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ORIGINAL RESEARCH

Optimizing Clinical Risk Management Through Motorcycle Emergency Response: A Three-Year Retrospective Study of the Khon Kaen International Marathon in Thailand

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Purpose: This study evaluates the effectiveness of motorcycle ambulances (motorlances) in delivering emergency medical response at the Khon Kaen International Marathon (KKIM), Thailand, over a three-year period (2023–2025).

Patients and Methods: We conducted a retrospective analysis of emergency medical service (EMS) data from three consecutive annual Khon Kaen International Marathons held on January 28–29, 2023; January 13–14, 2024; and January 11–12, 2025. Data including EMS operation intervals, clinical interventions carried out, and patient outcomes were collected from EMS patient care documents, organized by Srinagarind Hospital, Khon Kaen University, Thailand during the marathon events. A comparative analysis was carried out to evaluate year-over-year operational improvements utilizing IBM SPSS version 27.0, with continuous data expressed as means ± standard deviations, categorical data as frequencies and percentages, chi-square tests employed for associations among categorical variables, and $p<0.05$ considered statistically significant.

Results: Among 20,681 marathon participants, 132 cases (6.38%) required emergency intervention with motorlance support. The use of motorlances significantly increased from 25 cases in 2023 to 65 in 2025 ($p=0.011$), with consistently rapid mean response times (5.3–5.6 minutes each year). Clinical capabilities improved over the study period, evidenced by a rise in advanced interventions such as intravenous glucose administration and pain management (from 0% to 23.1%, $p=0.010$). Scene time increased in parallel with this expanded clinical scope (from 8.2 to 18.6 minutes, $p<0.001$). Importantly, over 90% of patients treated by motorlance were able to continue the race following on-scene care.

Conclusion: Motorcycle ambulances significantly enhance the efficiency of emergency medical responses during large marathon events. Notable results indicate a constant increase in motorlance utilization, consistently rapid response times, and enhanced clinical competencies with advanced interventions. Extended scene duration indicated enhanced on-site treatment delivery. Significantly, over 90% of patients treated by motorlance resumed to racing after treatment, indicating the efficacy of prehospital intervention.

Keywords: emergency medical services, risk management, motorlance, response time, marathon, patient safety

Introduction

International sporting events represent a category of mass gatherings that are increasingly common in our globalized society. Gatherings of numerous participants and spectators in restricted-access areas presents significant challenges for emergency medical services (EMS), evaluating the logistical resilience of healthcare systems and the efficacy of rapid clinical interventions. These occurrences typically pose substantial challenges to the public health and safety sectors of the host nations.[1–5]

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Marathons, in particular, attract significant worldwide attendance and pose unique challenges for emergency medical services (EMS). Although elaborate event planning, reaching distressed participants is frequently obstructed by crowd size and density, limited road access, and the long-lasting, occasionally isolated, landscapes of marathon routes. Traditional ambulances, despite being adequately equipped for advanced life support, may encounter delays due to these obstacles, thereby extending response times and increasing clinical risk for the individuals involved.[6–8] The prompt delivery of emergency care during these incidents is essential, as delays in intervention correlate with negative patient outcomes, particularly for acute conditions such as heat-related illnesses, metabolic disturbances, traumatic injuries, and sudden cardiac arrest. According to previous studies, patient outcomes are greatly impacted by the time between first medical contact and treatment, especially in situations that call for immediate intervention.[9–12] This highlights the necessity for event organizers and medical directors to adopt innovative solutions that can effectively manage these challenging environments.

The EMS in Thailand operate on a decentralized framework, overseen by the Ministry of Public Health, with regional hospitals acting as the principal EMS providers for their specific areas of coverage. The system primarily utilized ground ambulances; however, certain events or EMS units integrated conventional ground ambulances with specialized rapid response vehicles, such as motorlances. Motorlances, or motorcycle ambulances, provide a novel alternative to conventional emergency response vehicles by combining maneuverability with essential medical capabilities during mass gathering events. Motorlance EMS operations during marathon events involve the strategic placement of motorlances at crucial points along the route, including start/finish sites, high-risk zones, and medical stops to guarantee thorough coverage. In the event of a crisis, motorlances may maneuver through crowds and constricted passages,[13,14] accessing patients within minutes. The motorlance teams were operated by a two-person team composed of highly trained emergency personnel. The teams typically consisted of one emergency nurse and one advanced-level paramedic or emergency medical technician. The roles and responsibilities were clearly delineated to ensure operational efficiency. The vehicle operator was responsible for safely navigating the motorcycle along the marathon route to reach patients swiftly. Their duties also included establishing a safe scene, initiating radio communication with the central dispatch center, and providing initial first aid and basic life support. Emergency nurses or paramedics were served as primary medical providers. This individual was responsible for conducting the primary patient assessment, performing clinical triage, and delivering advanced medical interventions as needed. Their scope of practice included administering medications (for pain management), performing procedures such as intravenous glucose administration, managing wounds, and operating the automated external defibrillator (AED). They worked under online medical direction from the dispatch center physician and made the final determination on whether a patient could be treated on-site and continue the race or required transport to a higher-level medical facility via a conventional ambulance. Despite the utilization of motorlances in many global contexts, such as rural healthcare in impoverished countries and urban emergency response in densely populated locations, their applicability and effectiveness in international marathon environments are little researched.

Several factors merit consideration when evaluating motorlance deployment at athletic events. Key operational metrics include EMS response time, equipment capacity, medication availability, and the provider's scope of practice. While previous studies have examined various aspects of mass gathering medicine at athletic events, there remains a significant gap in the literature regarding the specific utility and performance of motorlances in marathon contexts, and longitudinal data that quantifies their clinical and operational effects during recurring, large-scale mass gathering events.[15–18]

A comprehensive assessment of motorlance deployment is essential to clarify their influence on operational metrics, including EMS activation and response times, as well as their effect on advanced clinical interventions and patient outcomes. Furthermore, assessing their role within the comprehensive risk management framework at athletic events can inform evidence-based policy and resource distribution for both event organizers and healthcare systems.

This study presents a novel and comprehensive analysis of the multi-year implementation and evolving role of motorcycle ambulances, distinct from prior reports on general EMS operations. This study intends to conduct a retrospective analysis of three years of data to assess the efficacy, clinical relevance, and operational development of motorcycle ambulances during a significant international marathon. The study aims to inform future risk management strategies and improve patient safety during significant mass gatherings.

Materials and Methods

A retrospective evaluation of medical data was conducted by the Srinagarind Hospital, Khon Kaen University, Thailand, during the Khon Kaen International Marathon (KKIM) from 2023 to 2025. The race takes place on public roads and is certified by the International Association of Athletics Federations (IAAF; Monaco). In 2004, the 40th anniversary of Khon Kaen University (KKU) was honored. The KKU Promotion Committee started the KKIM to commemorate the event. The subsequent year, the event was officially instituted and eventually came to recognition in Thailand's Khon Kaen province. Participants in KKIM over these three consecutive years were included. Participants with incomplete data did not participate from this study. The study population consisted of participants who utilized motorlance in the KKIM. The study flow diagram was displayed in Figure 1.

Data Collection

The KKIM took place on January 28–29, 2023; January 13–14, 2024; and January 11–12, 2025. The international sporting event featured a fun run (5.4 km), mini marathon (11.55 km), half marathon (21.1 km), and full marathon (42.195 km). The fun run served as the primary athletic event on the first day, while the marathon, half marathon, and mini marathon were held on the second day. The full marathon began at 3 a.m. and had a cut-off time of seven hours.

The EMS plan was a joint initiative between the Thai Ministry of Public Health and ten regional hospitals. The on-site medical infrastructure was structured as a staged response system comprising (1) first aid services, (2) response team, and (3) dispatch and medical command center. First aid services were allocated across eleven stations strategically

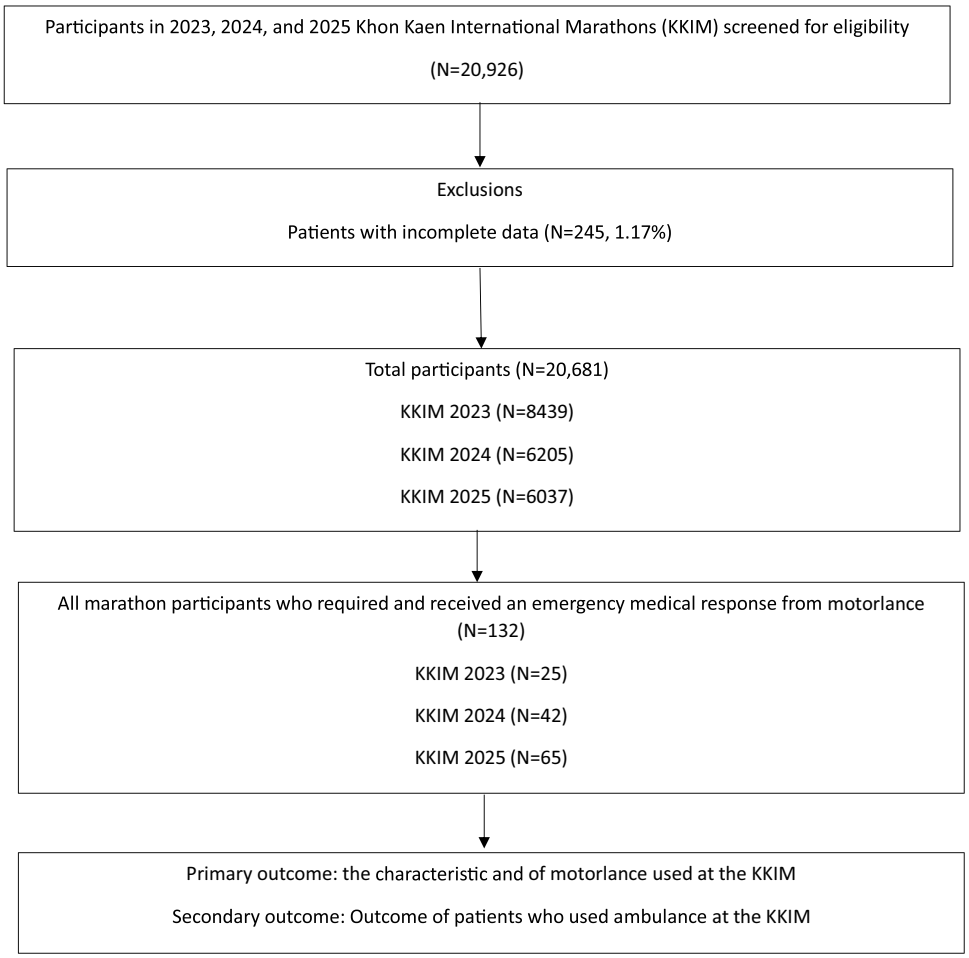

Figure 1 The study flow diagram.
Abbreviation: KKIM, Khon Kaen International Marathon.

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located along the marathon route, with increased concentration near the finish line and at sites designated as high-risk for medical incidents. Their primary responsibilities included managing minor injuries (blisters, abrasions), administering hydration, addressing muscle cramps, providing Basic Life Support, and identifying participants requiring advanced care. Every station functioned under the online medical oversight of the central command physician. The response team comprised ten motorlances and eight standard ambulances, which provided Advanced Life Support. During the patient transport preparations, the motorlances functioned as the principal rapid response units. The dispatch and medical command center, situated at the start/finish line, equipped with telemedicine and online medical direction, functioned as the central hub for all EMS operations. The facility was operated by experienced dispatchers and a senior emergency physician who offered online medical directions. Radio communication was the primary mode of contact between the dispatch and medical command center and EMS units. The emergency response started following alerts from course marshals, race officials, other runners, or direct contact with a first aid station. All inquiries were communicated to the dispatch and medical command center. The commanding physician would subsequently deploy the nearest motorlance team to conduct an initial on-site evaluation and intervention. According to the motorlance team's report, the command physician would determine whether on-site treatment was adequate or if a conventional ambulance was necessary for hospital transport.

The motorlances used in this study[9] were based on the Honda New Forza 300 model (Honda Motor Company, Ltd.; Tokyo, Japan). The vehicle's dimensions were 75.30 cm in width, 216.60 cm in length, 118.90 cm in height, 71.60 cm in seat height, and 13.90 cm in ground clearance, with a net weight of 192 kg. Three equipment boxes were mounted on the left and right sides of the vehicle and behind the passenger seat. An AED was stored in a box attached to the side of the motorlance. For enhanced safety, the motorlances were equipped with reflective stickers, emergency sirens, and radio communication systems (Figure 2).

Data were recorded using the standard national EMS operation checklist used in Thailand. This included demographic information (gender, age), response time, patient classification (trauma or non-trauma), initial procedures performed on scene, hospital length of stay, time spent in the emergency department, and patient outcomes. Patients with incomplete data were excluded. To ensure accuracy and eliminate duplicate entries, data were reviewed and recorded by two

Figure 2 The motorlance used in the KKIM.

independent investigators with over ten years of EMS experience. In cases of discrepancy, a senior emergency physician was consulted. A single synchronized clock at the dispatch center was used to track time, and telemedicine was employed to monitor EMS operations. The duration of each operational step was documented in the EMS database.

Sample Size

The sample size was calculated using a formula for estimating a proportion with specified absolute precision. The calculation was based on the following parameters: a standard normal value of 1.96 for a 95% confidence level, an absolute precision (d) of 0.09, and an expected prevalence (p) of 0.60. The expected prevalence of 0.60 was a conservative estimate derived from operational data from previous, similar large-scale running events in the region, where approximately 60% of patients receiving advanced on-site care did not require hospital transport. The assumption of an infinite population was considered suitable since the total number of participants in the KKIM population (N=20,681) is significantly large, making the finite population correction factor statistically insignificant. The authors determined that a sample size of 114 is necessary for the motorlance operation based on these parameters.

Statistical Analysis

IBM SPSS for Windows, version 27.0, licensed by Khon Kaen University (Khon Kaen, Thailand) (IBM Corp.; Armonk, New York, USA), was used to perform the statistical analysis. Continuous data were presented as means and standard deviations (SD), while categorical data were reported as frequencies and percentages. Associations between categorical variables were assessed using the chi-square test. A two-tailed p-value of less than 0.05 was considered statistically significant. The analysis was conducted using a complete case approach, where records with missing data for the variables under investigation were excluded from that specific analysis. The amount of missing data across key variables was minimal (<2%) and deemed unlikely to introduce significant bias.

Results

The demographic distribution of participants in the KKIM over three consecutive years (2023–2025) is presented in Table 1. A total of 20,681 runners participated, with the number of full marathon participants declining from 2,291 in 2023 to 1,147 in 2025 (p=0.020). Half marathon and mini marathon participation remained relatively stable across the three-year period with no significant changes. Males consistently represented the majority of participants across all race categories and years. The 40–59 age group dominated all race categories, representing approximately 45–48% of participants, particularly in full marathons. Age and gender distribution remained stable throughout the years.

Table 2 presents an analysis of motorlance utilization during the KKIM, with a total of 132 cases requiring emergency medical response via motorlance. Motorlance usage increased significantly over the three-year period (p=0.011). The

Table 1 Characteristics of All Participants in KKIM (N=20681)

Features	KKIM 2023 N=8439	KKIM 2024 N=6205	KKIM 2025 N=6037	*p*-value
Marathon (gender and age group)	2291	1279	1147	0.020[a]
Male 18–39	529	256	264	
Male 40–59	1100	614	516	
Male 60+	211	132	121	
Female 18–39	119	67	61	
Female 40–59	282	179	161	
Female 60+	50	32	24	

(*Continued*)

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Table 1 (Continued).

Features	KKIM 2023 N=8439	KKIM 2024 N=6205	KKIM 2025 N=6037	*p*-value
Half marathon (gender and age group)	2831	2140	2113	0.522
Male 18–39	654	449	486	
Male 40–59	1359	1027	951	
Male 60+	260	220	218	
Female 18–39	147	111	118	
Female 40–59	348	300	296	
Female 60+	62	32	44	
Mini marathon (gender and age group)	3317	2786	2777	0.632
Male 18–39	766	641	639	
Male 40–59	1592	1254	1250	
Male 60+	305	287	286	
Female 18–39	172	145	156	
Female 40–59	408	418	389	
Female 60+	73	42	58	

Notes: [a]statistically significant.
Abbreviation: KKIM, Khon Kaen International Marathon.

Table 2 Characteristics of Motorlance Access (N=132)

Features	KKIM 2023	KKIM 2024	KKIM 2025	*p*-value
Number of patients using motorlance	25	42	65	0.011[a]
Gender, Male (%)	21 (84.0)	37 (88.1)	60 (92.3)	0.822
Age, mean (SD), years	42.1 (3.6)	44.2 (3.9)	45.1 (3.6)	0.063
EMS triage (%)				0.020[a]
Resuscitation	2 (8.0)	4 (9.5)	5 (7.7)	
Urgent	8 (32.0)	11 (26.2)	28 (43.1)	
Non-urgent	15 (60.0)	27 (64.3)	32 (49.2)	
Patient type (%)				0.620
Trauma	21 (84.0)	37 (88.1)	58 (89.2)	
Non-trauma	4 (16.0)	5 (11.9)	7 (10.8)	

(*Continued*)

Table 2 (Continued).

Features	KKIM 2023	KKIM 2024	KKIM 2025	*p*-value
First procedure on the scene				0.010[a]
Dressing	12 (48.2)	15 (35.7)	20 (30.8)	
Hydration	10 (40.0)	8 (19.0)	21 (32.3)	
Muscle stretching, bandage	3 (11.8)	10 (23.8)	5 (7.7)	
Pain Medication	0	8 (19.0)	15 (23.1)	
Glucose IV	0	0	3 (4.6)	
AEDs performed	0	1 (2.5)	1 (1.5)	
Patient disposition (%)				0.852
Continued running	23 (92.0)	37 (88.1)	59 (90.8)	
Referred to hospital	2 (8.0)	5 (11.9)	6 (9.2)	
EMS operation, mean (SD), Min				<0.001[a]
Activation time	0.5 (0.1)	0.6 (0.2)	0.6 (0.2)	
Response time	5.3 (1.1)	5.5 (1.3)	5.6 (0.9)	
Scene time	8.2 (2.2)	12.3 (3.3)	18.6 (6.3)	

Notes: [a]statistically significant.
Abbreviations: KKIM, Khon Kaen International Marathon; SD, standard deviation; EMS, mots; IV, intravenous; AED, automated external defibrillator.

majority of patients requiring motorlance services were male. By 2025, there was a notable rise in urgent cases (43.1% compared to 32.0% in 2023; p=0.020). On-scene interventions evolved over time (p=0.010), with intravenous glucose administration and AED use introduced in the later years. Scene time also changed significantly, increasing from 8.2 minutes in 2023 to 18.6 minutes in 2025 (p<0.001).

Discussion

This study offers significant evidence regarding the utilization of motorlances as a key component of EMS in mass gathering contexts, particularly during large-scale marathons. Our three-year longitudinal study at the Khon Kaen International Marathon (KKIM) reveals that motorlances significantly enhance operational efficiency, clinical practice, and, importantly, risk management and patient safety.[19,20]

Regarding the demographic data of KKIM participants, the substantial prevalence of middle-aged male participants (ages 40–59) may influence injury patterns and the nature of medical emergencies, as this demographic is prone to increased rates of cardiovascular events and overuse injuries. This signifies that motorlance services must be prepared for injury patterns common among male runners, including cardiovascular events and musculoskeletal injuries. The notable decline in full marathon participation, coupled with stable shorter distance events, indicates a change in runner preferences, likely diminishing the highest-risk participant demographic; nevertheless, the enduring demographic trends over the years facilitate predictable resource allocation and risk stratification for motorlance deployment.

The progressive increase in motorlance utilization reflects both the growing implementation and acceptance of this emergency response modality. This trend suggests that, as EMS teams gained experience with motorlance operations, they increasingly recognized its value in navigating the challenging marathon environment. Large-scale events, such as marathons, create complicated risk environments where participant health rapidly deteriorates and care logistical obstacles are a continual threat. Conventional ambulance access is frequently hindered by congested crowds, prolonged routes, and restricted roadways. The integration of Motorlance directly mitigates these specific operational risks. A key

component of risk mitigation in emergency medicine, the consistent, quick response times (mean, 5.3–5.6 minutes annually) described highlight the usefulness of motorlances in reducing care delays. Motorlances address physical access limitations encountered by traditional ambulances, functioning as agile risk management tools that minimize the duration of clinical vulnerability for impacted individuals.[21,22]

For instance, when motorlances were utilized as first responders, the average duration from activation to definitive care decision was 14.2 minutes, in contrast to traditional ambulance-only responses, which averaged 16.72 minutes during the routine period of a prior study.[23] In instances necessitating hospital transport, motorlance pre-assessment diminished ambulance scene time by an average of 12.3 minutes, as the conventional ambulance crew arrived with pre-determined patient condition reports and treatment protocols.

The study also observed a substantial evolution in the clinical interventions performed by motorlance teams. Expanding clinical capabilities are demonstrated by an increase in urgent triage cases (from 32.0% to 43.1%) and the introduction of more sophisticated procedures including intravenous glucose delivery and the administration of pain medication (from 0% to 23.1%). The corresponding increase in scene time (from 8.2 minutes in 2023 to 18.6 minutes in 2025) reflects this evolution, as EMS providers delivered more comprehensive on-scene care rather than focusing solely on rapid transport.[24–28] Timely intervention in emergencies, including trauma, heat-related illnesses, and metabolic disturbances, is a recognized factor influencing favorable clinical outcomes. Our data indicated a statistically significant increase in both the number and complexity of on-scene interventions over time, encompassing the implementation of advanced measures (eg, intravenous glucose, pain management, and defibrillation). Such capabilities are crucial in high-risk situations, where any delay increases the likelihood of negative consequences, including illness and death. The motorlance model's capacity to administer these interventions quickly at the point of need represents a significant advancement in patient safety, effectively reducing the duration between symptom onset and definitive care. Our findings are consistent with previous research on motorcycle ambulances in other contexts, which have demonstrated similar advantages in both urban and rural emergency response.[29–32] This study specifically emphasizes their application in marathon contexts, where extensive geographic coverage, limited vehicle access, and urgent medical conditions pose unique operational challenges.

Our cohort comprised 132 patients necessitating urgent intervention facilitated by motorlances. Over 90% of these individuals were stabilized and permitted to safely resume the race, clearly illustrating the efficacy and suitability of prehospital care administered via this method. The percentage necessitating hospital referral remained low and consistent, indicating that prompt, focused interventions at the site directly enhanced immediate outcomes and diminished unnecessary transport or escalations in care. Moreover, increased scene times, escalating from 8.2 minutes to 18.6 minutes alongside heightened intervention complexity ($p < 0.001$), signify a shift towards holistic, patient-centered care rather than solely expedited transport, prioritizing patient safety and stabilization.

The implementation of motorlances into a holistic EMS framework, encompassing first aid stations and traditional ambulances, seems to facilitate an efficient tiered response model. Motorlances served as rapid first responders, providing initial assessment and treatment, while traditional ambulances were accessible for situations demanding more comprehensive intervention or transport. This approach leverages the strengths of both modalities while mitigating their respective limitations.[33–37] Future research ought to encompass patient satisfaction metrics, long-term health outcomes, cost-effectiveness analyses, and randomized controlled trials or quasi-experimental designs to more definitively address the comparative effectiveness question.

Several important limitations of this study must be acknowledged. First, as a single-center retrospective analysis, the findings may not be fully generalizable to marathons held in different geographic or organizational contexts. Regional variations in EMS systems, provider training, and course design could significantly affect motorlance efficacy. Additionally, the study did not include a direct comparison with traditional ambulance response times under identical conditions, which would have offered a clearer evaluation of the relative advantages of motorlances. Finally, the analysis focused on operational metrics and basic clinical outcomes, without assessing patient experience or satisfaction with motorlance services.

Conclusion

This three-year retrospective study demonstrated that motorcycle ambulances markedly improve emergency medical response efficiency during large marathon events. Significant findings indicated a progressive increase in motorlance utilization, consistently rapid response times, and enhanced clinical capabilities with advanced interventions. Increased Scene time reflected improved on-site treatment delivery. Notably, over 90% of patients treated by motorlance resumed the race post-treatment, demonstrating effective prehospital intervention. The integration of motorlances into a tiered EMS response system demonstrates operational efficiency while maintaining patient safety standards. These findings support implementing motorlance services as a valuable component of emergency medical planning for marathon events and mass gatherings requiring rapid access and immediate intervention capabilities.

Abbreviations

EMS, emergency medical services; KKIM, Khon Kaen International Marathon; AED, automated external defibrillator.

Data Sharing Statement

As the data include information that could compromise patient anonymity, the datasets analyzed in this study are not publicly available. However, they may be obtained from the corresponding author upon reasonable request.

Ethics Approval and Informed Consent

The Khon Kaen University Ethics Committee for Human Research approved the study, which was conducted in accordance with the Declaration of Helsinki and the ICH Good Clinical Practice Guidelines (HE681053). Informed consent was not required. All identifying information was removed from the collected data to ensure confidentiality.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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