Effectiveness of Emergency Medical Motorcycles in Out-of-Hospital Cardiac Arrest Management within the Bangkok EMS System

Tanya Pitiyakulchorn, MD[1], Wanida Pawaree, BNS, MPH[2]

[1] Emergency Medical Services Division, Bangkok Emergency Medical Center (Erawan Center), Department of Medical Service, Bangkok Metropolitan Administration (BMA), Bangkok, Thailand; [2] Standards and Systems Division, Bangkok Emergency Medical Center (Erawan Center), Department of Medical Service, Bangkok Metropolitan Administration (BMA), Bangkok, Thailand

Objective: To compare the effectiveness of an emergency medical motorcycle (motorlance)-first versus ambulance-first response for out-of-hospital cardiac arrest (OHCA) in Bangkok, focusing on return of spontaneous circulation (ROSC), 48-hour survival, and response-related factors associated with outcomes.

Materials and Methods: The present cohort study used data from the prospective Bangkok Emergency Medical Services (EMS) registry. It included 3,713 adult OHCA cases managed between May 2024 and July 2025 within a 10-kilometer operational radius. Patients were categorized by initial response type as motorlance-first or ambulance-first. There were 335 motorlance-first and 3,378 ambulance-first patients. Descriptive statistics, chi-square tests, multivariable logistic regression, Kaplan-Meier survival analysis, log-rank tests, and Cox proportional hazards models were applied.

Results: Motorlance-first response was associated with a significantly higher rate of ROSC compared with ambulance-first response at 54.0% versus 37.5% (p<0.0001) and a shorter mean response time at 8.8 versus 11.8 minutes (p<0.0001). After adjustment for initial ECG rhythm and other covariates, motorlance deployment remained independently associated with reduced mortality at the scene (adjusted OR 0.48, p<0.001) and increased ROSC. AED shock delivery occurred more frequently in the motorlance group at 22.39% versus 16.04% (p=0.003). No significant difference was observed in 48-hour survival between groups (p=0.306). Time-to-event analyses demonstrated significantly shorter time to ROSC in the motorlance group (log-rank p=0.0013). Multivariable Cox regression showed that each additional minute of response time was associated with a 5.4% decrease in the likelihood of finding survivors (HR 0.946, p<0.001).

Conclusion: Motorlance-first response in the Bangkok EMS system significantly improves early resuscitation outcomes in OHCA by reducing response time and increasing ROSC, although no difference in 48-hour survival was observed. Given the present study's limitations, these findings should be confirmed by future randomized controlled trials.

Keywords: Out-of-hospital cardiac arrest; OHCA; Motorlance; ROSC; Survival

Out-of-hospital cardiac arrest (OHCA) represents a critical medical emergency that demands rapid intervention to improve survival and neurological outcomes[1]. Overall survival of OHCA patients present with shockable rhythms remains low at around 10%[2], and each minute of delay in defibrillation reducing survival probability by 7% to

Correspondence to:

Pitiyakulchorn T.

Emergency Medical Services Division, Erawan Medical Center, Medical Services Department, Bangkok 10100, Thailand.

Phone: +66-95-7652018

Email: Ep7.tanya@gmail.com

10%[3], highlighting the importance of rapid response. Guidelines from the National Institute for Emergency Medicine (NIEM) of Thailand recommend initial basic life support intervention within four minutes and advanced life support within eight minutes after collapse[4,5]. However, the 2025 American Heart Association (AHA) Guidelines for cardiopulmonary resuscitation (CPR) and emergency cardiovascular care (ECC) emphasize the importance of a coordinated "System of Care" to improve OHCA survival, rather than setting a single, universal maximum prehospital response time[6]. The International Liaison Committee on Resuscitation (ILCOR) emphasizes the "Formula for Survival," which identifies three critical components for improved outcomes, guidelines based on sound science, effective education of resuscitation professionals, and well-functioning systems of care[7].

Internationally, several countries provide motorcycle ambulance service to respond to a medical emergency in heavy traffic[8], which can increase survival rates for critically ill patients, especially those in cardiac arrest[9,10]. In Bangkok, with its population exceeding 10 million including non-registered residents[11], dense urban structure, and chronic traffic congestion, meeting these benchmarks remains challenging. To address delayed emergency medical services (EMS) response, the Bangkok Metropolitan Administration introduced emergency medical motorcycle, known as motorlances, in May 2024. Motorlances offer advantages including agility in traffic, lower operational costs, and faster arrival at scenes compared to traditional ambulances. However, the efficacy of motorlances in improving OHCA outcomes in Bangkok has not been systematically evaluated.

LITERATURE REVIEW

The United States in 2024, EMS-treated, non-traumatic OHCA cases have survival to hospital discharge rate after EMS-treated adult OHCA was 10.5%, and favorable neurologic survival was 8.2%. Survival to hospital discharge was higher when the cardiac arrest occurred in a public place, at 21.1%, than if it occurred in a residential setting, at 8.9%. Only 12.6% of patients who experienced cardiac arrest in public had an automated external defibrillator (AED) applied by a lay rescuer[6].

Previous studies in Thailand have shown that motorlances can reduce EMS response times and improve early defibrillation rates[12]. In Khon Kaen Province, the average response time for motorlances was 6.12 minutes compared to 9.10 minutes[13] for ambulances during afternoon peak hours. International evidence indicates that earlier defibrillation for shockable rhythms increases survival, with each minute of delay reducing survival probability by 7% to 10%[3]. In Slovenia, OHCA patients reached by motorlances had a return of spontaneous circulation (ROSC) rate of 44.3% compared to 36.9% for ambulances[14]. Cost analysis in Philippines verified the financial feasibility of motorlance systems[15]. Pilot program in Malawi and Iran have demonstrated significant improvements in response times and cost-efficiency with motorlance systems[15]. A study in Iran showed the efficiency of the motorlance through appropriate screening of age, sex, cause, and time of the accident[16].

Evidence on the effectiveness of motorlance deployment for OHCA remains limited, particularly
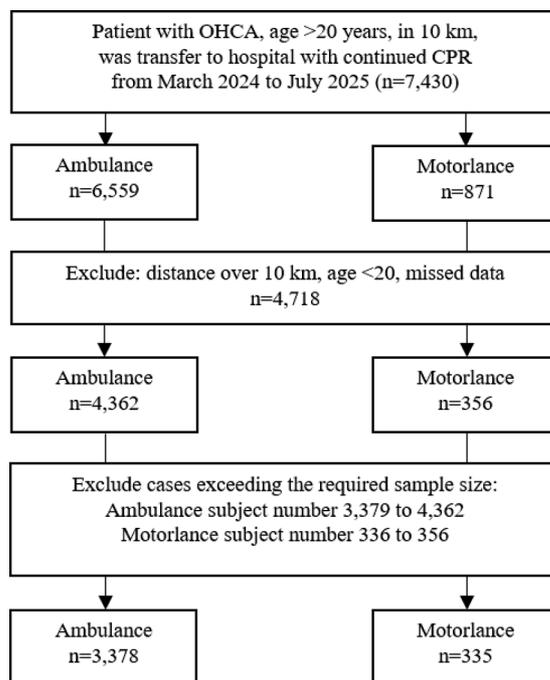

Figure 1. Flow diagram patient selection.

in large metropolitan EMS systems. In Thailand, existing data are restricted to a single-center study in Khon Kaen Province, which may not reflect the operational complexity of Bangkok. Moreover, no prior multicenter studies have evaluated motorlance-first response and early resuscitation outcomes within the Bangkok EMS system, highlighting a critical gap in knowledge.

OBJECTIVE

Firstly, to compare the effectiveness of patient access between motorlance and ambulance responses among patients with cardiac arrest in Bangkok. Secondly, to identify factors associated with survival among patients with OHCA initially accessed by motorlance and ambulance services.

MATERIALS AND METHODS
Methodology

Study design: The present study employed a cohort design, utilizing data from a prospective registry.

Setting: The incidents received by EMS from the Bangkok Erawan Center between May 2024 and July 2025.

Participants (as Figure 1): Inclusion criteria were older than 20 years, classified as OHCA, being transferred to the hospital with continued CPR,

and incident location within a 10-km operational radius[17]. Exclusion criteria included incorrect dispatch address, missing essential data, or loss to follow-up.

Variable

Motorlance-first response: Initial response by a motorlance registered in the Bangkok EMS system, staffed by either a medical assistant or a licensed healthcare provider, and always followed by an ambulance for continued care.

Ambulance-first response: Initial response by an ambulance registered in the Bangkok EMS system, staffed with an advanced-level emergency medical crew according to the NIEM standards, without prior motorlance deployment.

ROSC: The restoration of a palpable pulse and effective blood circulation following resuscitation efforts.

48-hour survival: Survival status defined as the patient remaining alive 48 hours after first contact by the EMS response team, from the dataset specified by NIEM.

Response time: Interval from receipt of the emergency call to the arrival of the response team at the scene or patient.

Distance: Distance from the base to the incident scene, calculated as odometer reading at the scenes minus odometer reading before departure.

Cardiac rhythm: Cardiac rhythm at the initiation of resuscitation, classified as shockable or non-shockable, as detected by an AED or defibrillator. Shockable rhythms included ventricular fibrillation (VF) and pulseless ventricular tachycardia (VT), while non-shockable rhythms included pulseless electrical activity (PEA) and asystole.

Licensed healthcare provider: Physicians, nurses, and paramedics.

Medical assistant: Emergency medical assistants, levels 1 to 6, as defined by NIEM.

AED/defibrillator use: Use of an AED in motorlance responses and use of an AED or defibrillator in ambulance responses.

Size of destination hospital: Categorized as small for less than 120 beds, medium for 120 to 500 beds, and large for more than 500 beds.

Data sources/measurement

Data were obtained from the registry of the Bangkok EMS system, an information technology-based platform of the Bangkok Emergency Medical Center (Erawan Center). The registry includes, at a minimum, the dataset elements specified by the NIEM. Response time was automatically captured from the EMS dispatch and electronic patient care reporting systems. Survival outcomes were determined from follow-up data available within the registry. Initial cardiac rhythm, witnessed status, bystander CPR, and AED use were documented by EMS personnel at the scene according to standardized reporting protocols. Measurement methods were identical for both motorlance and ambulance groups, as all data were collected using the same EMS documentation system and registry definitions, ensuring comparability between groups.

Bias

Ambulance crews may have been preferentially dispatched for death confirmation in cases with reported signs of irreversible death. To minimize the effect of selection bias, only patients transported to the hospital with ongoing CPR were included in the present study.

Study size

Calculation was based on the study by Škufca Sterle & Podbregar in Slovenia[14], as it was also a multicenter study similar to the present research. Using G*Power software, the calculation yielded n_1=304 and n_2=3,040. To allow for a 10% dropout rate, the final target sample was increased to n_1=335 and n_2=3,378, resulting in a total of 3,713 patients (power=80%, α=0.1, β=0.2, P_1=0.443, P_2=0.365).

Quantitative variables

Quantitative variables included age, distance, and response time, which were recorded in minutes. Continuous variables were assessed for normality using visual inspection and appropriate statistical tests. Normally distributed variables were summarized as means with standard deviations, while non-normally distributed variables were presented as medians.

Statistical analysis

Categorical data were analyzed using Chi-square tests. Associations were estimated with logistic regression. Time-to-event outcomes were analyzed with Kaplan-Meier survival curves and log-rank tests. Adjusted odds ratios (ORs) were calculated using the Mantel-Haenszel method.

RESULTS

Baseline characteristics of OHCA patients by type of initial response are presented in Table 1.

Table 1. Baseline characteristics of OHCA patients by type of initial response

Variable	Ambulance-first (n=3,378)	Motorlance-first (n=335)	p-value
Sex; n (%)			0.813
Male	2,029 (60.07)	199 (59.40)	
Female	1,349 (39.93)	136 (40.60)	
Age (years); mean±SD	61.00±21.92	63.34±16.26	0.04*
Type of incident; n (%)			0.239
Medical	2,713 (80.31)	278 (82.99)	
Accident	665 (19.69)	57 (17.01)	
Time of incident; n (%)			<0.0001*
0.01 to 8.00	783 (23.18)	7 (2.09)	
8.01 to 16.00	1,293 (38.28)	192 (57.31)	
16.01 to 0.00	1,302 (38.54)	136 (40.60)	
Location of incident; n (%)			0.820
Residential area	2,076 (61.46)	208 (62.09)	
Public area	1,302 (38.54)	127 (37.91)	
ECG rhythm; n (%)			0.003*
Shockable (VF/pulseless VT)	542 (16.04)	75 (22.39)	
Non-shockable (PEA/asystole)	2,836 (83.96)	260 (77.61)	

SD=standard deviation; ECG=electrocardiogram; VF=ventricular fibrillation; VT=ventricular tachycardia; PEA=pulseless electrical activity
p-values from chi-square test, * Statistical significance at p<0.05

Table 2. Comparison of ROSC and 48-hour survival rates between motorlance-first and ambulance-first response groups

Outcome	Ambulance-first (n=3,378); n (%)	Motorlance-first (n=335); n (%)	p-value
ROSC			<0.0001*
Yes	1,267 (37.51)	181 (54.03)	
No (death at scene)	2,111 (62.49)	154 (45.97)	
48-hour survival			0.306
Yes	590 (17.47)	66 (19.70)	
No (death in hospital)	2,788 (82.53)	269 (80.30)	

ROSC=return of spontaneous circulation
p-values from chi-square test, * Statistical significance at p<0.05

The majority of patients in both groups were male (p=0.813) The mean age in both groups was over 60 years, although a small but statistically significant difference was observed (p=0.04). Medical cases were more common than accident-related cases in both groups. The most frequent operational time for motorlance responses was between 08:01 and 16:00, whereas ambulance responses most often occurred between 16:01 and 00:00. Most cardiac arrest events occurred in residential locations in both groups, with no significant difference in incident location (p=0.820). A shockable rhythm was detected in 75 patients (22.39%) in the motorlance group and in 542 patients (16.04%) in the ambulance group, a difference that was statistically significant (p=0.003).

Survival outcomes

As shown in Table 2, the motorlance-first group achieved significantly higher rates of ROSC compared with the ambulance-first group. ROSC occurred in 181 patients (54.03%) in the motorlance group versus 1,267 patients (37.51%) in the ambulance group (p<0.0001), while 48-hour survival was observed in 154 patients (45.97%) in the motorlance group compared with 2,111 patients (62.49%) in the ambulance group (p<0.0001). In contrast, no statistically significant difference was observed in 48-hour survival between the two groups. 48-hour survival was observed in 66 patients (19.70%) in the motorlance group and in 590 patients (17.47%) in the ambulance group (p=0.306).

Multivariable logistic regression showed that motorlance response was associated with a significant reduction in mortality at scene (adjusted OR 0.48, 95% CI 0.40 to 0.64, p<0.0001) but no significant difference in the 48-hour survival (adjusted OR 0.86,
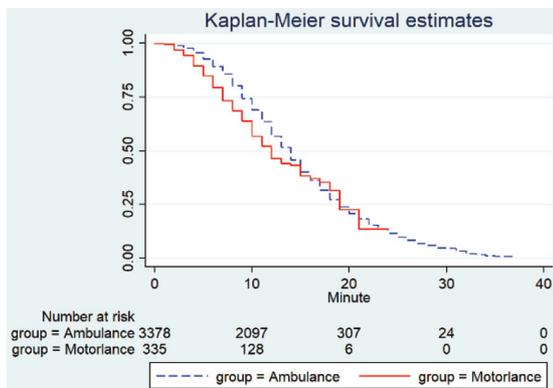
Figure 2. Survival curves at scene.

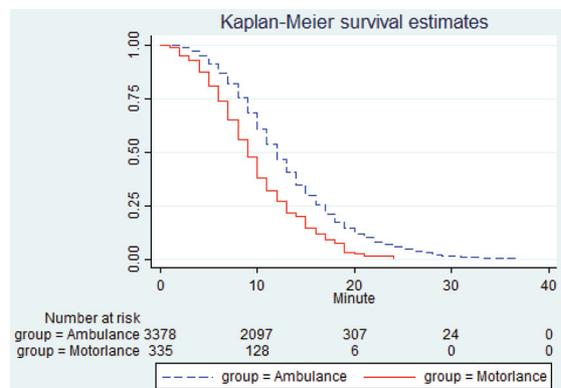X-axis: Response time, Y-axis: Probability of survival

Figure 3. Survival curves at 48-hours.

X-axis: Response time, Y-axis: Probability of survival

95% CI 0.65 to 1.15, p=0.307).

For ROSC, interaction analysis with electro-cardiogram (ECG) rhythm type demonstrated a significant interaction (adjusted OR 0.024, p<0.001), indicating that motorlance deployment in shockable patients was associated with reduced mortality at scene, corresponding to 1.85-fold increase in the odds of ROSC. In contrast, for 48-hour survival, interaction analysis showed no statistically significant interaction effect (adjusted OR 0.68, p=0.142).

Kaplan-Meier survival curves as Figure 2 and 3. Because all study participants had already experienced cardiac arrest at baseline, using death as the event (death=1) in time-to-event analyses may be misleading. Earlier arrival of motorlance teams can result in earlier confirmation or declaration of death, which does not necessarily reflect earlier biological death. Consequently, shorter time to death in the motorlance group should not be interpreted as worse outcomes. The log-rank test confirmed significant differences between groups in time to ROSC (p=0.0013) and 48-hour survival (p<0.0001).

When comparing patients with shockable and non-shockable rhythms in the present study, no significant differences were observed in either ROSC (p=0.708) or 48-hour survival (p=0.823) between the two rhythm types.

Analysis of other patient access factors

As shown in Table 3, the mean response time in the ambulance group was 11.8 minutes compared with 8.8 minutes in the motorlance group, a statistically significant difference (p<0.0001). Multivariate logistic regression analysis showed that response time was not significantly associated with ROSC (adjusted OR 1.01, p 0.135) or 48-hour survival (p=0.164).

Multivariate cox regression analysis revealed that each additional minute of response time was associated with a 5.4% decrease in the likelihood of finding survivors (HR 0.946, 95% CI 0.940 to 0.952, p<0.001) and motorlance deployment was associated with a 33.5% reduction in the hazard of death compared with ambulance response (HR 0.665, 95% CI 0.588 to 0.753, p<0.001). The mean distance in the ambulance group was 5.2 km compared with 4.8 km in the motorlance group, a statistically significant difference (p=0.02). However, multivariate logistic regression analysis demonstrated that mean distance was not significantly associated with either ROSC (adjusted OR 0.98, p=0.215) or 48-hour survival (adjusted OR 0.98 p=0.382).

Among motorlance cases, 284 patients (84.78%) were attended by crews led by medical assistants, while 51 patients (15.22%) were attended by licensed healthcare providers. Logistic regression analysis showed that crew leader type had no significant effect on ROSC or 48-hour survival.

According to Bangkok EMS accreditation standards, all ambulances are equipped with defibrillators or AEDs; therefore, AED application was performed in 100% of OHCA cases, with shock delivery occurring in 16.04% of patients. Similarly, all motorlances were equipped with AEDs, resulting in a 100% application rate, with shock delivery in 22.39% of the cases.

There was no significant difference in destination hospital level between the ambulance-first and motorlance-first groups (p=0.205). Most patients in both groups were transported to large hospitals, accounting for 65.25% of ambulance-first cases and 63.88% of motorlance-first cases. Multivariable regression analysis showed that patients transported

Table 3. Comparison of patient access factors by type of initial response

Outcome	Ambulance-first (n=3,378)	Motorlance-first (n=335)	p-value
Leader; n (%)			<0.0001*
Medical assistant	0 (0.00)	284 (84.78)	
Licensed healthcare provider	3,378 (100)	51 (15.22)	
Response time (minutes); mean	11.824	8.758	<0.0001*
Distance (km); mean	5.193	4.842	0.02*
AED/defibrillator use; n (%)			0.003*
Patch application	3,378 (100)	335 (100)	
Shock delivery	542 (16.04)	75 (22.39)	
No shock delivery	2,836 (83.96)	260 (77.61)	
No application	0 (0.00)	0 (0.00)	
Destination hospital; n (%)			0.205
Small hospital	508 (15.04)	62 (18.51)	
Medium hospital	666 (19.72)	59 (17.61)	
Large hospital	2,204 (65.25)	214 (63.88)	

AED=automated external defibrillator

p-values from chi-square test; * Statistical significance at p<0.05

to large hospitals had a 7% lower odds of death compared with those transported to small hospitals. However, this association was not statistically significant (adjusted OR 0.92, p=0.419).

DISCUSSION

According to the AHA, OHCA patients with shockable rhythms have significantly greater survival when defibrillated promptly compared with those with non-shockable rhythms[18]. Early deployment of motorlances equipped with AED has been shown to improve survival, Apiratwarakul et al., reported survival rates of 80% for patients reached by motorlance compared with 37.5% for those reached by ambulance[19].

In the present study, although motorlances operate with fewer personnel, less advanced training, and more limited equipment than ambulances, they are consistently followed by an ambulance for continued care, and all standardized ambulances in the Bangkok EMS system are equipped with AEDs. The motorlance-first group was able to reach patients more rapidly (p<0.0001) and achieved significantly higher rates of ROSC even after adjustment for initial ECG rhythm, along with higher AED shock delivery (p=0.003). However, no statistically significant difference was observed in 48-hour survival compared with the ambulance-first group (p=0.306), suggesting that post-resuscitation care processes should be further explored.

According to NIEM standards, motorlance crews may be led by either a medical assistant or a licensed healthcare provider. A previous study in Slovenia demonstrated that motorlance response teams led by paramedics were associated with shorter response times, higher survival rates, and improved neurological outcomes among OHCA patients[17]. In the present study, subgroup analysis of the motorlance group demonstrated no significant differences in ROSC or survival between cases led by medical assistants and those led by licensed healthcare providers. However, this finding should be interpreted with caution due to the limited sample size.

Interpretation of time-to-event outcomes in the present study requires caution, as all participants had already experienced cardiac arrest at baseline. Earlier arrival of motorlance teams may lead to earlier confirmation or declaration of death, which does not necessarily reflect earlier biological death. Consequently, time-to-death analyses may underestimate the benefit of faster response. When survival-based outcomes were considered instead, shorter response time remained strongly associated with improved outcomes. Multivariable cox regression demonstrated that each additional minute of response time was associated with a 5.4% reduction in the likelihood of finding survivors, underscoring the critical role of rapid EMS access in OHCA care.

LIMITATION

The Bangkok EMS data registry is used as a standardized template for all categories of EMS cases and is not a dedicated Utstein-style OHCA

registry, which requires substantial time and effort to complete. As a result, the Bangkok EMS data registry may have less detailed recording of OHCA-specific variables. Additionally, data are provided by multiple EMS base hospitals not directly supervised by the Erawan Center, leading to potential variability in data quality.

INTERPRETATION

Patients reached first by a motorlance crew, followed by ambulance support, achieved ROSC more frequently and more rapidly than those reached by ambulance alone, despite having fewer personnel and less equipment. Longer response times were associated with reduced survival.

Further double-blind randomized controlled trials are needed to establish a dedicated Utstein-style OHCA registry and to minimize selection bias. Future studies should also evaluate long-term outcomes, including survival to hospital discharge, six-month survival, and quality of survival. In addition, future trials may consider using a more stringent Type I error significance level (α=0.01 to 0.05) to further enhance the reliability of study findings.

GENERALIZABILITY

Given the higher proportion of shockable rhythms and the observed improvement in ROSC, implementation of motorlances in other areas should be encouraged, and all motorlances should be equipped with AEDs as a standard configuration, consistent with Bangkok EMS standards. However, the findings are derived from a Bangkok EMS system and may have limited generalizability beyond the Bangkok metropolitan area.

WHAT IS ALREADY KNOWN ABOUT THIS TOPIC?

The NIEM has set a standard that patients with OHCA should be reached within eight minutes (response time)[2]. Motorlances have shorter response times compared with traditional ambulances[5]. For cardiac arrest patients with a shockable rhythm, if defibrillation is not delivered promptly, survival decreases by 7% to 10% with every minute of delay[7].

WHAT DOES THIS STUDY ADD?

The use of motorlances in the Bangkok EMS system significantly reduced response times for OHCA patients to less than eight minutes. Moreover, motorlances equipped with an AED improved both survival and ROSC. However, the type of leader on the motorlance did not affect the likelihood of achieving ROSC or survival.

AUTHORS' CONTRIBUTIONS

TP: Conceptualization, study design, data interpretation, statistical analysis, manuscript drafting, and manuscript revision. WP: Data curation, registry management, manuscript review, and manuscript revision. Both authors read and approved the final manuscript.

DATA AVAILABILITY STATEMENT

The data sets 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. S010hc/68_EXP).

CLINICAL TRIAL REGISTRATION

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

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 take full responsibility for the final content for publication.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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