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ORIGINAL ARTICLE

Association between On-Scene Interval and 24-Hour Mortality among Code Red Emergency Medical Services Patients: A Retrospective Cohort Study

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Abstract: **Introduction:** On-scene interval (OSI) is a modifiable component of prehospital care, but the interpretation of prolonged OSI is complex because longer scene time may reflect either avoidable delay or necessary life-saving care. This study aimed to evaluate the association between OSI and 24-hour mortality among Code Red emergency medical services (EMS) patients and to identify an operational OSI range that may warrant quality-improvement review. **Methods:** We conducted a retrospective cohort study of all eligible Code Red EMS activations dispatched with advanced life support teams in Saraburi Province, Thailand, from May 2017 to July 2019. EMS dispatch records, ambulance run sheets, and hospital electronic medical records were used. OSI was defined as the interval from EMS arrival at the scene to departure from the scene. OSI was categorized in 5-minute intervals for operational interpretability and was also modeled continuously using restricted cubic splines. The primary outcome was all-cause mortality within 24 hours of EMS activation. Multivariable logistic regression, adjusted predicted probabilities, and restricted mean survival time were used to evaluate associations. **Results:** Of 2,500 Code Red EMS activations screened, 2,321 patients were included. The 24-hour mortality rate was 5.1% (118/2,321). Non-survivors had a longer median OSI than survivors (12 [interquartile range (IQR): 9-16] vs. 9 [IQR: 6-12] minutes; $p < 0.001$). After adjustment, OSI of 21-25 minutes was associated with higher odds of 24-hour mortality compared with OSI of 5 minutes or less (adjusted OR: 5.61, 95% CI: 1.58-19.97; $p < 0.01$). Restricted cubic spline analysis suggested a non-linear increase in mortality risk with longer OSI, although estimates at longer intervals were imprecise because of sparse data. Patients with OSI of 20 minutes or longer had 321.7 fewer expected survival minutes within the 24-hour horizon than those with OSI shorter than 20 minutes (95% CI: -530.1 to -113.2; $p = 0.002$). Low Glasgow Coma Scale score ($p < 0.001$) and prehospital life-saving interventions ($p < 0.001$) were the strongest predictors of death. **Conclusions:** Prolonged OSI was associated with 24-hour mortality, with the clearest adjusted signal observed at 21-25 minutes. However, this finding should be interpreted cautiously because patient severity and the need for life-saving interventions were dominant predictors of mortality, and the optimal OSI threshold may differ by clinical condition. OSI should be used as an operational quality-improvement benchmark rather than a standalone prognostic marker or universal cutoff.

Keywords: Emergency Medical Services; Mortality; Thailand

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1. Introduction

Timely prehospital care is central to emergency medical services (EMS), particularly for injuries requiring time-sensitive definitive treatment (1). Total prehospital time is commonly divided into response, on-scene, and transport intervals (1). Among these components, the on-scene interval (OSI) is particularly important because it encompasses patient access, initial assessment, stabilization, essential procedures, extrication or patient removal, coordination with dispatch and receiving facilities, and preparation for transport (2). Whereas response and transport intervals are substantially influenced by geography and system configuration, OSI is more directly affected by patient characteristics, clinical interventions, hospital acceptance processes, and operational workflow (2).

The clinical interpretation of OSI is complex. A shorter OSI may reduce delays to definitive hospital-based care in selected time-dependent emergencies, particularly penetrating trauma (3). Conversely, a longer OSI may be clinically appropriate when essential interventions must be completed before transport. Endotracheal intubation and intravenous access add measurable on-scene time (4), while hemorrhage-control measures, immobilization, airway management, and advanced resuscitation are also associated with longer OSI (5). For out-of-hospital cardiac arrest, continued on-scene resuscitation rather than intra-arrest transport has been associated with better survival, illustrating that additional scene time may represent necessary treatment rather than avoidable delay (6). Thus, prolonged OSI may reflect either potentially avoidable delay or appropriate treatment time in patients with greater physiologic instability. This dual meaning makes OSI particu-

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larly susceptible to reverse causation and confounding by indication: patients with greater injury severity or acuity are more likely to require longer on-scene management and are also at higher baseline risk of death (6, 7).

Previous studies have reported inconsistent associations between scene time and outcomes across EMS populations. Trauma studies often support minimizing avoidable scene time, while cardiac arrest studies suggest that the optimal interval depends on factors such as witnessed status, rhythm, resuscitation response, transport time, and access to advanced hospital interventions. Stroke protocols also emphasize rapid scene workflow, but the appropriate threshold may differ from trauma and cardiac arrest. These findings suggest that a single universal OSI target may be overly simplistic and that condition-specific benchmarks are likely needed (8-12).

Identifying an empirically supported OSI range in this real-world setting may inform operational audit, protocol development, and future condition-specific quality improvement. Therefore, this study aimed to evaluate the association between OSI and 24-hour mortality among Code Red EMS patients activated with ALS teams.

2. Methods

2.1. *Study design and reporting*

This retrospective cohort study used routinely collected EMS and hospital data from Saraburi Province, Thailand, to evaluate the association between OSI and 24-hour mortality among Code Red EMS patients. The study period was May 2017 through July 2019, before the COVID-19 pandemic, to avoid pandemic-related changes in EMS demand, dispatch processes, on-scene workflow, and transport practices. The report was prepared in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidance for cohort studies (13). Because this study used existing records, no intervention was assigned by the investigators.

Saraburi Province is located in central Thailand and covers approximately 3,576.486 km2, with a reported population of 639,165 in 2024 (14). The provincial EMS system operates under a hospital-based model. Emergency calls are received through a centralized dispatch center via the national emergency number 1669 and triaged using the National Institute for Emergency Medicine criteria-based dispatch system. Cases classified as Level 1 or Code Red represent the highest-acuity group and are dispatched with advanced life support (ALS) teams led by trained prehospital personnel. ALS teams are capable of performing time-critical life-saving interventions on scene before transport to a receiving facility.

The Human Research Ethics Committee of Thammasat University (Medicine) approved this study and waived the requirement for informed consent (approval number: 072/2563). Saraburi Hospital, the owner of the electronic medical records used in this study, approved access to the data. To protect patient confidentiality, all identifiable information was removed before analysis, and access to the study data was restricted to authorized members of the research team. All study procedures were conducted in accordance with relevant guidelines and regulations governing research involving routinely collected clinical data.

2.2. *Participants*

All patients who accessed the Saraburi EMS system, were classified as Code Red, and had an ALS team dispatched between May 2017 and July 2019 were eligible. The exclusion criteria were canceled dispatch or no patient found at the scene, death confirmed before EMS arrival, refusal of treatment, request for transfer to a hospital other than Saraburi Hospital, and transport by family or private vehicle. These criteria were chosen to ensure that included patients had an assessable ALS on-scene interval and an ascertainable 24-hour outcome within the Saraburi Hospital system. Of 2,500 Code Red activations screened, 179 were excluded, leaving 2,321 patients in the final analytic cohort.

2.3. *Data gathering*

Data were obtained from three routinely collected sources: EMS dispatch records, ALS ambulance run sheets, and hospital electronic medical records. Dispatch records provided call and timing variables, including EMS activation, ALS team arrival at the scene, departure from the scene, arrival at the receiving facility, response interval, transport interval, and distance from the EMS base to the scene. Ambulance run sheets provided prehospital clinical assessments, including initial vital signs, Glasgow Coma Scale (GCS), trauma status, pediatric status, previous transfer from a basic life support team, and prehospital life-saving interventions. Hospital electronic medical records were used to confirm comorbidities and 24-hour survival status.

Response interval was defined as the time from EMS activation to ALS arrival at the scene.

OSI was defined as the time from ALS arrival at the scene to departure from the scene toward the receiving facility.

Transport interval was defined as the time from scene departure to hospital arrival.

Symptom onset-to-call interval was based on the onset time documented by EMS personnel based on patient, bystander, or caregiver report. Distance was extracted from the EMS dispatch record. Physiological variables were defined using the first prehospital values recorded by the ALS team. Hemodynamic values of zero were retained when they represented cardiac arrest or unrecordable vital signs at initial EMS assessment. GCS was categorized as 13-15, 9-12, and 3-8 based on the first documented prehospital GCS score.

Prehospital life-saving intervention was defined as any ALS intervention documented in the ambulance record as being performed to stabilize an immediately life-threatening condition before transport, including airway management, cardiopulmonary resuscitation or defibrillation, hemorrhage control, resuscitative vascular access or medication administration, or other emergency stabilization judged necessary by the ALS team. The primary outcome, all-cause mortality within 24 hours of EMS activation, was determined from hospital records and was selected because it is temporally close to prehospital care and minimizes confounding from late hospital complications compared with longer-term mortality.

2.4. *Outcome*

We selected 24-hour mortality as the primary outcome because it is an objective, reliably ascertainable, early outcome that is temporally close to prehospital care and is less influenced by later in-hospital complications than longer-term mortality.

The primary exposure was OSI, defined as the time from ALS team arrival at the scene to departure from the scene toward the receiving facility. For clinical and operational interpretability, OSI was categorized into 5-minute intervals: 5 minutes or less, 6-10 minutes, 11-15 minutes, 16-20 minutes, 21-25 minutes, 26-30 minutes, and 31-45 minutes. Five-minute intervals were chosen before the main analysis because they correspond to a simple EMS quality-review unit and allow a practical comparison across increasingly prolonged scene times. OSI of 5 minutes or less was used as the reference category to represent the shortest operationally achievable scene interval. The 21–25-minute interval was not selected as an a priori cutoff; rather, it emerged as the category with the clearest adjusted association with 24-hour mortality and was therefore interpreted as an empirical signal for operational review, not as a universal clinical threshold. OSI was also modeled as a continuous variable using restricted cubic splines to evaluate non-linearity and avoid relying solely on categorized exposure groups.

2.5. *Covariates*

Covariates were selected a priori based on clinical relevance, availability in the EMS and hospital databases, and plausibility as confounders of the association between OSI and mortality. The following variables were extracted: age, sex, response interval, transport interval, distance from EMS base to scene, symptom onset-to-call interval, systolic blood pressure, diastolic blood pressure, pulse rate, respiratory rate, oxygen saturation, GCS score, trauma status, pediatric status, underlying comorbidities, previous transfer from a basic life support team, and performance of prehospital life-saving interventions. GCS was categorized as 13-15, 9-12, and 3-8. Trauma status was included as the most consistently recorded broad clinical-condition grouping. More granular diagnosis-specific categories, such as acute coronary syndrome, stroke, respiratory failure, and cardiac arrest, were not complete enough across the registry to support stable condition-specific OSI threshold modeling. Hemodynamic values of zero were retained when they reflected patients in cardiac arrest or patients for whom vital signs were unrecordable at initial EMS assessment.

2.6. *Statistical analysis*

The study size was determined by the number of eligible Code Red EMS activations available during the predefined study period. No formal a priori sample-size calculation was performed because all eligible cases in the routinely collected EMS database were included. The final analytic cohort included 2,321 patients and 118 deaths within 24 hours. This event count was considered sufficient for the prespecified multivariable analysis, although estimates in longer OSI categories and diagnosis-specific subgroups were expected to be imprecise and were therefore interpreted cautiously.

Baseline characteristics were summarized using means with standard deviations, medians with interquartile ranges, or frequencies with percentages, as appropriate. Survivors and non-survivors at 24 hours were compared using chi-square or Fisher exact tests for categorical variables and t tests or rank-sum tests for continuous variables, depending on distributional characteristics.

The primary multivariable analysis used logistic regression to estimate adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for 24-hour mortality. The model adjusted for demographic factors, prehospital time intervals, distance, vital signs, GCS category, trauma status, selected comorbidities, previous basic life support transfer, and prehospital life-saving interventions. OSI of 5 minutes or less was used as the reference category in the categorized analysis. Because categorization may reduce information and obscure non-linear associations, OSI was also examined as a continuous exposure using restricted cubic splines with knots at the 10th, 50th, and 90th percentiles and a reference OSI of 5 minutes.

Adjusted predicted probabilities were estimated from the multivariable model to express absolute mortality risk across OSI categories. To complement odds ratios (OR) with a clinically interpretable time-based measure, restricted mean survival time (RMST) over a 1,440-minute (24-hour) horizon was compared between patients with OSI shorter than 20 minutes and those with OSI of 20 minutes or longer. The 20-minute threshold for RMST was chosen because the categorized analysis suggested the clearest increase in adjusted mortality in the adjacent 21-25-minute OSI category and because a 20-minute operational trigger is easier to apply in EMS quality monitoring. RMST differences and 95% CIs were estimated using the delta method. Because this was a heterogeneous Code Red cohort and diagnosis-specific event counts were limited, condition-specific OSI thresholds were not estimated. Instead, the main analysis adjusted for trauma status and other severity markers, and the need for condition-specific validation was addressed in the interpretation. Analyses were conducted using Stata version 18 (StataCorp, College Station, TX, USA). A two-sided p value less than 0.05 was considered statistically significant.

3. Results

3.1. *Baseline characteristics of studied cases*

Of 2,500 Code Red EMS activations screened during the study period, 2,321 patients met the eligibility criteria and were included in the final analytic cohort (Figure 1). Overall, 118 patients died within 24 hours of EMS activation, corresponding to a 24-hour mortality rate of 5.1%. Non-survivors had a longer median OSI than survivors (12 [IQR: 9-16] vs. 9 [IQR: 6-12] minutes; $p < 0.001$). Non-survivors also had shorter response ($p = 0.03$), transport ($p < 0.001$), and onset-to-call intervals ($p < 0.001$), were more likely to be male ($p = 0.03$), and were more likely to have traumatic injury ($p < 0.001$). They presented with greater physiologic derangement ($p < 0.001$ across all parameters), lower GCS scores ($p < 0.001$), more frequent previous transfer from a basic life support team ($p < 0.001$), and substantially more frequent prehospital life-saving interventions ($p < 0.001$) (Table 1).

3.2. *Multivariable logistic regression*

In the adjusted logistic regression model, OSI of 21-25 minutes was associated with higher odds of 24-hour mortality compared with OSI of 5 minutes or less (adjusted OR: 5.61, 95% CI: 1.58-19.97; $p < 0.01$). Other OSI categories did not reach statistical significance after adjustment, and estimates for intervals longer than 25 minutes were imprecise because of sparse data. The strongest independent predictors of 24-hour mortality were GCS 3-8 (adjusted OR: 5.36, 95% CI: 2.46-11.66; $p < 0.001$) and prehospital life-saving interventions (adjusted OR: 16.02, 95% CI: 5.24-48.99; $p < 0.001$), indicating that disease severity and the need for critical on-scene treatment were major determinants of early death (Table 2).

3.3. *Restricted cubic spline and adjusted predicted probabilities*

Restricted cubic spline analysis suggested a non-linear increase in the odds of 24-hour mortality as OSI lengthened (Figure 2). The estimated odds ratio crossed the null value at approximately 8-10 minutes and increased thereafter; however, estimates at longer OSI values should be interpreted cautiously because of limited observations and wider confidence intervals. Adjusted predicted probabilities remained relatively low across OSI intervals up to 20 minutes, approximately 4%-6%, and increased to approximately 10% (95% CI: 5%-15%) in the 21–25-minute group (Figure 3).

3.4. *Restricted mean survival time*

Over the 24-hour horizon, patients with OSI of 20 minutes or longer had a mean restricted survival time of 924.0 (95% CI: 718.0-1,130.0) minutes, compared with 1,245.7 (95% CI: 1,206.7-1,284.7) minutes among patients with OSI shorter than 20 minutes (p = 0.002). The RMST difference was -321.7 (95% CI: -530.1 to -113.2) minutes, equivalent to approximately 5.4 fewer expected survival hours within 24 hours among patients with OSI of 20 minutes or longer (Table 3).

4. Discussion

In this retrospective cohort of Code Red EMS patients in Saraburi Province, longer OSI was associated with 24-hour mortality, with the most evident adjusted signal observed in the 21–25-minute interval. The spline analysis supported a non-linear exposure-outcome pattern, and the RMST analysis suggested fewer expected survival minutes within the first 24 hours among patients with OSI of 20 minutes or longer. However, these results should be interpreted cautiously. The association was not uniform across all OSI categories, and estimates beyond 25 minutes were unstable because of small numbers. Most importantly, low GCS and the need for prehospital life-saving interventions were much stronger predictors of death than OSI itself (2, 15-18).

The 21–25-minute range should not be interpreted as a definitive or universal cutoff. This range was derived from pre-specified 5-minute operational categories and emerged as the category with the clearest adjusted association compared with OSI of 5 minutes or less. It was supported directionally by the spline and RMST analyses, but the categorized analysis, spline model, adjusted probabilities, and RMST analysis represent complementary exploratory approaches rather than independent proof of a causal threshold. Therefore, the 21–25-minute range is best viewed as a pragmatic trigger for case review and quality improvement rather than a rigid target for individual patient management.

The heterogeneity of the Code Red population is central to interpretation. The cohort included traumatic and non-traumatic emergencies, and it likely included conditions with different relationships between scene time and outcome, such as trauma, out-of-hospital cardiac arrest, stroke, acute coronary syndrome, respiratory failure, and other critical illnesses. A single OSI threshold may therefore obscure clinically important differences across etiologies. Although trauma status was included in the multivariable model, the routinely collected dataset did not provide sufficiently complete and standardized diagnosis-specific categories with adequate event counts to support stable threshold estimation for each clinical condition. This limitation reduces the ability to propose condition-specific targets and underscores the need for future stratified analyses.

These findings support a nuanced interpretation of prehospital scene time. OSI is potentially modifiable, but it is not simply a measure of delay. In high-acuity EMS cases, longer OSI may reflect time required to perform clinically necessary interventions, manage airway or circulation, stabilize the patient before transport, coordinate safe extrication, or continue resuscitation. The marked association between prehospital life-saving interventions and mortality suggests substantial confounding by indication: patients who are more severely ill require more on-scene care and have a higher baseline risk of early death. Therefore, reducing OSI without considering intervention quality or patient severity could be harmful in some cases (19, 20).

The rationale for using 24-hour mortality was to focus on an early, objective outcome that is temporally close to prehospital care and less influenced by late hospital complications than longer-term mortality. Nevertheless, 24-hour mortality is still affected by patient severity, hospital resuscitation, emergency department care, and early inpatient management. It does not capture neurological outcome, functional recovery, quality of life, or preventability of death. Therefore, the outcome is suitable for identifying early risk and operational signals, but it should not be interpreted as a direct measure of the causal effect of OSI alone.

The present findings are consistent with previous literature showing that the relationship between scene time and outcomes varies by clinical condition. Trauma studies often support minimizing avoidable scene time when rapid definitive hemorrhage control or surgical care is required (21-24). In out-of-hospital cardiac arrest, however, outcomes depend on dynamic factors such as initial rhythm, witnessed status, bystander cardiopulmonary resuscitation, response to resuscitation, availability of advanced therapies, and transport interval (6, 15, 25, 26). Stroke systems similarly emphasize rapid scene workflow, but recommended scene targets differ from trauma and cardiac arrest (9). Taken together, these observations argue against a single universal OSI threshold for all Code Red patients and favor condition-specific operational benchmarks (27-29).

This study has several strengths. It used a real-world EMS cohort of high-acuity patients in a provincial Thai EMS system, focused on an objective early mortality outcome, and applied complementary analytic approaches. Logistic regression provided adjusted relative associations, restricted cubic splines explored non-linearity without assuming a linear exposure-response relationship, adjusted predicted probabilities expressed absolute risk, and RMST translated mortality differences into a time-based measure that is clinically easier to interpret. However, the use of multiple analytic approaches also increases the need for cautious interpretation; the results should be regarded as hypothesis-generating and useful for operational review rather than confirmatory evidence of a precise causal threshold.

Future studies should validate these findings prospectively, stratify analyses by clinical condition, and evaluate whether structured scene-time protocols improve outcomes without reducing the quality of prehospital care. Additional work should distinguish beneficial intervention time from avoidable operational delay and should incorporate measures of intervention quality, receiving hospital capability, and post-arrival treatment timelines.

4.1. *Limitations*

First, the retrospective observational design precludes causal inference, and residual confounding by indication is likely despite multivariable adjustment. Second, the cohort included mixed Code Red conditions rather than diagnosis-specific groups; therefore, the optimal OSI threshold may differ across trauma, cardiac arrest, stroke, acute coronary syndrome, respiratory failure, and other emergencies. Third, the available dataset did not support formal subgroup threshold estimation by each clinical condition, and small numbers in longer OSI categories produced wide confidence intervals and unstable estimates. Fourth, routinely collected EMS data may be affected by timestamp error, documentation variability, and incomplete capture of scene complexity, intervention quality, extrication requirements, and hospital treatment. Fifth, the study evaluated 24-hour mortality and did not assess longer-term survival, neurological status, functional outcome, or preventability of death. Finally, the single-province design may limit generalizability to EMS systems with different geography, dispatch criteria, staffing, scope of practice, and hospital access.

5. Conclusions

Prolonged OSI was associated with 24-hour mortality, with the clearest adjusted increase observed at 21-25 minutes. Nevertheless, low GCS and prehospital life-saving interventions were the dominant predictors of death, underscoring the importance of patient severity and confounding by indication. The 21–25-minute range should be considered an operational signal for EMS quality review rather than a universal cutoff or standalone prognostic marker. Because optimal scene time likely varies by clinical condition, condition-specific targets and prospective validation are needed before applying a uniform OSI threshold across all high-acuity EMS patients.

6. Declarations

6.1. *Acknowledgments*

None.

6.2. *Conflict of interests*

The authors declare that they have no competing interests.

6.3. *Funding and supports*

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

6.4. *Authors' contributions*

All authors made significant contribution to the work reported, whether 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. All authors read and approved the final version of the manuscript.

6.5. *Ethical statement*

The Human Research Ethics Committee of Thammasat University (Medicine) approved this study and waived informed consent (approval number: 072/2563). Saraburi Hospital approved access to the electronic medical records.

6.6. *Informed consent*

The requirement for informed consent was waived by the Human Research Ethics Committee of Thammasat University (Medicine) because this retrospective study used de-identified routinely collected clinical data.

6.7. *Availability of supporting data*

The dataset contains routinely collected EMS and hospital information and is not publicly available. De-identified data may be made available from the corresponding author upon reasonable request and with permission from Saraburi Hospital and the relevant ethics committee.

6.8. *Using artificial intelligence chatbots statement*

During the preparation of this work, the authors used ChatGPT4.0 to check and correct grammatical errors during the manuscript writing process. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Table 1: Baseline characteristics of code red EMS patients stratified by 24-hour mortality

Parameter	24-hour survival		p-value
	No (N = 118)	Yes (N = 2,203)	
Demographics			
Male	76 (64.4)	1,188 (53.9)	0.03
Age (year)	55.02 ± 20.19	55.14 ±21.66	0.95
Intervals			
Response interval (minute)	9 [6 - 13]	10 [7 - 15]	0.03
On-scene interval (minute)	12 [9 - 16]	9 [6 - 12]	<0.001
Transport interval (minute)	7 [5 -13]	10 [6 - 15]	<0.001
Onset to call interval (minute)	30 [10 - 60]	90 [30 - 330]	<0.001
Distance (km)			
Scene to hospital	5 [2 - 10]	5 [2 - 11]	0.99
Vital signs			
SBP (mmHg)	0 [0 - 110]†	132 [112 - 156]	<0.001
DBP (mmHg)	0 [0 - 67]†	80 [66 - 90]	<0.001
Pulse (beat/min)	0 [0 - 99]†	90 [80 - 110]	<0.001
RR (/min)	0 [0 - 20]†	20 [20 - 24]	<0.001
O2 saturation (%)	88.78 ± 10.55	95.41 ± 5.77	<0.001
GCS			
13–15	21 (17.8)	1740 (79.0)	<0.001
9–12	5 (4.2)	257 (11.7)	<0.001
3–8	92 (77.0)	206 (9.4)	<0.001
Trauma	39 (33.1)	302 (13.7)	<0.001
Pediatric	1 (0.9)	52 (2.4)	0.52
Underlying comorbidities			
Hypertension	26 (22.0)	753 (34.2)	<0.001
ACS	9 (7.6)	230 (10.4)	0.44
DM	20 (16.6)	517 (23.5)	0.12
CVA	3 (2.5)	159 (7.2)	0.06
Cirrhosis	1 (0.9)	48 (2.2)	0.51
CKD	3 (2.5)	127 (5.8)	0.21
COPD	2 (1.7)	81 (3.7)	0.44
Previous transfer by BLS team	15 (12.7)	101 (4.6)	<0.001
Prehospital life-saving intervention	70 (59.3)	18 (0.8)	

Data are presented as mean ± standard deviation, frequency (%), and median [interquartile range]. EMS: emergency medical services; ACS: acute coronary syndrome; BLS: basic life support; CKD: chronic kidney disease; COPD: chronic obstructive pulmonary disease; CVA: cerebrovascular accident; DBP: diastolic blood pressure; DM: diabetes mellitus; GCS: Glasgow Coma Scale; IQR: interquartile range; RR: respiratory rate; SBP: systolic blood pressure; SD: standard deviation.

†Values of zero reflect patients presenting in cardiac arrest, for whom hemodynamic parameters were unrecordable at the time of EMS assessment.

Table 2: Crude and adjusted odds ratios for on-scene interval (OSI) and associated factors for 24-hour mortality among code red EMS patients

Parameter	Crude OR	p-value	Adjusted OR	P
≤5 minutes	Reference	—	Reference	—
6–10 minutes	0.60 (0.40–0.90)	0.01	1.40 (0.45–3.38)	0.68
11–15 minutes	1.44 (0.97–2.13)	0.07	1.24 (0.50–3.91)	0.52
16–20 minutes	2.40 (1.43–4.02)	<0.01	2.19 (0.69–6.95)	0.19
21–25 minutes	3.87 (1.97–7.59)	<0.001	5.61 (1.58–19.97)	<0.001
26–30 minutes	0.81 (0.11–6.05)	0.84	0.49 (0.01–21.59)	0.71
31–45 minutes	1.16 (0.15–8.88)	0.88	0.71 (0.04–12.05)	0.82
Response interval	0.96 (0.93–0.99)	0.02	1.03 (0.95–1.12)	0.42
Transport interval	0.97 (0.94–1.00)	0.04	1.01 (0.95–1.07)	0.80
Distance	0.99 (0.96–1.02)	0.53	0.95 (0.87–1.03)	0.21
Onset to call interval <2 hours	4.15 (2.01–8.61)	<0.001	1.18 (0.48–2.90)	0.72
Onset to call interval >8 hours	1.11 (0.42–2.90)	0.84	0.96 (0.32–2.93)	0.96
Male	1.54 (1.05–2.27)	0.03	1.70 (0.93–3.13)	0.09
Trauma	3.10 (2.08–4.65)	<0.001	1.76 (0.86–3.61)	0.12
Hypertension	0.54 (0.35–0.85)	<0.01	1.11 (0.51–2.40)	0.79
SBP	0.97 (0.96–0.97)	<0.001	0.99 (0.97–1.00)	0.07
DBP	0.95 (0.94–0.96)	<0.001	1.01 (0.98–1.03)	0.54
O2 saturation	0.95 (0.94–0.95)	<0.001	0.99 (0.98–1.01)	0.54
GCS 9–12 (ref: GCS 13–15)	1.61 (0.60–4.31)	0.34	1.46 (0.53–4.06)	0.47
GCS 3–8 (ref: GCS 13–15)	37 (22.55–60.74)	<0.001	5.36 (2.46–11.66)	<0.001
Previous transfer by BLS team	3.03 (1.70–5.40)	<0.001	2.26 (0.93–5.52)	0.07
Prehospital life-saving intervention	177.03 (97.97–319.89)	<0.001	16.02 (5.24–48.99)	<0.001

All measures are presented with 95% confidence interval. BLS: basic life support; CI: confidence interval; DBP: diastolic blood pressure; GCS: Glasgow Coma Scale; OR: odds ratio; SBP: systolic blood pressure. OSI of 5 minutes or less was used as the reference category for both crude and adjusted odds ratios.

Table 3: Comparison of Restricted Mean Survival Time at 1,440 Minutes by On-Scene Interval Group

Group	RMST (minutes)	95% CI
On-scene interval <20 minutes	1,245.7	1,206.7–1,284.7
On-scene interval ≥20 minutes	924.0	718.0–1,130.0
Difference	**−321.7**	**−530.1 to −113.2 (p = 0.002)**

CI: confidence interval; RMST: restricted mean survival time up to 1,440 minutes (24 hours). Difference = on-scene interval ≥20 minutes' minus <20 minutes estimated by the delta method.

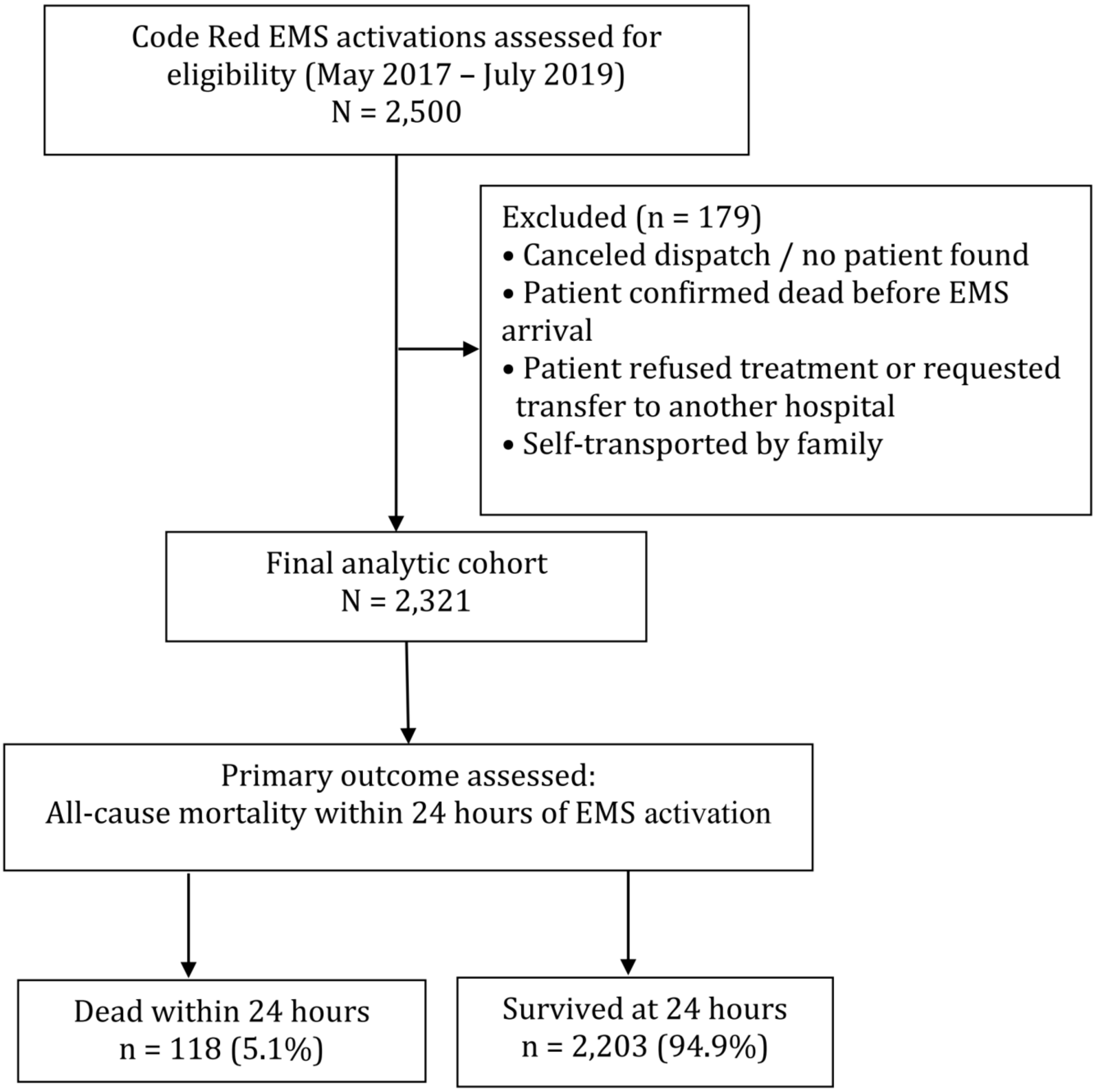

Figure 1: Study flow diagram of patients' inclusion. EMS: Emergency Medical Services. Exclusion criteria were applied to the initial 2,500 Code Red activations. The final analytic cohort of 2,321 patients was used for all statistical analyses.

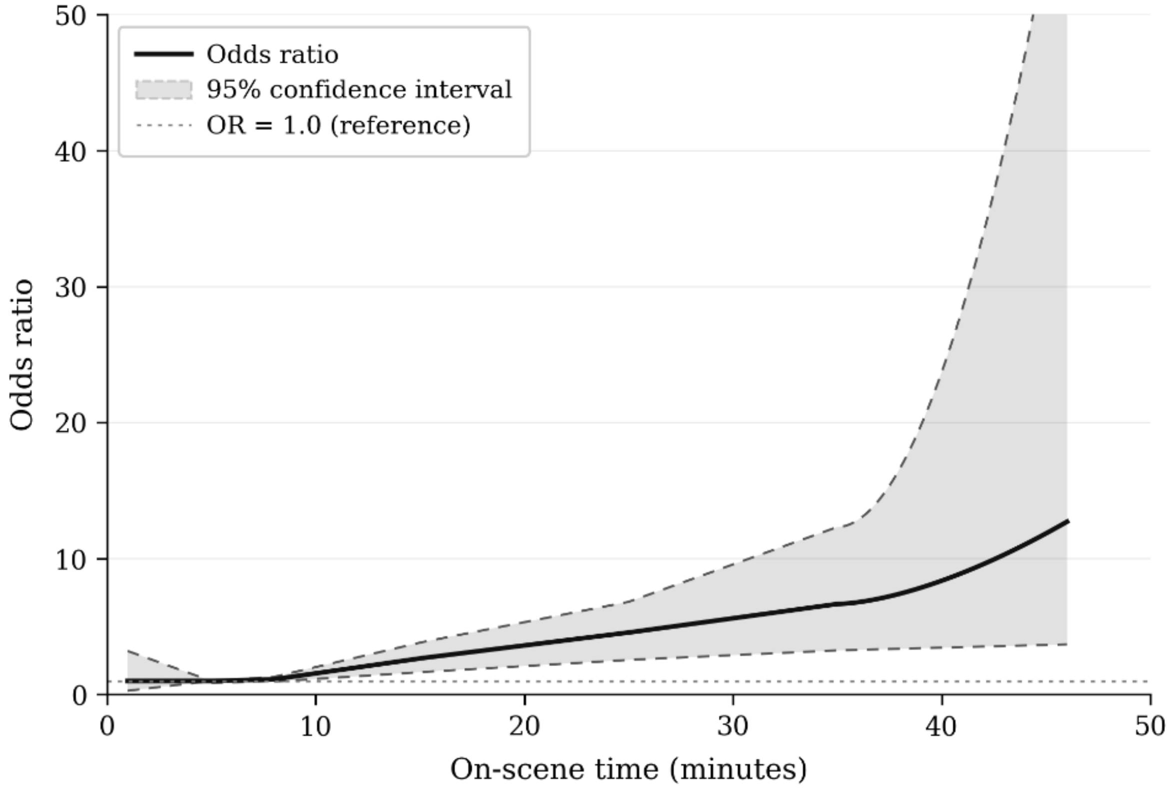

Figure 2: Restricted cubic spline analysis. Restricted cubic spline of the association between on-scene interval and odds ratio of 24-hour mortality with 95% confidence interval (CI). Odds ratios (ORs) are estimated using knots at the 10th, 50th, and 90th percentiles of on-scene interval. Reference: on-scene interval = 5 minutes. The shaded area represents 95% CI. Wide confidence intervals beyond 35 minutes reflect sparse data and should be interpreted with caution.

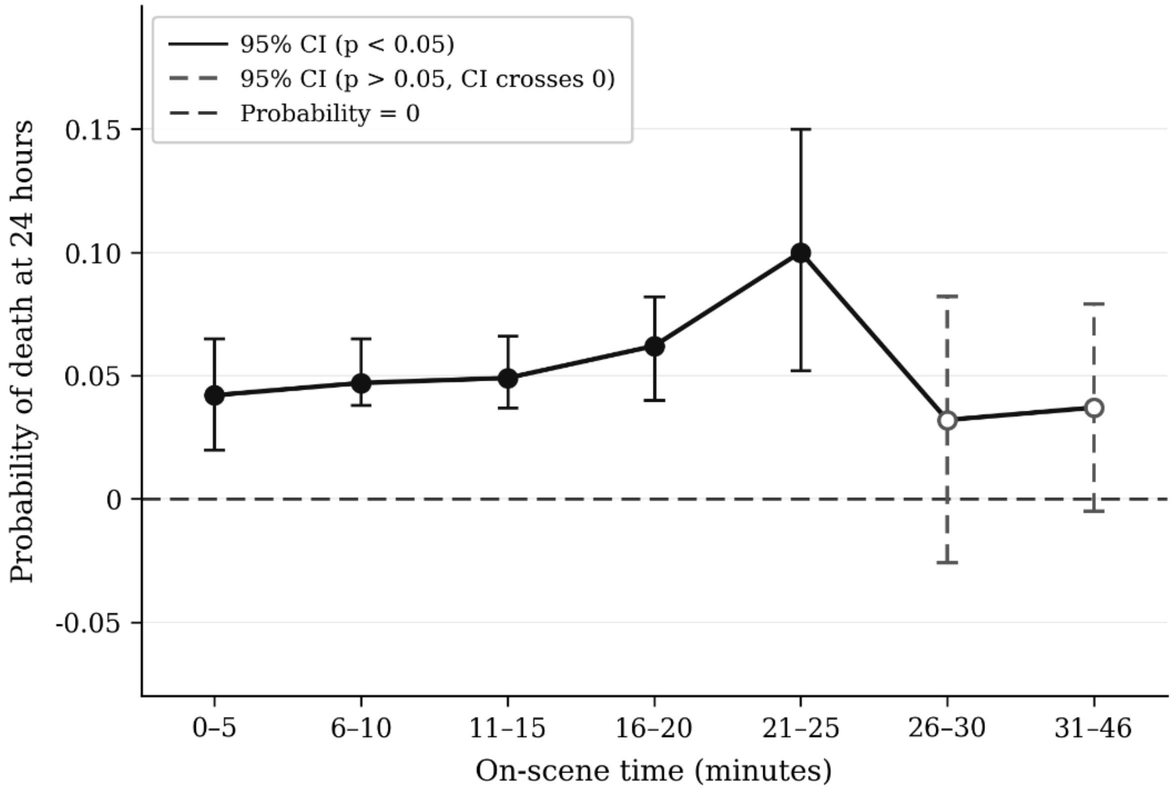

Figure 3: Adjusted predicted probabilities. Predictive margins of on-scene interval on the probability of 24-hour mortality with 95% confidence intervals (CIs). Filled markers indicate statistically significant estimates ($p < 0.05$); open markers with dashed CI bars indicate non-significant estimates. Dashed horizontal line indicates probability = 0.