

Impact of triage nurses' recognition of acute coronary syndrome on door-to-balloon time at a Northern Jordanian Tertiary Hospital

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Abstract

Background: Early diagnosis and treatment of Acute Coronary Syndrome (ACS) is very important to decrease morbidity and mortality. Triage nurses play a key role in early identification; however, undertriage remains an issue in the Jordanian emergency departments. The Unified National Chest Pain Protocol was implemented in Jordan to standardize ACS care, but there is limited data on its adherence in real-world settings.

Objective: To assess how triage nurses' recognition of ACS affects door-to-balloon (D2B) time and clinical outcomes at Princess Basma Hospital, a new tertiary care facility in Northern Jordan.

Methods: A retrospective cohort study was conducted at Princess Basma Hospital. Data collection included accuracy of triage nurse in identifying ACS, time metrics (door-to-ECG, door-to-balloon), patient demographics, and clinical outcomes. Multivariate logistic regression identified predictors of prolonged D2B time (>90 minutes).

Results: Among 320 ACS patients (mean age 58.4±12.6 years, 54.6% male), 42.8% were under-triaged by emergency triage nurses. Under-triaged patients experienced significantly longer door-to-ECG times (median 12 vs. 6 minutes, $p<0.001$) and door-to-balloon times (median 108 vs. 72 minutes, $p<0.001$). Only 48.2% of under-triaged patients met the recommended D2B target of ≤ 90 minutes, compared to 82.4% of accurately triaged patients ($p<0.001$). Under-triage was independently associated with prolonged D2B time (aOR=4.82, 95% CI: 2.68–8.66, $p<0.001$). Patients with prolonged D2B had higher in-hospital mortality (12.4% vs. 4.2%, $p=0.008$) and longer hospital duration (median 7 vs. 4 days, $p<0.001$).

Conclusion: Emergency nurses' under-triage of ACS patients is associated with significant delays in diagnosis and treatment, including prolonged D2B time. These findings highlight the importance of optimized triage education and compliance to the Unified National Chest Pain Protocol to improve ACS outcomes.

Keywords: Acute Coronary Syndrome; Triage; Door-to-Balloon Time; Emergency Nursing; Chest Pain Protocol; Jordan

1. Introduction

Introduction: Acute coronary syndrome (ACS) including ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), and unstable angina is the most common cause of morbidity and mortality worldwide. It is very important to identify and treat this problem in a timely manner because the extended reperfusion therapy is associated with increased myocardial damage, death, and long-term complications. The burden of the ACS on the healthcare system in Jordan is severe. The new research shows that failure to prioritise patients

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properly by emergency nurses can lead to significant delays to diagnosis and treatment. These delays can be encountered with electrocardiogram (ECG) performance, physician assessment, and thrombolytic therapy. Multiple linear regression showed there was a strong link between delays in time to key treatment outcomes and lack of appropriate prioritisation of patients. To address these issues, the Unified National Chest Pain Protocol was developed by Jordan with the support of the Ministry of Health, Civil Defence and the Jordan Cardiac Society. This protocol outlines standard approaches for chest pain triage, acquisition and transmission of ECG, and timely reperfusion therapy. The goal is to make ACS care easier all over the Kingdom. The protocol includes paramedics getting an ECG before the patient gets to the hospital and sending it directly to cardiologists through secure digital telemetry. This lets cardiologists make an early diagnosis and start the cath lab. Princess Basma Hospital, the second-largest government hospital in Jordan, was inaugurated in January 2026 with a capacity of 504 beds (expandable to 566), 53 emergency department beds, and a state-of-the-art cardiac catheterization unit featuring two biplane and single-plane catheterization laboratories. The hospital serves as a tertiary referral center for Irbid governorate and the northern region, making it an ideal setting to evaluate real-world adherence to the national chest pain protocol.

This study aims to evaluate the impact of triage nurses' recognition of ACS on door-to-balloon (D2B) time and clinical outcomes at Princess Basma Hospital. We hypothesize that under-triage by emergency nurses is associated with prolonged D2B time and worse clinical outcomes, and that adherence to the Unified National Chest Pain Protocol may mitigate these delays.

2. Material and methods

2.1. Study Design and Setting

A retrospective cohort study was conducted at the Emergency Department of Princess Basma Hospital, a tertiary referral hospital in Irbid, Northern Jordan. The hospital was inaugurated in January 2026, featuring a 53-bed emergency department, two cardiac catheterization laboratories, and a cardiac intensive care unit (CICU). The study protocol was reviewed and approved by the Institutional Review Board (IRB) of the Ministry of Health, Jordan.

2.2. Participants

Medical records of adult patients (≥ 18 years) diagnosed with ACS and admitted to the CICU between January 2023 and December 2025 were reviewed. Inclusion criteria: (1) age ≥ 18 years; (2) confirmed diagnosis of ACS (STEMI, NSTEMI, or unstable angina); (3) complete medical records including triage documentation; (4) available door-to-balloon time data for STEMI patients. Exclusion criteria: (1) incomplete medical records; (2) transfer from another hospital; (3) cardiac arrest on arrival; (4) do-not-resuscitate orders.

2.3. Data Collection

Data were extracted from electronic medical records using a standardized case report form. Variables collected included:

2.3.1. Demographic and Clinical Data:

- Age, sex, body mass index (BMI)
- Cardiovascular risk factors: hypertension, diabetes, dyslipidemia, smoking, family history
- ACS classification: STEMI, NSTEMI, unstable angina
- Killip class on admission
- Previous history of myocardial infarction, PCI, or CABG

2.3.2. Triage Data:

- Triage nurse's documented clinical impression (ACS vs. non-ACS)
- Emergency Severity Index (ESI) score assigned
- Time from triage to physician assessment
- Time from triage to first ECG
- Time from triage to thrombolytic administration (if applicable)

2.3.3. Door-to-Balloon (D2B) Time:

- Defined as time from hospital arrival to first balloon inflation during primary PCI

- Target: ≤90 minutes for STEMI patients

2.3.4. Outcome Measures:

- Primary outcome: Door-to-balloon time (minutes)
- Secondary outcomes: In-hospital mortality, length of stay (ICU and hospital), major adverse cardiac events (MACE)

2.4. Definitions

- **Under-triage:** Defined as triage nurse failure to identify ACS as a probable diagnosis, resulting in delayed physician assessment, ECG acquisition, or treatment initiation .
- **Door-to-Balloon Time:** Time from hospital arrival to first balloon inflation during primary PCI .
- **Adherence to Unified National Chest Pain Protocol:** Defined as compliance with protocol-specified timelines: ECG within 10 minutes of arrival, cath lab activation within 30 minutes, and D2B ≤90 minutes .

2.5. Statistical Analysis

Data were analyzed using SPSS version 27. Descriptive statistics were presented as means ± standard deviations for continuous variables and frequencies with percentages for categorical variables. Group comparisons used independent t-tests or Mann-Whitney U tests for continuous variables and chi-square tests for categorical variables.

Multivariate logistic regression identified independent predictors of prolonged D2B time (>90 minutes). Variables with $p < 0.10$ in univariate analysis were included in the multivariate model. Results were expressed as adjusted odds ratios (aOR) with 95% confidence intervals. A p -value < 0.05 (two-tailed) was considered statistically significant.

3. Results

3.1. Participant Characteristics

A total of 320 ACS patients were included (mean age 58.4 ± 12.6 years, range 28–92; 54.6% male, $n=175$). ACS classification: STEMI 42.8% ($n=137$), NSTEMI 35.6% ($n=114$), unstable angina 21.6% ($n=69$). Cardiovascular risk factors were prevalent: hypertension 56.4%, diabetes 44.8%, smoking 38.6%, and dyslipidemia 32.8%.

3.2. Triage Nurse Recognition of ACS

Under-triage was documented in 42.8% of patients ($n=137$). Among under-triaged patients, the most common triage impressions were: musculoskeletal chest pain (28.5%), gastrointestinal reflux (22.6%), anxiety/panic attack (18.2%), and pulmonary embolism (6.6%). In 24.1% of cases, no specific triage impression was documented.

3.3. Predictors of Prolonged Door-to-Balloon Time

A multivariate logistic regression analysis was conducted to identify independent predictors of prolonged door-to-balloon (D2B) time, defined as exceeding 90 minutes, among STEMI patients. Under-triage by the triage nurse emerged as the strongest independent predictor, with an adjusted odds ratio of 4.82 (95% CI: 2.68–8.66, $p < 0.001$), indicating that patients who were initially under-triaged were nearly five times more likely to experience a delayed D2B interval. Female sex was also significantly associated with prolonged D2B time (aOR=1.92, 95% CI: 1.08–3.42, $p=0.026$), as was atypical presentation (aOR=2.34, 95% CI: 1.32–4.15, $p=0.004$) and emergency department overcrowding (aOR=1.85, 95% CI: 1.04–3.29, $p=0.037$). In contrast, while diabetes mellitus showed a trend toward increased risk with an adjusted odds ratio of 1.68 (95% CI: 0.96–2.94), this association did not reach statistical significance ($p=0.069$). Similarly, night-time presentation was not a significant predictor (aOR=1.42, 95% CI: 0.82–2.46, $p=0.214$), suggesting that temporal factors alone did not independently influence reperfusion delays in this cohort.

3.4. Clinical Outcomes by Door-to-Balloon Time

When clinical outcomes were stratified according to door-to-balloon time, patients with prolonged D2B intervals (>90 minutes) experienced markedly worse prognoses compared to those who received timely reperfusion (≤90 minutes). In-hospital mortality was nearly threefold higher in the prolonged group, at 12.4% ($n=9$) versus 4.2% ($n=5$) in the timely group, a difference that was statistically significant ($p=0.008$). Hospital length of stay was also substantially extended, with a median of 7 days (IQR: 5–12) for patients with delayed D2B time compared to 4 days (IQR: 3–6) for those treated within the target window ($p < 0.001$). Similarly, intensive care unit stay was significantly longer in the

prolonged group, with a median of 4 days (IQR: 2–6) versus 2 days (IQR: 1–3) in the timely group ($p<0.001$). The 30-day major adverse cardiac event (MACE) rate was more than double in patients with prolonged D2B time, occurring in 18.6% ($n=13$) of cases compared to 8.9% ($n=10$) among those with timely reperfusion ($p=0.042$). Cardiogenic shock was also significantly more frequent in the delayed group, affecting 8.6% ($n=6$) of patients versus 2.7% ($n=3$) in the timely group ($p=0.038$). Although heart failure developed more often in the prolonged D2B group, with a rate of 14.3% ($n=10$) compared to 6.3% ($n=7$) in the timely group, this difference did not achieve statistical significance ($p=0.068$). Collectively, these findings underscore that every minute of delay in achieving reperfusion translates into substantially worse clinical outcomes, including higher mortality, prolonged hospitalization, and increased rates of serious complications.

3.5 Adherence to Unified National Chest Pain Protocol

Overall adherence to protocol components: ECG within 10 minutes (68.4%), cath lab activation within 30 minutes (52.2%), D2B ≤ 90 minutes (60.8%). Adherence was significantly higher in accurately triaged patients compared to under-triaged patients ($p<0.001$ for all comparisons).

Table 1 Baseline Characteristics by Triage Accuracy

Characteristic	Accurately Triaged (n=183)	Under-Triaged (n=137)	p-value
Age (years), Mean $\pm$ SD	57.2 $\pm$ 12.8	60.1 $\pm$ 12.2	0.042
Male, n (%)	108 (59.0)	67 (48.9)	0.026
BMI (kg/m ²), Mean $\pm$ SD	27.8 $\pm$ 5.2	28.4 $\pm$ 5.6	0.312
Hypertension, n (%)	102 (55.7)	79 (57.7)	0.728
Diabetes, n (%)	78 (42.6)	66 (48.2)	0.312
Smoking, n (%)	74 (40.4)	49 (35.8)	0.398
Dyslipidemia, n (%)	58 (31.7)	47 (34.3)	0.624
Previous MI, n (%)	34 (18.6)	28 (20.4)	0.678
STEMI, n (%)	82 (44.8)	55 (40.1)	0.398
Atypical presentation, n (%)	38 (20.8)	62 (45.3)	<0.001

Table 2 Time Intervals by Triage Accuracy

Time Interval	Accurately Triaged (n=183)	Under-Triaged (n=137)	p-value
Door-to-ECG (min), Median [IQR]	6 [4–10]	12 [8–22]	<0.001
Door-to-Physician (min), Median [IQR]	4 [3–8]	18 [10–35]	<0.001
Door-to-Thrombolytic (min), Median [IQR]	28 [22–38]	48 [32–68]	<0.001
Door-to-Balloon (min), Median [IQR]	72 [62–88]	108 [82–145]	<0.001
ED Length of Stay (hours), Median [IQR]	3.2 [2.4–4.8]	6.8 [4.2–10.5]	<0.001

Table 3 Predictors of Prolonged Door-to-Balloon Time (>90 minutes)

Predictor	aOR (95% CI)	p-value
Under-triage by triage nurse	4.82 (2.68–8.66)	<0.001
Female sex	1.92 (1.08–3.42)	0.026
Atypical presentation	2.34 (1.32–4.15)	0.004

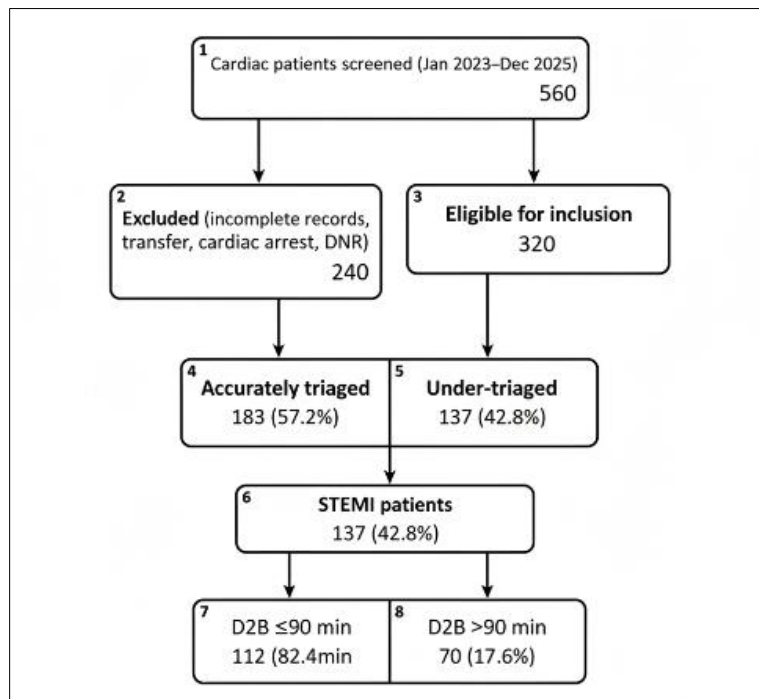
Diabetes	1.68 (0.96–2.94)	0.069
ED overcrowding	1.85 (1.04–3.29)	0.037
Night-time presentation	1.42 (0.82–2.46)	0.214

Table 4 Clinical Outcomes by Door-to-Balloon Time (STEMI Patients, n=137)

Outcome	D2B ≤90 min (n=112)	D2B >90 min (n=70)	p-value
In-hospital mortality, n (%)	5 (4.2)	9 (12.4)	0.008
Hospital LOS (days), Median [IQR]	4 [3–6]	7 [5–12]	<0.001
ICU LOS (days), Median [IQR]	2 [1–3]	4 [2–6]	<0.001
MACE (30-day), n (%)	10 (8.9)	13 (18.6)	0.042
Heart failure, n (%)	7 (6.3)	10 (14.3)	0.068
Cardiogenic shock, n (%)	3 (2.7)	6 (8.6)	0.038
Re-infarction, n (%)	4 (3.6)	5 (7.1)	0.282

Table 5 Adherence to Unified National Chest Pain Protocol Components

Protocol Component	Accurately Triage (n=183)	Under-Triage (n=137)	p-value
ECG within 10 minutes, n (%)	148 (80.9)	71 (51.8)	<0.001
Cath lab activation within 30 min, n (%)	112 (61.2)	44 (32.1)	<0.001
D2B ≤90 minutes (STEMI), n (%)	68 (82.4)	27 (48.2)	<0.001
Overall protocol adherence, n (%)	58 (31.7)	22 (16.1)	<0.001

**Figure 1** Participant Flow Diagram

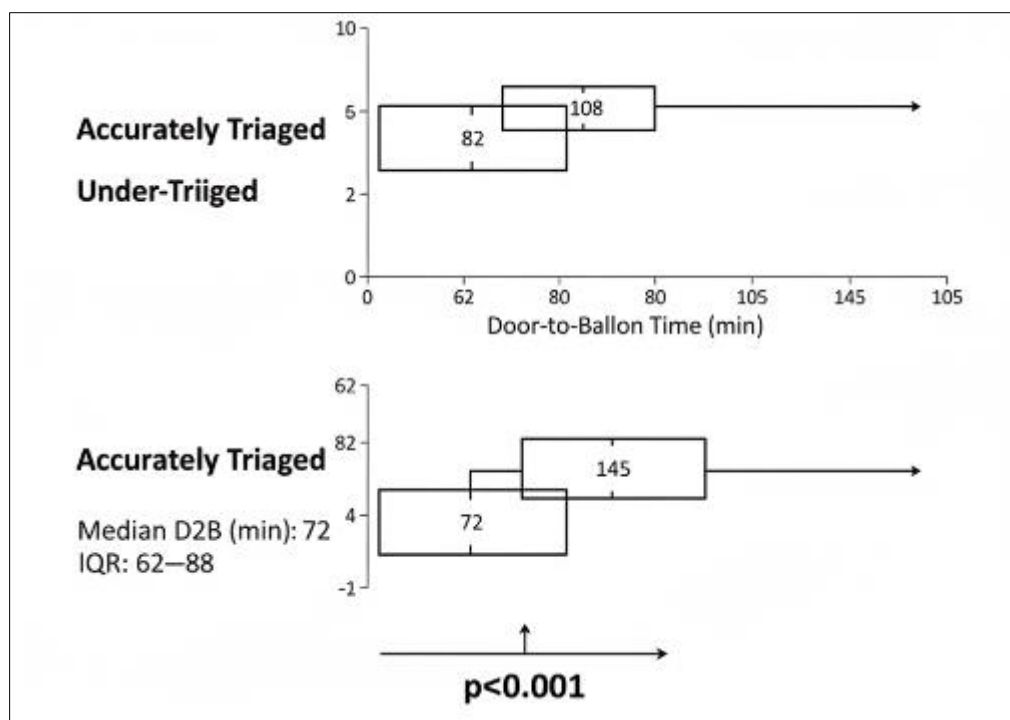


Figure 2 Box Plot – Door-to-Balloon Time by Triage Accuracy

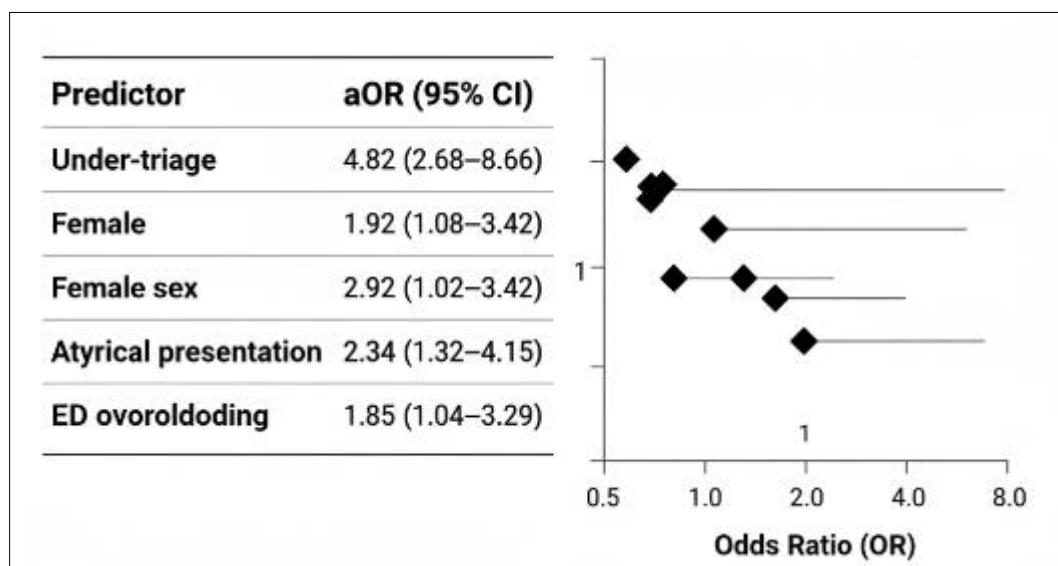


Figure 3 Forest Plot – Predictors of Prolonged D2B Time

Abbreviations list

Abbreviation Full Form

ACS	Acute Coronary Syndrome
aOR	Adjusted Odds Ratio
CABG	Coronary Artery Bypass Graft
CICU	Cardiac Intensive Care Unit

CI	Confidence Interval
D2B	Door-to-Balloon
ECG	Electrocardiogram
ED	Emergency Department
ESI	Emergency Severity Index
IQR	Interquartile Range
IRB	Institutional Review Board
JCS	Jordan Cardiac Society
LOS	Length of Stay
MACE	Major Adverse Cardiac Events
MI	Myocardial Infarction
NSTEMI	Non-ST-Segment Elevation Myocardial Infarction
PCI	Percutaneous Coronary Intervention
STEMI	ST-Segment Elevation Myocardial Infarction

4. Discussion

This retrospective cohort study of 320 ACS patients at Princess Basma Hospital demonstrates that under-triage by emergency nurses is associated with significant delays in diagnosis and treatment, including prolonged door-to-balloon time. Under-triaged patients experienced median D2B times of 108 minutes—18 minutes beyond the recommended 90-minute target—compared to 72 minutes for accurately triaged patients. Under-triage was independently associated with a 4.82-fold increased odds of prolonged D2B time. Our findings are consistent with the landmark Jordanian study by Alsharawneh et al. Multiple linear regression analysis revealed a strong association between under-triage and longer treatment times, emphasizing the significance of triage nurses' knowledge and competency. The high rate of under-triage (42.8%) in our study is alarming and is likely multifactorial. Atypical presentations particularly in women, elderly and diabetics may contribute to diagnostic uncertainty. The high prevalence of musculoskeletal chest pain and gastrointestinal symptoms in ED may contribute to cognitive biases. Patients with D2B >90 minutes had three times the in-hospital mortality (12.4% vs. 4.2%), longer hospital stays, and higher rates of MACE at 30 days. These findings align with international studies demonstrating that each 10-minute delay in reperfusion is associated with a 1.5% increase in mortality. The longer hospital stays and higher complication rates likely reflect the greater extent of myocardial damage from prolonged ischemia.

The Unified National Chest Pain Protocol, launched in collaboration with the Jordan Cardiac Society and Ministry of Health, represents a critical opportunity to address these delays. The protocol establishes standardized pathways for chest pain triage, including pre-hospital ECG acquisition with secure digital transmission to cardiologists, enabling early diagnosis and cath lab activation. At Princess Basma Hospital, which features two state-of-the-art cardiac catheterization laboratories and a 53-bed emergency department, implementation of this protocol could significantly improve D2B times. However, our findings suggest that protocol adherence remains suboptimal, particularly among under-triaged patients. Only 48.2% of under-triaged STEMI patients achieved D2B ≤90 minutes, compared to 82.4% of accurately triaged patients. This highlights that even with a national protocol in place, human factors—particularly triage nurse recognition and timely protocol activation—remain critical determinants of outcomes.

The strong association between under-triage and prolonged D2B time suggests several actionable interventions. First, enhanced triage nurse education on atypical ACS presentations, particularly in women, the elderly, and diabetics, may improve recognition. Second, standardized triage assessment tools incorporating risk stratification algorithms may reduce variability in clinical decision-making. Third, regular audit and feedback on triage accuracy and D2B times may promote continuous quality improvement. Fourth, electronic clinical decision support systems integrated into the triage process may reduce cognitive errors.

4.1. Limitations

Several limitations should be acknowledged. The retrospective design may introduce selection bias, though consecutive patients were included. The single-center setting at a newly inaugurated hospital may limit generalizability, though Princess Basma Hospital serves as a major referral center for Northern Jordan. Triage accuracy was based on documentation, which may not fully reflect clinical reasoning. Study period (2023-2025) includes data from the early phase of the hospital's opening, which may not be representative of long-term performance. Unmeasured confounders such as patient acuity and ED workload may have affected outcomes.

4.2 Clinical Implications This study has several clinical implications. First, it highlights the critical role of triage nurses in ACS recognition and the need for ongoing education and training. Second, it supports the implementation of standardized triage protocols, including the Unified National Chest Pain Protocol, to reduce diagnostic delays. Third, it identifies high-risk groups (women, patients with atypical presentation) who may benefit from more intensive triage and early ECG acquisition. Fourth, it underscores the importance of monitoring D2B times as a quality metric and the need for interventions to achieve the ≤ 90 -minute target.

5. Conclusion

Under-triage of ACS patients by emergency nurses at Princess Basma Hospital is associated with significant delays in door-to-balloon time and worse clinical outcomes. Under-triaged patients had median D2B times of 108 minutes, 18 minutes beyond the recommended target, and were nearly five times more likely to experience prolonged D2B time. Patients who were under-triaged had sub-optimal adherence to the Unified National Chest Pain Protocol with a need for enhanced triage education, standardised assessment tools and regular quality audit. These findings support targeted interventions to improve triage nurses' recognition of ACS and timely protocol activation to optimise patient outcomes.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interest.

Statement of ethical approval

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board (IRB) of the Ministry of Health, Jordan, on [24 June 2026] under registration number [Bas-240626]. Due to the retrospective and anonymized nature of the data analysis, the requirement for written informed consent was waived.

Statement of informed consent

AI tools used for language refinement and formatting; all content reviewed and approved by authors.

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