

Outcome of the Direct Admission System for STEMI Patients to the Catheterization Laboratory (D-Cath) within the Bangkok EMS Network

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ABSTRACT

Objective: To compare treatment timelines, diagnostic concordance, and short-term mortality between ST-elevation myocardial infarction (STEMI) patients transferred via the D-Cath system and those managed without the system.

Materials and Methods: A prospective descriptive cohort study was conducted among STEMI patients diagnosed in the prehospital setting by the Bangkok EMS system. Patients were divided into the D-Cath group (83 patients) and the non-D-Cath group (83 patients). Descriptive and inferential statistics were applied using an intention-to-treat analysis.

Results: Baseline characteristics were similar between groups. The D-Cath group had a significantly shorter diagnosis-to-catheterization laboratory (cath lab) time compared with the non-D-Cath group (30.0 vs. 51.0 minutes, $p<0.001$). However, the proportion of patients who reached the cath lab within 90 minutes was similar between groups (68.7% vs. 67.5%, $p=1.000$). When using a stricter benchmark of ≤ 60 minutes, a significantly higher proportion of patients in the D-Cath group met this target (62.7% vs. 50.6%, $p=0.022$). The diagnosis-to-wire crossing time was also shorter in the D-Cath group (87.0 vs. 106.0 minutes, $p=0.045$). While the proportion of patients achieving wire crossing within 120 minutes did not differ significantly between groups (59.0% vs. 50.6%, $p=0.125$), a significantly higher proportion of patients in the D-Cath group achieved wire crossing within 90 minutes (42.2% vs. 21.7%, $p=0.002$). Diagnostic concordance between prehospital and in-hospital physicians was 70.5%, and 48-hour mortality did not differ significantly between groups (12.0% vs. 15.7%, $p=0.500$).

Conclusion: The D-Cath system significantly reduced both diagnosis-to-cath lab and diagnosis-to-wire crossing times. However, the relatively low diagnostic concordance raises concerns regarding the efficiency of resource utilization. Further studies with larger sample sizes are needed to better determine the overall clinical benefit of this system.

Keywords: STEMI; Direct admission; Catheterization laboratory; Bangkok EMS

Received 11 December 2025 | Revised 21 March 2026 | Accepted 25 March 2026

J Med Assoc Thai 2026;109(10):823-7

<https://doi.org/10.35755/jmedassocthai.2026.10.03878>

ST-elevation myocardial infarction (STEMI) carries an estimated 14% mortality rate⁽¹⁾. The current 2023 European Society of Cardiology (ESC)⁽²⁾ and the 2025 American College of Cardiology/American Heart Association (ACC/AHA) guidelines⁽³⁾ emphasize rapid percutaneous coronary intervention (PCI), mandating

reperfusion within 90 to 120 minutes of diagnosis for both direct presentations and transfer cases. However, various patient and healthcare accessibility factors often cause critical treatment delays^(4,5). Minimizing these delays is vital for survival; research shows that every 30-minute delay in primary angioplasty increases the relative risk for 1-year mortality by 7.5%⁽⁶⁾, which

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How to cite this article:

Pitiyakulchorn T, Sukma K, Hiransasithanon T, Panyapanuwat P, Umpornwirojkit W. Outcome of the Direct Admission System for STEMI Patients to the Catheterization Laboratory (D-Cath) within the Bangkok EMS Network. J Med Assoc Thai 2026;109:823-7.

What is already known about this topic?

STEMI is a critical cardiac emergency that requires coronary reperfusion within 90 or 120 minutes. With advances in Bangkok EMS, prehospital diagnosis of STEMI can now be performed through telemedicine-enabled 12-lead EKG interpretation in Bangkok EMS ambulances.

What does this study add?

The direct admission system for STEMI patients to the cath lab (D-Cath) within the Bangkok EMS network significantly reduced the time to coronary wire crossing; however, this reduction did not necessarily translate into clinically meaningful outcomes. It seems that this interval may have reached its limit of effect. Furthermore, the prehospital diagnostic accuracy was only 70.5%.

corresponds to an adjusted hazard ratio increase of approximately 10% to 15% per hour⁽⁷⁾.

In Bangkok, only 34% of STEMI patients achieve the recommended 120-minute target⁽⁸⁾. Inspired by successful regionalized transfer networks, such as those established in Minnesota⁽⁹⁾, Bangkok Emergency Medical Service (EMS) introduced the Direct Admission to Catheterization Laboratory (D-Cath) model. By utilizing ambulance-based 12-lead electrocardiogram (EKG) and telemedicine interpretation, this system allows STEMI patients to bypass the emergency department entirely (Figure 1).

For suspected STEMI, dispatch coordinates direct D-Cath admission within a 20-kilometer radius; otherwise, patients are routed to the nearest catheterization laboratory (cath lab)-equipped emergency department. Although bypassing the ER theoretically reduces delays, real-world constraints—including low hospital participation, high patient volumes, and reliance on off-site cardiologists—often limit its overall effectiveness. This study aims to evaluate the real-world effectiveness of the D-Cath program within Bangkok's unique urban context, specifically focusing on treatment time intervals, diagnostic concordance, and short-term mortality.

OBJECTIVE

The primary objective of this study was to compare the time intervals from STEMI diagnosis to cath lab arrival and wire crossing between patients transferred through the D-Cath coordination system (D-Cath group) and those transferred via conventional referral (non-D-Cath group). The secondary endpoints were to assess the diagnostic concordance of prehospital STEMI diagnosis and the 48-hour mortality rate among these patients.

MATERIALS AND METHODS

This study was approved by the Bangkok Metropolitan Human Research Ethics Committee (No. S007hc/68_EXP). This prospective descriptive cohort study included STEMI patients transported by Bangkok EMS within a 20-km radius. Patients were divided into two groups: D-Cath (direct admission) and non-D-Cath (conventional referral).

Variable Definitions

- Cath lab time: The time interval from STEMI diagnosis to patient arrival at the cath lab.
- Wire crossing time: The duration from STEMI diagnosis to the moment the guidewire successfully crossed the culprit coronary lesion.

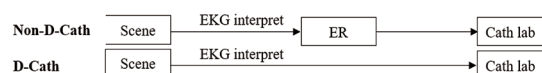


Figure 1. The models of D-Cath and non-D-Cath systems.

- Diagnostic concordance: Defined as cases in which the final hospital diagnosis agreed with the EMS physician's diagnosis of STEMI.
- Mortality rate: In-hospital mortality within 48 hours of admission.
- Unit response time: The time interval from EMS dispatch activation to the ambulance's arrival at the scene.

Sample size estimation was based on data from Farshid et al. in Australia⁽¹⁰⁾. Using G*Power software, the calculation yielded $n=75$ per group. To allow for a 10% dropout rate, the final target sample was increased to $n=83$ per group, resulting in a total of 166 patients (power=80%, $\alpha=0.05$, $\beta=0.2$, $P_1=0.84$, $P_2=0.64$). Data were analyzed using an intention-to-treat analysis. Chi-square or Student's t-tests were applied to normally distributed data, while Mann-Whitney U tests were used for non-normally distributed variables.

RESULTS

Among the 166 patients included in the study, the D-Cath and non-D-Cath groups exhibited generally comparable baseline characteristics (Table 1). Both groups were predominantly male, with mean ages of 58.6 and 63.4 years, respectively. The median unit response time was approximately 13.0 minutes in both groups, while the median distance from base to scene was similar, around 8 km. The transport distance from the scene to the hospital was 7.0 km in the D-Cath group and 8.0 km in the non-D-Cath group.

Although the median symptom onset time was shorter in the D-Cath group compared to the non-D-Cath group (42.0 vs. 73.0 minutes), this difference was not statistically significant ($p=0.141$). Regarding prehospital care, the types of interventions varied notably between the groups; the D-Cath group required cardiopulmonary resuscitation (CPR) more frequently, whereas endotracheal intubation was more common in the non-D-Cath group. Overall, however, the total rate of prehospital interventions remained comparable between the two groups ($p=0.020$).

Analysis of the diagnosis-to-hospital time revealed a non-normal distribution; therefore, data were presented as median and interquartile range (IQR). As shown in Table 2, the median time was 26.0 minutes in the D-Cath group and 31.0 minutes in the non-D-Cath

Table 1. Baseline characteristics of STEMI patients in both groups

Characteristics	D-Cath group (n=83)	Non-D-Cath group (n=83)	p-value
Sex; n (%)			0.310
Male	61 (73.5)	55 (66.3)	
Female	22 (26.5)	28 (33.7)	
Age (years); mean±SD	58.6±17.4	63.4±13.6	0.051
Onset of symptom (minutes); median (IQR)	42.0 (30.0 to 101.0)	73.0 (30.0 to 120.0)	0.041
Pre-hospital treatment; n (%)			0.020
CPR	6 (7.2)	3 (3.6)	
Intubation only	4 (4.8)	6 (7.2)	
Fluid IV resuscitation only	12 (14.5)	11 (13.3)	
Both Intubation and fluid resuscitation	0 (0.0)	1 (1.2)	
None	61 (73.5)	62 (74.7)	
Unit response time from dispatch to scene arrival; median (IQR)	13.0 (6.0 to 21.0)	13.0 (8.0 to 19.0)	0.849
Distance from base to scene (km); median (IQR)	8.0 (4.0 to 13.0)	8.0 (4.0 to 12.0)	0.970
Distance from scene to hospital (km); median (IQR)	7.0 (3.0 to 11.0)	8.0 (4.0 to 11.0)	0.347

SD=standard deviation; IQR=interquartile range; CPR=cardiopulmonary resuscitation; IV=intravenous
p-values from the chi-square test indicate statistical significance at $p<0.05$

Table 2. Comparison of the outcomes between the two groups

Times	D-Cath group (n=83)	Non-D-Cath group (n=83)	p-value
Time 1: diagnosis to hospital			
Dx-to-hospital (minutes); median (IQR)	26.0 (19.0 to 48.0)	31.0 (19.0 to 42.0)	0.482
Time 2: diagnosis to cath lab			
Dx-to-cath lab (minutes); median (IQR)	30.0 (25.0 to 42.0)	51.0 (40.0 to 63.0)	<0.001
Dx-to-cath lab time ≤90 minutes; n (%)	57.0 (68.7)	56.0 (67.5)	1.000
Dx-to-cath lab time ≤60 minutes; n (%)	52.0 (62.7)	42.0 (50.6)	0.022
Time 3: diagnosis to wire crossing			
Dx-to-wire crossing (minutes); median (IQR)	87.0 (70.5 to 107.8)	106.0 (81.0 to 123.0)	0.045
Dx-to-wire time ≤120 minutes; n (%)	49.0 (59.0)	42.0 (50.6)	0.125
Dx-to-wire time ≤90 minutes; n (%)	35.0 (42.2)	18.0 (21.7)	0.002
Mortality rate; n (%)	10 (12.0)	13 (15.7)	0.500
Diagnostic concordance; n (%)	59 (71.1)	58 (69.9)	0.865

Dx=diagnosis; IQR=interquartile range; cath lab=catheterization laboratory
p-values from the chi-square test indicate statistical significance at $p<0.05$

group, with no statistically significant difference based on the Mann-Whitney U test ($p=0.482$).

The intention-to-treat analysis revealed that some patients in the D-Cath group did not undergo cardiac catheterization. Consequently, in the D-Cath group, the mean diagnosis-to-hospital time was not equivalent to the diagnosis-to-cath lab time. For the diagnosis-to-cath lab time, the D-Cath group demonstrated a significantly shorter median interval compared with the non-D-Cath group (30.5 vs. 51.0 minutes, $p<0.001$). The proportion of patients arriving at the cath lab within 90 minutes was similar between groups (68.7% and 67.5%, $p=1.000$). When a stricter benchmark of ≤60 minutes was applied, a significantly higher proportion

of patients in the D-Cath group achieved this target (62.7% vs. 50.6%, $p=0.022$).

Regarding the diagnosis-to-wire crossing time, the D-Cath group also demonstrated a significantly shorter median time compared with the non-D-Cath group (87.0 vs. 106.0 minutes, $p=0.045$). The proportion of patients achieving wire crossing within 120 minutes was 59.0% in the D-Cath group and 50.6% in the non-D-Cath group ($p=0.125$). However, when considering the stricter target of ≤90 minutes, a significantly higher proportion of patients in the D-Cath group achieved this benchmark (42.2% vs. 21.7%, $p=0.002$).

Analysis of 48-hour mortality showed that the D-Cath group had a mortality rate of 12.0%, which

was slightly lower than that of the non-D-Cath group (15.7%), although the difference was not statistically significant ($p=0.500$). Kaplan-Meier survival analysis and the Log-rank test demonstrated no significant difference in survival probability (diagnosis-to-hospital time) between the D-Cath and non-D-Cath groups ($p=0.177$). In the multivariate logistic regression analysis, there was no statistically significant difference in mortality between patients transferred via the D-Cath system and those in the non-D-Cath group (adjusted OR 1.78, 95% CI 0.68 to 4.67, $p=0.238$).

The present study found that the overall diagnostic concordance of STEMI between EMS prehospital diagnosis and hospital diagnosis was 70.5%, with no significant difference observed between the D-Cath and non-D-Cath groups ($p=0.865$).

DISCUSSION

The diagnosis-to-cath lab interval should ideally remain within 60 or 90 minutes to achieve 90- or 120-minute reperfusion benchmarks⁽¹¹⁾. While the overall median transport time reduction was not statistically significant, significantly more D-Cath patients reached the cath lab within 60 minutes. Furthermore, the total diagnosis-to-wire crossing time was significantly shorter in the D-Cath group. This suggests that bypassing the emergency department effectively minimizes in-hospital delays, aligning with international studies reporting reduced door-to-balloon and pain-to-balloon times⁽¹²⁾.

No significant difference in 48-hour mortality was observed. While previous studies show long-term mortality benefits⁽¹²⁾, our lack of difference is likely due to limited sample size and statistical power. Additionally, the prehospital diagnostic concordance was 70.5%, which is consistent with prior reports of 66.6% accuracy^(13,14). This highlights the ongoing challenge of false-positive prehospital activations and unnecessary cath lab utilization.

LIMITATIONS

This study has several limitations. First, the observational, non-randomized design relied on real-world dispatch decisions, potentially introducing selection bias. Second, variations in prehospital interventions may act as confounders. Third, the study was powered for treatment timelines (diagnosis-to-wire crossing) rather than mortality outcomes. Finally, assessing only short-term 48-hour mortality may not reflect long-term clinical outcomes. Future studies should utilize propensity-score matching or cluster randomization to mitigate these biases.

GENERALIZABILITY

Bangkok's complex, multi-organization healthcare landscape limits the utility of standard provincial zoning. However, restricting this study to a 20-km radius successfully isolated the bypass protocol's operational efficiency from long-distance transport delays.

CONCLUSION

In summary, the D-Cath model successfully shortened critical treatment intervals and provides a robust framework for complex urban EMS systems. While a trend toward lower 48-hour mortality was observed, this finding must be interpreted cautiously due to statistical power limitations.

Acknowledgment

The authors would like to thank the Bangkok Emergency Medical Center (Erawan Center), Department of Medical Service, Bangkok Metropolitan Administration, and all categories of participating personnel and base hospitals for their contributions to data collection and patient care. We also thank all the emergency medical service personnel who participated in the D-Cath coordination system.

Authors' Contributions

TP: Conceptualization, methodology, data curation, manuscript drafting, manuscript revision, and project administration. KS and TH: Investigation, data collection, and prehospital data management. PP: Formal analysis, methodology, and validation. WU: Supervision and validation

Clinical Trial Registration

Not applicable. This study was a prospective observational study and was not registered as a clinical trial.

Conflicts of Interest

The authors declare no conflict of interest.

Data Availability Statement

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

This study was approved by the Bangkok Metropolitan Human Research Ethics Committee (approval No. S007hc/68_EXP). Verbal informed consent was obtained from all individual participants

prior to their inclusion and data collection. The consent procedure was approved by the Institutional Review Board.

Funding Disclosure

The present study was funded by the Bangkok Metropolitan Administration (BMA).

Use of Artificial Intelligence

During the preparation of this manuscript, the authors used Google Gemini 3.1 Pro to improve language and readability. After using this tool/service, the authors reviewed and edited the content as needed and took full responsibility for the final content for publication.

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