correlation coefficient was used to assess the relationships between management delays and markers of myocardial damage and left ventricular function.

For the secondary analysis, paired comparisons of left ventricular ejection fraction (LVEF) between baseline and the three-month follow-up evaluation were performed using the Wilcoxon signed-rank test. The change in LVEF (Δ LVEF) between early and late presenters was compared using the Mann–Whitney U test.

All statistical tests were two-sided, and a p-value <0.05 was considered statistically significant.

RESULTS

Baseline Characteristics

The mean age was 63.1 ± 9.9 years, with a male predominance (62.5%). Most patients resided in the Rabat–Salé–Temara area (65.8%), with a median distance of 12 km [IQR, 7–52.3] from the study center. Health insurance coverage was available for 79.2% of patients. Hypertension was the most prevalent cardiovascular risk factor (57.5%), followed by diabetes mellitus (40.8%). Almost half of the patients had a history of smoking, including former and current smokers (47.5%). Known coronary artery disease was reported in 39.2% of patients.

Table 1: Baseline demographic and clinical characteristics of the study population

Variable	Total (n=120)
Age (years), mean $\pm$ SD	63.1 $\pm$ 9.9
Sex, n (%)	
Male	75 (62.5)
Female	45 (37.5)
Geographic area of residence, n (%)	
Rabat–Salé–Temara (RST) area	79 (65.8)
Remaining Rabat – Salé – Kénitra (RSK) region	33 (27.5)
Outside RSK region	8 (6.7)
Distance from the study center (km), median [IQR]	12 [7 ; 52.3]
Health insurance, n (%)	95 (79.2)
Hypertension, n (%)	69 (57.5)
Diabetes mellitus, n (%)	49 (40.8)
Dyslipidemia, n (%)	45 (37.5)
Smoking status, n (%)	
Non smoker	63 (52.5)
Former smoker	30 (25.0)
Current smoker	27 (22.5)
Central obesity, n (%)	15 (12.5)
Family history of coronary artery disease, n (%)	4 (3.3)
Known coronary artery disease, n (%)	47 (39.2)

SD: standard deviation; IQR : interquartile range; CAD: coronary artery disease; RST: Rabat–Salé–Temara area; RSK: Rabat–Salé–Kénitra region.

Clinical Presentation and Initial Assessment

Clinical presentation and initial assessment are summarized in Table 2. Typical chest pain was the predominant presenting symptom, occurring in 91.7% of patients, whereas dyspnea was reported in 20.0%. The final diagnosis was NSTEMI in 75.0% of patients and unstable angina in 25.0%. Abnormal electrocardiographic findings were present in 82.5% of

patients, with T-wave abnormalities being the most frequent ECG abnormality (61.7%). The median troponin level at admission was 1.41 ng/mL [IQR, 0.08–4.75], and the mean GRACE score was 116 ± 24.8 . According to the GRACE risk classification, most patients were classified as intermediate risk (57.5%), whereas 15.8% were considered high risk (GRACE score >140).

Table 2: Clinical presentation and initial assessment

Variable	Total(n=120)
Clinical presentation, n (%)	
Typical chest pain	110 (91.7)
Dyspnea	24 (20)
Final diagnosis, n (%)	
NSTEMI	90 (75)
Unstable angina	30 (25)
ECG findings, n (%)	
Abnormal ECG	99 (82.5)
T-wave abnormalities	74 (61.7)
ST-segment depression	32 (26.7)
Transient ST-segment elevation	5 (4.2)
Conduction abnormalities	30 (25)
Biological data	
Troponin at admission (ng/mL), median [IQR]	1.41 [0.08; 4.75]
Hemoglobin (g/dL), mean $\pm$ SD	13.8 ± 1.7
Creatinine (mg/L), median [IQR]	8.7 [7.6; 11.1]
Risk stratification	
GRACE score, mean $\pm$ SD	116 ± 24.8
Low risk (GRACE < 109)	32 (26.7)
Intermediate risk (GRACE 109-140)	69 (57.5)
High risk (GRACE > 140)	19 (15.8)

NSTEMI: non-ST-segment elevation myocardial infarction; ECG: electrocardiogram; IQR: interquartile range; SD: standard deviation; GRACE: Global Registry of Acute Coronary Events.

Echocardiographic Findings

Baseline echocardiographic findings are summarized in Table 3. The median initial LVEF was

50% [IQR, 41.5–60], and regional wall motion abnormalities were present in 68.3% of patients.

Table 3: Echocardiographic findings

Variable	Total (n=120)
Initial LVEF (%), median [IQR]	50 [41.5; 60]
Regional wall motion abnormalities, n (%)	82 (68.3)

LVEF: left ventricular ejection fraction; IQR: interquartile range.

Coronary Angiographic Findings and Management

Coronary angiographic findings and revascularization strategies are summarized in Table 4. Single-vessel coronary artery disease was the predominant angiographic pattern, observed in 86.7% of patients, whereas multivessel disease was present in

10.0%. Non-obstructive coronary artery disease was identified in 3.3% of patients. Percutaneous coronary intervention (PCI) was the most frequently performed revascularization strategy (75.0%), followed by optimal medical therapy (16.7%) and coronary artery bypass grafting (CABG) (8.3%).

Table 4: Coronary angiographic findings and revascularization strategy

Variable	Total (n=120)
Extent of coronary artery disease, n (%)	
Non-obstructive coronary artery disease	4 (3.3)
Single-vessel disease	104 (86.7)
Multivessel disease	12 (10.0)
Revascularization strategy, n (%)	

PCI	90 (75)
CABG	10 (8.3)
Optimal medical therapy	20 (16.7)

PCI: percutaneous coronary intervention; CABG: coronary artery bypass grafting

Management Delays and Contributing Factors

The median symptom-to-door delay was 24 hours [IQR, 12–72], whereas the median door-to-angiography and symptom-to-angiography delays were 24 hours [IQR, 24–72] and 73 hours [IQR, 48–144], respectively. Patient-related contributing factors were identified in 45.8% of patients, predominantly due to

symptom neglect (45.0%). System-related contributing factors were observed in 46.7% of patients, mainly related to interhospital transfer (28.3%) and off-hours admission (24.2%). The overall patient pathway, management delays, and treatment strategies are illustrated in Figure 2.

Table 5: Management delays and contributing factors

Variable	Total (n=120)
Delays	
Symptom-to-door delay (hours), median [IQR]	24 [12; 72]
Door-to-angiography delay (hours), median [IQR]	24 [24; 72]
Symptom-to-angiography delay (hours), median [IQR]	73 [48; 144]
Patient-related contributing factors, n (%)	55 (45.8)
Symptom neglect	54 (45)
Temporary medical reason for delayed coronary angiography	2 (1.7)
System-related contributing factors, n (%)	56 (46.7)
Off-hours admission	29 (24.2)
Interhospital transfer delay	34 (28.3)

IQR: interquartile range. Patient-related and system-related contributing factors categories were not mutually exclusive; some patients had more than one contributing factor.

In-Hospital Outcomes

In-hospital clinical outcomes are summarized in Table 6. Recurrent angina was the most frequent in-hospital complication, occurring in 5.0% of patients,

followed by acute heart failure (2.5%) and cardiogenic shock (0.8%). No in-hospital major adverse cardiovascular events (MACE) occurred.

Table 6: In-hospital clinical outcomes

Variable	Total (n=120)
Recurrent angina, n (%)	6 (5)
Acute heart failure, n (%)	3 (2.5)
Cardiogenic shock, n (%)	1 (0.8)
In-hospital Major Adverse Cardiovascular Events (MACE), n (%)	0 (0)

Three-Month Follow-Up

Three-month follow-up outcomes are summarized in Table 7. Among the 31 patients with available follow-up data, the median LVEF at three months was 58% [IQR, 55–61]. No rehospitalization for

acute heart failure occurred. One patient (3.2%) experienced a non-fatal myocardial infarction, representing the only major adverse cardiovascular event (MACE) recorded during follow-up.

Table 7: Clinical outcomes at three-month follow-up.

Variable	Total (n=31)
LVEF at 3-month follow-up, median [IQR]	58 [55; 61]
Rehospitalization for acute heart failure, n (%)	0 (0)
Major adverse cardiovascular events (MACE), n (%)	1 (3.2)

LVEF: left ventricular ejection fraction; IQR : interquartile range.

Comparison Between Early and Late Presenters

For comparative analyses, patients were divided into two groups according to symptom-to-door delay: early presenters (≤ 24 hours, n = 66) and late presenters (> 24 hours, n = 54). The 24-hour cutoff corresponded to the median symptom-to-door delay observed in the study

population. Baseline characteristics, clinical presentation, management, and outcomes were compared between the two groups.

No significant differences were observed between early and late presenters in baseline

characteristics, cardiovascular risk factors, clinical presentation, electrocardiographic findings, coronary angiographic findings, or revascularization strategy (Table 8). Compared with late presenters, early presenters had significantly higher troponin levels at

admission (median 2.53 ng/mL [IQR, 0.14–7.28] vs 0.775 ng/mL [IQR, 0.045–3.05]; $p = 0.026$) and higher initial LVEF (median 55% [IQR, 45.8–60] vs 45% [IQR, 40–57.3]; $p = 0.019$).

Table 8: Univariate analysis comparing early and late presenters according to symptom-to-door delay

Variable	Early presenters ≤ 24 h (n = 66)	Late presenters > 24 h (n = 54)	p-value
Baseline characteristics			
Age (years), mean ± SD	62.2 ± 9.7	64.1 ± 10.1	0.300
Male sex, n (%)	41 (62.1)	34 (63.0)	0.925
Geographic area of residence, n (%)			0.062*
Rabat–Salé–Temara area	49 (74.2)	30 (55.6)	
Remaining RSK region	15 (22.7)	18 (33.3)	
Outside RSK region	2 (3.0)	6 (11.1)	
Distance from the study center, km, median [IQR]	7 [7; 38]	26 [7; 88]	0.061
Health insurance, n (%)	53 (80.3)	42 (77.8)	0.735
Hypertension, n (%)	39 (59.1)	30 (55.6)	0.697
Diabetes mellitus, n (%)	29 (43.9)	20 (37.0)	0.444
Smoking status, n (%)			0.879
Non-smoker	36 (54.5)	27 (50)	
Former smoker	16 (24.2)	14 (25.9)	
Current smoker	14 (21.2)	13 (24.1)	
Dyslipidemia, n (%)	28 (42.4)	17 (31.5)	0.218
Abdominal obesity, n (%)	10 (15.2)	5 (9.3)	0.332
Family history of CAD, n (%)	2 (3.0)	2 (3.7)	1.000*
Known CAD, n (%)	24 (36.4)	23 (42.6)	0.487
Clinical characteristics			
Typical chest pain, n (%)	62 (93.9)	48 (88.9)	0.343*
Dyspnea, n (%)	12 (18.2)	12 (22.2)	0.582
NSTEMI, n (%)	53 (80.3)	37 (68.5)	0.138
ECG findings			
Abnormal ECG, n (%)	51 (77.3)	48 (88.9)	0.096
ST-segment depression, n (%)	18 (27.3)	14 (25.9)	0.868
Transient ST segment elevation, n (%)	2 (3.0)	3 (5.6)	0.656*
T-wave abnormalities, n (%)	36 (54.5)	38 (70.4)	0.076
Biological and risk stratification			
Troponin at admission (ng/mL), median [IQR]	2.53 [0.14; 7.28]	0.775 [0.045; 3.05]	0.026
Hemoglobin (g/dL), mean ± SD	13.9 ± 1.71	13.6 ± 1.66	0.254
Creatinine (mg/L), median [IQR]	8.85 [7.60; 10.5]	8.70 [7.62; 11.5]	0.637
GRACE score, mean ± SD	116 ± 22.4	116 ± 27.6	0.914
Echocardiographic findings			
Initial LVEF (%), median [IQR]	55 [45.8; 60]	45 [40; 57.3]	0.019
Regional wall motion abnormalities, n (%)	41 (62.1)	41 (75.9)	0.106
Coronary angiographic findings			
Non-obstructive CAD, n (%)	3 (4.5)	1 (1.9)	0.626
Single-vessel disease, n (%)	57 (86.4)	47 (87.0)	0.914
Multivessel disease, n (%)	6 (9.1)	6 (11.1)	0.714
Revascularization, n (%)	54 (81.8)	46 (85.2)	0.622

CAD: coronary artery disease; ECG: electrocardiogram; GRACE: Global Registry of Acute Coronary Events; IQR: interquartile range; LVEF: left ventricular ejection fraction; NSTEMI: non-ST-segment elevation myocardial infarction; PCI: percutaneous coronary intervention; RSK: Rabat–Salé–Kénitra region; RST: Rabat–Salé–Temara area; SD: standard deviation.

Continuous variables are presented as mean ± SD or median [IQR], and categorical variables as n (%). P-values marked with an asterisk (*) were calculated using Fisher's exact test, whereas all other categorical variables were analyzed using the chi-square test.

Multivariable Logistic Regression Analysis

The multivariable logistic regression analysis identified four factors independently associated with late

presentation (Table 9). Greater distance from the study center and the presence of an abnormal ECG were associated with an increased likelihood of late

presentation, whereas higher troponin levels at admission and higher initial LVEF were associated with a lower likelihood of late presentation.

Table 9: Multivariable logistic regression analysis of factors independently associated with late presentation (symptom-to-door delay >24 h)

Variable	OR	95% CI	p-value
Distance from study center (km)	1.009	[1.001 – 1.017]	0.027
Troponin at admission (ng/mL)	0.934	[0.873 – 0.998]	0.045
Abnormal ECG	3.957	[1.203 – 13.013]	0.024
Initial LVEF (%)	0.959	[0.924 – 0.994]	0.023

CI: confidence interval; OR: odds ratio from multivariable logistic regression; LVEF: left ventricular ejection fraction.

Left Ventricular Functional Recovery at Three Months

Comparison of patients with symptom-to-door delay ≤ 24 h and >24 h showed no significant differences in initial LVEF, LVEF at three months, or Δ LVEF (Table

10). Overall, among the 31 patients with available echocardiographic follow-up, LVEF improved significantly from a median of 55% at baseline to 58% at three months (Wilcoxon signed-rank test, $p = 0.003$).

Table 10: Comparison of left ventricular functional recovery according to symptom-to-door delay in patients with three-month echocardiographic follow-up (n = 31)

Variable	≤ 24 h (n=16)	>24 h (n=15)	p-value
Initial LVEF (%), median [IQR]	55.5 [43.8; 60]	55 [48.5; 60]	0.825
LVEF at 3 months (%), median [IQR]	55.5 [53.8; 61.5]	60 [55; 61]	0.720
Δ LVEF (%), median [IQR]	2.5 [0; 5]	2 [0; 4.5]	0.536

LVEF: left ventricular ejection fraction; Δ LVEF: absolute change in LVEF from baseline to 3-month follow-up; IQR: interquartile range. P-values were obtained using the Mann–Whitney U test.

Correlation Analyses

Spearman correlation analyses are presented in Table 11. In the overall study population, longer symptom-to-door delay was weakly associated with lower initial LVEF ($\rho = -0.196$, $p = 0.032$) and lower troponin levels at admission ($\rho = -0.250$, $p = 0.006$). Symptom-to-angiography delay was also weakly

associated with lower initial LVEF ($\rho = -0.181$, $p = 0.048$), whereas door-to-angiography delay was not significantly correlated with initial LVEF.

Among patients with available three-month follow-up, symptom-to-door delay was not significantly correlated with either LVEF at three months or Δ LVEF.

Table 11: Spearman correlations between management delays and markers of myocardial injury and left ventricular function

Variable	ρ	p-value
Overall study population (n = 120)		
STD vs Initial LVEF	-0.196	0.032
STA vs Initial LVEF	-0.181	0.048
DTA vs Initial LVEF	-0.084	0.359
STD vs Troponin at admission	-0.250	0.006
Patients with three-month follow-up (n = 31)		
STD vs LVEF at 3 months	0.127	0.497
STD vs Δ LVEF	-0.081	0.664

STD: symptom-to-door delay; STA: symptom-to-angiography delay; DTA: door-to-angiography delay; LVEF: left ventricular ejection fraction; Δ LVEF: absolute change in LVEF from baseline to 3-month follow-up. ρ : Spearman's rank correlation coefficient. Statistically significant p-values are shown in bold.

DISCUSSION

Main Findings

This retrospective single-center study included 120 consecutive patients with NSTEMI-ACS admitted to a tertiary referral center in Rabat, Morocco. Our study showed several important findings. The median symptom-to-door delay was 24 hours. Patient-related

contributing factors were identified in 45.8% of patients, with symptom neglect being the most frequently documented factor. The median symptom-to-angiography delay was 73 hours. Greater distance from the study center, abnormal ECG findings, lower troponin levels at admission, and lower initial LVEF were independently associated with late presentation. Longer

symptom-to-door delay was also associated with lower troponin levels and lower initial LVEF, although these associations were weak. At three months, no significant relationship was found between symptom-to-door delay and improvement in LVEF, despite an overall increase in LVEF during follow-up.

Prehospital Delay and Associated Factors

In our study, the median symptom-to-door delay was 24 hours, showing that delayed hospital presentation remains common among patients with NSTEMI-ACS. Similar findings have been reported in other studies of patients with NSTEMI, where prehospital delay is still a major challenge despite improvements in management [8,9]. The time to hospital presentation depends on both patient-related and healthcare system factors, particularly in low- and middle-income countries [5].

These findings contrast with current ESC recommendations advocating early invasive assessment in high-risk NSTEMI-ACS patients, highlighting the gap between guideline recommendations and real-world practice. [3]

Patient-related contributing factors were identified in 45.8% of patients, whereas healthcare system-related contributing factors were identified in 46.7%. The most frequently documented factors were symptom neglect, interhospital transfer, and off-hours admission. These findings suggest that prehospital delay is related to both patient behaviour and healthcare system factors. Previous studies have also reported that poor recognition of symptoms, difficulties in accessing medical care, and interhospital transfer contribute to delayed hospital presentation [6,22,23].

Symptom neglect was the main patient-related cause of delayed presentation in our cohort. Similar findings have been reported in previous studies, showing that many patients do not recognize the seriousness of their symptoms, think that the symptoms are not related to the heart, or wait before seeking medical care [7]. This may be because, unlike STEMI, patients with NSTEMI-ACS often have less typical and less severe symptoms, making it more difficult to recognize the seriousness of their condition [3]. In our setting, this may also be related to limited public awareness of acute coronary syndrome symptoms and a low perception of the seriousness of acute chest pain, which may delay the decision to seek medical care. This highlights the need for public education to improve early recognition of symptoms and encourage earlier hospital presentation.

In multivariable analysis, greater distance from the study center, abnormal ECG findings, lower troponin levels at admission, and lower initial LVEF were independently associated with delayed presentation. The association with greater distance is consistent with previous studies showing that geographical barriers may

delay access to emergency cardiac care [24]. Lower troponin levels may be related to the timing of presentation, as previous studies have also reported differences in troponin levels according to presentation delay [8]. The association between lower initial LVEF and late presentation may reflect differences in myocardial injury severity; however, the observational design does not allow causal conclusions.

Impact of Prehospital Delay on Myocardial Injury and Left Ventricular Function

In our study, longer symptom-to-door delay was associated with lower troponin levels at admission. Similar findings were reported by Kim *et al.*, who found that patients presenting earlier had significantly higher troponin levels than those presenting later [8]. One possible explanation is that some patients presenting late may have already passed the peak troponin level by the time of hospital admission.

Longer symptom-to-door delay was also associated with lower initial LVEF. One possible explanation is that prolonged ischemic exposure may contribute to greater myocardial injury. However, the present study cannot determine whether prolonged ischemia was responsible for the lower LVEF. Similar findings have been reported in previous studies showing that longer symptom-to-door delay is associated with lower left ventricular function after myocardial infarction [25,26]. In contrast, door-to-angiography delay was not associated with initial LVEF in our study. These findings should be interpreted as associations and do not establish a causal relationship between delayed presentation and impaired left ventricular function.

Regarding the secondary objective, no significant association was found between prehospital delay and left ventricular functional recovery at 3 months. However, this finding should be interpreted with caution, as follow-up echocardiographic assessment was available for only 31 patients. Consequently, the statistical power of this analysis was limited, and a clinically relevant difference between early and late presenters cannot be excluded. Larger prospective studies with systematic echocardiographic follow-up are therefore warranted to clarify the impact of prehospital delay on left ventricular functional recovery.

Previous studies reported similar improvement in left ventricular function after myocardial infarction [27–29]. This improvement may be explained by the recovery of stunned but viable myocardium after revascularization and optimal medical treatment. Our findings suggest that although prolonged prehospital delay may be associated with less favorable left ventricular functional recovery at 3 months, LVEF may still improve during follow-up.

Clinical Implications

Our findings highlight the importance of reducing prehospital delay in patients with NSTEMI-ACS. Public education programs to improve symptom recognition and encourage early medical consultation may help reduce patient-related delays. Strengthening referral pathways and improving coordination between referring hospitals and tertiary centers may reduce system-related delays, particularly those related to interhospital transfer. Developing dedicated acute cardiac care pathways and expanding access to catheterization facilities, particularly in underserved areas, may further reduce management delays. Earlier hospital presentation may allow earlier assessment and treatment.

Strengths and Limitations

Our study has several strengths. It provides data on management delays in patients with NSTEMI-ACS in a tertiary care center in Morocco, where local data remain limited. It included a detailed assessment of the factors contributing to delayed presentation, including both patient-related and healthcare system-related factors. In addition, it evaluated the impact of geographical accessibility by including the distance from the study center as a potential factor associated with delayed presentation, an aspect that has rarely been studied. Multivariable analysis was used to identify factors independently associated with delayed presentation. Finally, left ventricular function was evaluated both at admission and at the 3-month follow-up, allowing an exploratory assessment of early LVEF changes among patients with available follow-up echocardiography.

This study has several limitations that should be acknowledged. First, its retrospective single-center design may have introduced selection and information bias and may limit the generalizability of the findings. Second, the relatively small sample size may have reduced the statistical power of some analyses. Furthermore, delayed presentation was defined using a data-driven 24-hour cutoff corresponding to the median symptom-to-door delay of our cohort rather than an externally validated clinical threshold, which may limit external validity and comparisons with studies using predefined cutoffs.

Assessment of the secondary endpoint also warrants caution. Follow-up echocardiographic evaluation at 3 months was available for only 31 patients, limiting the statistical power to detect clinically meaningful differences in left ventricular functional recovery and introducing the potential for selection bias.

Because major adverse cardiovascular events were infrequent in our cohort, we were unable to evaluate the relationship between management delays and short-term clinical outcomes. In addition, admission troponin concentrations may have been influenced by the timing of blood sampling relative to symptom onset, which

should be considered when interpreting their association with delayed presentation. Furthermore, potentially relevant determinants of delayed presentation, including socioeconomic status and educational level, were not available. Finally, some findings from the multivariable analysis, particularly the association between abnormal ECG findings and delayed presentation, should be interpreted with caution and confirmed in larger prospective studies.

CONCLUSION

This study highlights that prolonged prehospital delay remains common among patients presenting with NSTEMI-ACS in our setting, with a median symptom-to-door time of 24 hours. Both patient-related and healthcare system-related factors contributed to delayed presentation, with symptom neglect representing the most frequently identified patient-related cause.

Greater distance from the tertiary care center, abnormal ECG findings, lower admission troponin levels, and lower baseline left ventricular ejection fraction were independently associated with prolonged prehospital delay. These findings emphasize the multifactorial nature of delayed presentation and underscore the importance of improving public awareness of ACS symptoms, facilitating timely access to medical care, and strengthening referral pathways within regional healthcare networks.

Although no significant association was observed between prehospital delay and left ventricular functional recovery at 3 months, this secondary analysis should be interpreted with caution because follow-up echocardiographic assessment was available for only 31 patients, limiting the statistical power to detect clinically meaningful differences.

Overall, our findings provide novel data on factors associated with prehospital delay among Moroccan patients with NSTEMI-ACS and identify potentially modifiable factors that may guide future public health interventions. Larger prospective multicenter studies with systematic follow-up are warranted to validate these findings and to further investigate the impact of delayed presentation on long-term clinical and functional outcomes.

Conflict of Interest: The authors declare that they have no conflicts of interest.

Funding: The authors received no financial support for the research, authorship, or publication of this article.

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