

# A Retrospective Study of Ambulance Response Time in Priority One Cases

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## Abstract

**Background:** Ambulance response time (ART) is one of the key performance indices set by the Ministry of Health (MOH) in Malaysia. In priority one cases, the response time must be 15 minutes or less. The association between ART and patient outcomes has yet to be assessed in the Malaysian setting. **Methods:** This was a single-centre study that coordinated by the Medical Emergency Call Centre (MECC) of the Emergency and Trauma Department Hospital Raja Perempuan Zainab II (ETDHRPZ II) and received a call from the Malaysian Emergency Response Services (MERS) 999 or a direct line. Patients must have met the Delta and Echo classification using the Medical Priority Dispatch System for priority one case with age more or equal to 18 years. The data were collected was done from November 2019 to March 2020. **Results:** A total of 175 ambulance calls were recorded during the study period, during which the number of ambulances could reach 141 (80.6%) patients within 15 minutes or less. The remaining 34 (19.4%) patients responded in more than 15 minutes. The associations between ART and mortality and morbidity were not significant, with  $p\text{-value}=0.746$  and  $p\text{-value}=0.749$  respectively. The median length of stay (LOS) among admitted patients was the same which was four days. **Conclusion:** This study revealed no significant association between ART (less than or equal to 15 minutes) in priority one cases and patient outcomes. However, there is a need to consider multiple variables that influence the emergency medical response due its nature of complexity.

**keywords:** ambulance response time, emergency medical service, priority one case

## INTRODUCTION

The ambulance Response Time (ART) serves as a critical benchmark for evaluating the quality of Emergency Medical Services (EMS) globally. Defined as the interval from emergency call receipt by the Medical Emergency Coordination Centre (MECC) to ambulance arrival at the scene.<sup>1</sup> According to Azizan et al, the ART varies significantly across countries, each setting its own Key Performance Indicators (KPIs) for EMS delivery.<sup>2</sup> For example, Western Australia targets an ART of less than or equal to 15 minutes, whereas the United States averages approximately ten minutes for an EMS response.<sup>3</sup> In Malaysia, based on KPI, the ART target for priority one cases—those involving severe conditions—is also set at less than or equal to 15 minutes across all states, despite diverse geographical and infrastructural challenges.<sup>4</sup>

The implementation of the Medical Priority Dispatch System aids in EMS triage, where paramedics assess call outcomes ranging from low to high acuity levels categorized as priorities one, two, and three.<sup>5</sup> Priority one cases typically involve patients with critical conditions such as poor consciousness or abnormal breathing, automatically coded under DELTA (poor conscious level) or ECHO (abnormal breathing pattern) codes by the system.<sup>6</sup> This classification guides the dispatch of appropriate emergency ambulance responses based on the severity of the condition identified during the initial phone assessment.<sup>7</sup>

Globally, studies examining the correlation between ART and patient outcomes have reported mixed findings. Research by James et al. in the United

States indicates that longer ART is associated with higher mortality rates among motor vehicle accident (MVA) patients.<sup>8</sup> Conversely, studies in Scotland, such as those by J P Pell et al., suggest that shortening ART improves survival rates in Hospital Cardiac Arrest (OHCA) cases.<sup>9</sup> A study by CH Chen et al in four Asian countries (Japan, Korea, Malaysia and Taiwan) regarding prehospital time intervals, which included response time (RT), scene-to-hospital time (SH), and total prehospital time (TPT) showed that there was no association between longer prehospital times and the risk of 30 day-day mortality but an increase in the risk of poor functional outcomes in injured patients.<sup>10</sup> No study in Malaysia has focused on ART alone or its association with patient outcomes

Despite these global insights, there is a notable gap in research specific to Malaysia focusing on ART and its direct impact on patient outcomes. This study aims to address this gap by investigating several critical outcomes following ART for priority one cases in a Malaysian state capital. These outcomes included mortality post-ward admission, morbidity indicators such as the need for intubation, transfer to the operation theatre, admission to the intensive care unit (ICU), and length of stay (LOS) in the ward.

By conducting a retrospective analysis of EMS records and employing statistical methods, this study sought to uncover associations between ART and patient outcomes in one of the state capitals in Malaysia.

## METHODS

This retrospective cohort study was conducted in Kota Bharu, Kelantan, a state capital city with a population of approximately 400,000, encompassing diverse demographics in terms of age, gender, and race.<sup>11</sup> The study utilized data collected from November 2019 to March 2020 from the Medical Emergency Coordination Centre (MECC) database and the *Sistem Pengurusan Pesakit* Hospital Raja Perempuan Zainab II.

## PATIENTS SELECTION

This study focused on patients who were coordinated by the Medical Emergency Coordination Centre (MECC) at ETDHRPZ II, identified through calls from MERS 999 or direct lines classified as priority one cases based on DELTA or ECHO code classification generated by Medical Priority Dispatch System software. These codes categorize patients based on abnormal consciousness levels or breathing efforts. Eligible patients were aged 18 years or older and

received an emergency ambulance response from ETDHRPZ II, subsequently they were transported to EDHRPZ II for further medical management.

The data extracted from the database included sociodemographic variables (age, gender, race), clinical variables (comorbidities, chief complaints), operational variables (ART), triage status, admission details, and outcome variables (length of stay [LOS], morbidity, mortality). Morbidity was defined by the need for interventions such as intubation, transfer to the operation theatre, or admission to the intensive care unit (ICU). Mortality was assessed post admission to the ward. As the Malaysian Ministry of Health (MOH) benchmark for priority one ambulance responses is 15 minutes or less, thus the rationale for dichotomizing ART into two groups which are ART less than or equal to 15 minutes, and more than 15 minutes.<sup>4</sup>

## DATA ANALYSIS

IBM SPSS 25 was utilized for data entry and statistical analyses. Prior to analysis, the data underwent exploratory checks and cleaning to identify and correct any wrong, duplicated, or missing entries. Descriptive statistics were computed for sociodemographic and clinical variables. Comparisons of ART with other variables (age, gender, race, comorbidities, chief complaint, triage status, admission details, LOS, morbidity, mortality) was conducted using appropriate statistical tests, including independent t-tests or Mann-Whitney U tests for continuous variables and Pearson's chi-square tests or Fisher's exact tests for categorical variables, selected due to the non-normal distribution of the data.

## RESULTS

During the study period, a total of 175 ambulance calls were documented. Of these cases, 81% achieved an ART of 15 minutes or less, while 19% experienced a response time exceeding 15 minutes. The duration of ART ranged from a minimum of four minutes, attributable to proximity to the hospital, to a maximum of 44 minutes.

Table 1 shows the results of the descriptive analysis of the patients' sociodemographic. There were 175 patients involved in the study, with an average age of 49.94 years and a standard deviation of 21.39. The percentages of males and females involved in this study was 59.4% (n=104) and 40.6% (n=71), respectively. Most of the patients were Malay (n=157, 89.7%), residing predominantly in urban areas (n = 174, 99.4%). Regarding comorbidities, more than half

of the patients had no reported comorbid conditions. Chief complaints were categorized into medical problems (n=105, 60.0%), surgical problems (n=4, 2.3%), and motor vehicle accidents (MVA)/trauma (n=66, 37.7%). The number of patients treated in the yellow zone (n=99, 56.6%) was greater than that treated in the red zone (n=53, 30.3%) followed by the green zone (n=23, 13.1%). Other results of the descriptive analysis are shown in the table.

Table 2 presents the descriptive analysis of patients' sociodemographic by ambulance response time. During the study period, a total of 175 ambulance calls were analysed. Of these, 141 patients (80.6%) had an ART of 15 minutes or less, while 34 patients (19.4%) experienced an ART exceeding 15 minutes. The average age of patients with an ART  $\leq$  15 minutes was 49.32 years (SD = 21.27), which was slightly lower than the average age of 52.53 years (SD = 22.04) for patients with an ART > 15 minutes. In urban areas, 141 patients were retrieved within 15 minutes, and the remaining 33 patients responded in more than 15 minutes. There was only one patient from a rural area, and the response time was more than 15 minutes. In both ART categories, the number of patients without comorbidities was higher than those with comorbidities. The figures also showed that the number of patients treated in the yellow zone was greater than those treated in the green and red zones for both ART groups. The median length of stay among admitted patients was consistent at 4 days in both ART groups.

The Mann-Whitney test was conducted to assess the impact of ART on the length of stay among patients (Table 3). The analysis revealed no significant difference in the median length of stay between these two ART categories (median (IQR) for  $\leq$  15 minutes = 4.00 (5.00), median (IQR) for >15 minutes = 4.00 (4.00)).

Table 4 revealed the results of Fisher's exact test, which showed no significant association between ART and patient mortality or morbidity. This is a positive outcome, indicating that ART does not increase the risk of mortality or morbidity. The proportion of patients alive was greater in both ART categories (n (%) for  $\leq$ 15 minutes = 128 (90.8), >15 minutes = 30 (88.2)), suggesting hope for improved patient outcomes. The association between ART and morbidity was also not significant, with the percentage of those with no morbidity being higher in both ART categories; n (%) for  $\leq$ 15 minutes = 123 (87.2), >15 minutes = 30 (88.2).

**Table 1:** Descriptive analysis of the sociodemographic data of the patients (n=175)

Variables	Frequency (%)
Age (years) <sup>a</sup>	49.94 (21.39)
Gender	
Male	104 (59.4)
Female	71 (40.6)
Race	
Malay	157 (89.7)
Siamese	5 (2.9)
Chinese	12 (6.9)
Others	1 (0.6)
Residence	
Urban	174 (99.4)
Rural	1 (0.6)
Hypertension	
Yes	64 (36.6)
No	111 (63.4)
Diabetes mellitus	
Yes	52 (29.7)
No	123 (70.3)
Heart disease	
Yes	28 (16.0)
No	147 (84.0)
CKD	
Yes	17 (9.7)
No	158 (90.3)
Lung disease	
Yes	13 (7.4)
No	162 (92.6)
CVA	
Yes	22 (12.6)
No	153 (87.4)
Other comorbid	
Yes	22 (12.6)
No	153 (87.4)
Complain	
Medical problem	105 (60.0)
Surgical problem	4 (2.3)
MVA/Trauma	66(37.7)
Triage	
Green zone	23 (13.1)
Yellow zone	99 (56.6)
Red zone	53 (30.3)
Admission	
Yes	96 (54.9)
No	79 (45.1)
Length of Stay (days) <sup>b</sup>	4.00 (5.00)
Morbidity	
No	153 (87.4)
Intubation	10 (5.7)
Operation	1 (0.6)
ICU	3 (1.7)
Intubation and ICU	7 (4.0)
Intubation and operation	1 (0.6)
Mortality	
Alive	158 (90.3)
Dead	17 (9.7)

<sup>a</sup>Mean (SD), <sup>b</sup>Median (IQR)

**Table 2:** Descriptive analysis of patient sociodemographic by ambulance response time (ART)

Variable	n	ART Frequency
≤15 minutes (n, % = 141, 80.6%)		>15 minutes (n, % = 34, 19.4%)
Age (years) <sup>a</sup>	<b>175</b>	<b>49.32 (21.27)</b>
Gender		
Male	104	20 (58.5)
Female	71	14 (41.4)
Race		
Malay	157	29 (85.3)
Siamese	5	1 (2.9)
Chinese	12	3 (8.8)
Others	1	1 (2.9)
Residence		
Urban	174	33 (97.1)
Rural	1	1 (2.9)
Hypertension		
Yes	64	12 (35.3)
No	111	22 (64.7)
Diabetes Mellitus		
Yes	52	10 (29.4)
No	123	24 (70.6)
Heart disease		
Yes	28	7 (20.6)
No	147	27 (79.4)
Chronic kidney disease		
Yes	17	3 (8.8)
No	158	31 (91.2)
Lung disease		
Yes	13	5 (14.7)
No	162	29 (85.3)
CVA		
Yes	22	6 (17.6)
No	153	28 (82.4)
Other comorbid		
Yes	22	5 (14.7)
No	153	29 (85.3)
Complain		
Medical problem	105	24 (70.6)
Surgical problem	4	1 (2.9)
MVA/Trauma	66	9 (26.5)
Triage		
Green zone	23	2 (5.9)
Yellow zone	99	22 (64.7)
Red zone	53	10 (29.4)
Admission		
Yes	96	21 (61.8)
No	79	13 (38.2)
Length of stay (days) <sup>b,c</sup>	96	4.00 (4.00)
Morbidity		
None	153	30 (88.2)
Intubation	10	1 (2.9)
Operation	1	0 (0.0)
ICU	3	1 (2.9)
Intubation and ICU	7	2 (5.9)
Intubation and operation	1	0 (0.0)
Mortality		
Alive	158	30 (88.2)
Dead	17	4 (11.8)

<sup>a</sup>Mean (SD), <sup>b</sup>Median (IQR)<sup>c</sup>Length of stay for patients with Admission (Yes): ≤15 minutes (n=75), >15 minutes (n=21)

**Table 3:** Effect of ART on the length of stay according to the Mann-Whitney test<sup>a</sup>

Variable	Median (IQR)		z-statistics	p-value
	≤15 minutes (n = 75)	>15 minutes (n = 21)		
Length of stay	4.00 (5.00)	4.00 (4.00)	-0.018	>0.95

<sup>a</sup>Normality distribution of each ART group assumption for the independent t-test was violated

**Table 4:** Association between ART and mortality status and morbidity

Variable	ART, frequency (%)		n	p-value <sup>a</sup>
	≤15 minutes (n=141)	>15 minutes (n=34)		
Mortality				
Alive	128 (90.8)	30 (88.2)	158	0.746
Dead	13 (9.2)	4 (11.8)	17	
Morbidity				
None	123 (87.2)	30 (88.2)	153	0.749
Intubation	9 (6.4)	1 (2.9)	10	
Operation	1 (0.7)	0 (0.0)	1	
ICU	2 (1.4)	1 (2.9)	3	
Intubation and ICU	5 (3.5)	2 (5.9)	7	
Intubation and operation	1 (0.7)	0 (0.0)	1	

<sup>a</sup>Expected count of less than 5 was more than 20%; Fisher’s exact test was applied

## DISCUSSION

The WHO recommends an ideal ambulance response time equal to or less than eight minutes.<sup>12</sup> A few studies concerning the relationship between the ambulance response time and patient outcomes have been published. Alumran et al. concluded that fewer than eight minutes of ambulance response time did not strongly affect patients with out-of-hospital cardiac arrest (OHCA) outcomes.<sup>13</sup> Pons et al. reported that a response time of more than four minutes did not influence mortality in unselected patients.<sup>14</sup> Weiss et al. conducted a retrospective study on ambulance response time and patient outcome but found no significant relationship between these two variables.<sup>15</sup> However, a study by D.W. Lee et al. showed a positive finding that an ambulance response time of less than seven and a half minutes led to better neurologic outcomes in patients with OHCA of presumed cardiac origin.<sup>16</sup>

Our study revealed no significant correlation between an ART of 15 minutes or less in priority one

cases and patient outcomes. This study may be valuable as it specifically examines the association between ART in priority one cases and patient outcomes in one of the state capitals of Malaysia.<sup>17,18</sup> However, several factors must be considered, such as the discrepancy between the symptoms reported by the caller and the clinical triage conducted by paramedics upon patient encounter. Symptoms reported by the caller are triaged according to the Emergency Medical Dispatch Protocol, which assigns ambulance response priority based on the protocol.

In this study, all responded patients were initially assigned to priority one. Upon arrival at the destination, the paramedics assessed each patient by using the Field Responder Guide protocol and triaged them accordingly. The data revealed that although all patients were initially assigned priority one status during the ambulance dispatch, most were re-triaged to the green or yellow zones upon arrival at the emergency department. These cases were possibly not actual priority one cases, which are typically triaged to the red zone upon arrival in the emergency department. Patients triaged to the green and yellow

zones were generally more stable compared to those in the red zone and received different management practices. Consequently, the outcomes varied, with stable patients often being discharged despite being brought in by an ambulance.

Second, in addition to ambulance response time, several variables must also be examined. The ambulance response process involves the MECC receiving, processing, and categorizing a call before notifying the corresponding team. The dispatched team's arrival time at the scene may be influenced by traffic conditions, service timing, weather, and the type of ambulance. Once on the scene, additional factors include the time required to locate the patient's exact location, particularly in unplanned rural areas, and any treatment administered before returning to the hospital. Upon arrival at the hospital, the patient is re-triaged based on their latest clinical condition.<sup>19</sup> Each component requires further evaluation, as these may affect patient outcomes and ART. While ART did not show a significant correlation in this study, it remains a crucial factor in emergency medical services. Other critical factors include the quality of care provided upon arrival, the severity of the patient's condition, prehospital interventions, and overall system efficacy.

However, this study had several limitations. It was conducted at a single centre located in an urban area over a short period, limiting the ability to compare different settings since the ambulance response distances ranged from four to 15 kilometres from the hospital to the scene. Additionally, data were collected retrospectively from the computerized system and ambulance response forms, posing a threat to internal validity as variables could not be controlled. Some data were incomplete due to improper charting of the ambulance response forms and poor documentation by personnel. Furthermore, dichotomizing ART into  $\leq 15$  minutes and  $> 15$  minutes resulted in a loss of information.

## CONCLUSION

This study highlights the complexities and challenges in evaluating the effectiveness of ARTs and their impact on patient outcomes. Although there was no significant correlation between an ART of 15 minutes or less and patient outcomes, there is a need to consider multiple variables influencing emergency medical response. Further research should aim to address these variables and explore their intricate interactions to enhance the efficacy of EMS and patient outcomes.

## ACKNOWLEDGEMENT

Ethical approval for this study was obtained from the National Medical Research Register [NMRR-20-532-53831 (IIR)] on 13 April 2020. Our special thanks to the Hospital Raja Perempuan Zainab II director, Dato' Dr. Hj. Selasawati Binti Hj. Ghazali, and the head of the department ETDHRPZII, Dr Mohd Ghazali Bin Ab. Rashid, for supporting this study.

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