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Factors Influencing the Emergency Medical Service Response Time for Cardiovascular Disease in Guangzhou, China*

Xiao-qian CHEN[1†], Zi-feng LIU[2†], Shi-kun ZHONG[3], Xing-tang NIU[4], Yi-xiang HUANG[1#], Ling-ling ZHANG[5]
[1]*Department of Health Policy and Management, School of Public Health, Sun Yat-sen University, Guangzhou 510080, China*
[2]*Department of Medicine, Guanghua School of Stomotology, Hospital of Stomatology, Sun Yat-sen University, Guangzhou 510080, China*
[3]*Department of Network Management, Guangzhou City Emergency Care Centre, Guangzhou 510080, China*
[4]*Department of Plastic Surgery, the First Affiliated Hospital, Sun Yat-sen University, Guangzhou 510080, China*
[5]*Department of Nursing, College of Nursing and Health Sciences, University of Massachusetts Boston, Boston 02125-3393, USA*

Summary: While emergency medical service (EMS) response time (ERT) is a major factor associated with the survival of patients with cardiovascular disease (CVD), relatively few studies have explored the factors associated with ERT. This study aimed to assess the current status of ERT and to identify the factors affecting ERT in patients with CVD in China. Between January 1, 2011 and December 31, 2015, EMS responses to CVD incidents in Guangzhou, China, were examined. The primary outcome was ERT, defined as the time from receipt of an emergency call to the arrival of paramedics on the scene. Factors associated with ERT were evaluated by multivariable logistic regression. A total of 44 383 CVD incidents were analysed. The median ERT was 12.58 min (interquartile range=9.98–15.67). Among the risk factors, distance (OR=13.73, 95% CI=11.76–16.04), level of hospital (OR=1.57, 95% CI=1.40–1.75), and site of the incident (OR=1.53, 95% CI=1.38–1.69) were the top three significant factors affecting the ERT. Our results suggest that greater attention should be given to factors affecting the ERT. It is essential to make continuous efforts to promote the development of effective interventions to reduce the response time.
Key words: emergency medical service; cardiovascular disease; response time; factors; China

The quality and timeliness of emergency medical service (EMS) care is the focus of considerable public interest in recent years. The medical conditions of patients who require immediate care suggest that delay in treatment could result in a worsening of the patients' conditions, particularly for cardiovascular disease (CVD)[1]. CVD has been acknowledged to be an acute time-sensitive condition, and its care outcomes are of great importance in the performance of many emergency systems in the world. In China, CVD is a leading cause of death and is responsible for more than 3.5 million deaths (approximately 40% of all deaths)[2].

EMS response time (ERT), defined as the interval between call receipt and arrival of paramedics on the scene, remains a leading measure of EMS system performance across different countries[3]. There is supportive data to demonstrate that a shorter ERT is closely associated with a better prognosis for CVD patients[4]. The acute time-sensitive nature of CVD further highlights the importance of ERT in the performance of China's EMS system.

Despite its importance, the factors associated with ERT are still unclear. It is essential to identify those that affect ERT in order to decrease the mortality of CVD. Many factors have been shown to influence ERT, including call-taking and dispatching delays, resource availability, system demand, case priority, the patient's age, sex, and ethnicity, hour of day, and day of week[5–7]. However, the majority of these studies that examined the factors were conducted in developed countries. No evidence has been found so far concerning the factors affecting ERT for CVD patients in China. Furthermore, as a result of diversity in ethnicity, culture, socio-economic features and healthcare systems, factors associated with prolonged ERT may vary among populations[8]. In addition, due to the uniqueness of social development patterns compared to those of the developed countries, China

Xiao-qian CHEN, E-mail: chenxq35@mail2.sysu.edu.cn;
Zi-feng LIU, E-mail: sumsliu@hotmail.com
†The authors contributed equally to this work.
#Corresponding author, E-mail: huangyx@mail.sysu.edu.cn
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may also be distinctive in the management of CVD and in factors associated with ERT.

The objective of this study was to identify the factors affecting ERT for patients with CVD in a megacity of China and to lay the foundation for the development of interventions aiming to reduce ERT and improve outcomes for patients.

1 MATERIALS AND METHODS

1.1 Study Design and Setting

We performed a retrospective data analysis utilizing the computerized dispatch log database maintained by the Guangzhou City Emergency Care Centre of China from January 1, 2011 to December 31, 2015. Guangzhou is the most populous city of Guangdong province in southern China. Moreover, it is currently the third largest city in China, with a land area of 7434.4 square kilometres and an approximate census of 14.0 million people[9].

The Guangzhou EMS system is single-tiered and government-based and is operated by the Guangzhou City Emergency Care Centre. The 1-2-0 number is an emergency hotline for citywide emergencies. Emergency responses in Guangzhou are governed by a unified communications command. Sixty-four well-equipped ambulances are located in sixty-four hospitals, respectively. Following a call regarding CVD, a primary call dispatcher would send the information to the nearest hospital within one minute and dispatch the ambulance. Operationally, if no ambulance is available at the nearest hospital, an ambulance will be deployed from the next-nearest hospital. The ambulance is instructed to depart from the hospital within 4 min after receiving the notification. An ambulance is staffed with five crew members: an emergency physician, a registered nurse, a driver, and two stretcher-bearers. While on the scene, paramedics provide an initial assessment of the patient and advanced life support. Patients are usually conveyed to the nearest public hospital.

1.2 Data Collection

Patients with CVD who were treated by EMS between January 1, 2011 and December 31, 2015 were enrolled in the present study. CVD was defined according to the International Classification of Diseases version 10 (ICD-10). The diagnosis of CVD was confirmed by the emergency physicians. We collected data on call date, age, sex, site (home or not), call time, scene arrival time, caller (relatives or not), traffic (rush hour or not), level of the hospital, holiday, distance, region and final diagnosis. According to the traffic characteristics of Guangzhou, traffic conditions were categorized by time of day: 07:00 to 09:00 a.m. and 17:00 to 19:00 p.m. were considered rush hour, with the other times considered non-rush hour. Based on location, numbers of beds, staff expertise, and facilities, the national health commission of China has divided hospitals into three levels: tertiary hospitals (municipal), secondary hospitals (regional), and primary hospitals (community-based). For the purpose of our analysis, the level of the hospital was recorded into one of two categories: secondary hospital and below, and tertiary hospital. Holidays were classified as stipulated by Chinese law. The risk factors evaluated in this study were selected based on the availability of data and a contextual understanding of whether the factors would affect ERT.

1.3 Outcome Measure

The outcome measure was ERT, which covers the period from receipt of the 1-2-0 call by a dispatcher to the arrival of the paramedics at the emergency scene[3]. The time intervals were categorized into three groups: short (<8 min), intermediate (8–15 min), and long (>15 min). These categories were based on established benchmarks from the American Heart Association/American Stroke Association (AHA/ASA) stroke guidelines[10], and the national EMS provider in China followed a response time target of less than 15 min[11].

1.4 Statistical Analysis

Categorical variables were presented as number (n) and percentage (%), whereas the mean and standard deviation (SD) or median and interquartile range (IQR) were calculated for continuous variables. The chi-squared test was used to test for the significance of univariate associations against the ERT. Since the outcome variable was discrete, a multivariable logistic regression analysis model was performed. "Short" ERT was defined as the baseline category. Under the model assumption, we assumed that the outcome variable was nominal as the proportional odds assumption of ordered logistics regression was rejected. The Statistical Package for Social Sciences (IBM Corp. Released 2011, IBM SPSS Statistics for Windows, Version 20.0, USA) was used to perform all of the statistical analyses. For all hypothesis-testing, a P value <0.05 was considered to be statistically significant. Geospatial visualizations were plotted and obtained with ArcGIS10 (ESRI, USA).

2 RESULTS

Data selection details are presented in fig. 1. Of the 59 620 CVD incidents registered during the 5-year period, 15 237 calls with incomplete data were directly excluded from the dataset. In total, 44 383 (77.44%) were finally assessed for eligibility. ERT was markedly skewed; therefore, median and IQR were used. The median ERT was 12.58 min (IQR=9.98–15.67) overall.

Table 1 summarizes the descriptive statistics for the study by frequency and percentage. Of the 44 383 patients for whom data were available, the average

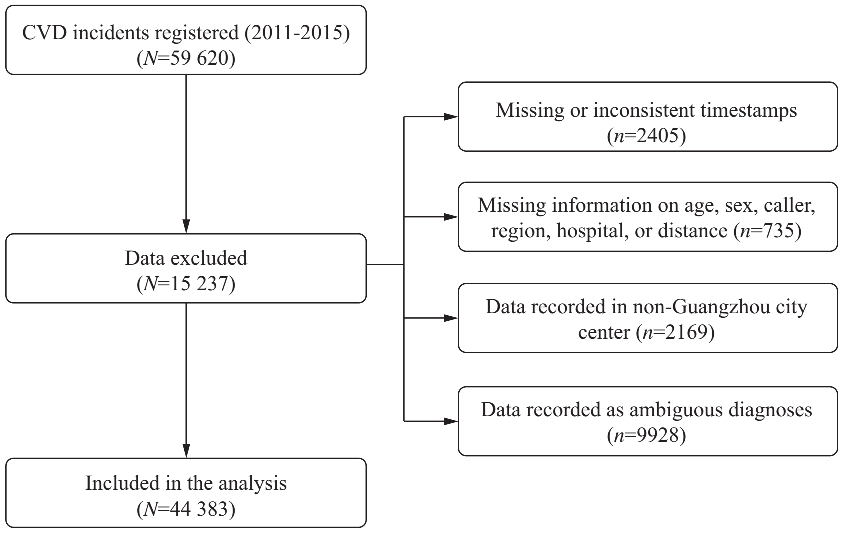

Fig. 1 Flow diagram of selection process

age was 66.76±18.17 years old, and 25 361 (57.14%) of the patients were male. A total of 36 453 (82.13%) incidents occurred at home. Additionally, 29 588 (66.67%) incidents were responded to by tertiary hospitals, and approximately half of the ambulances travelled 5 kilometres or less. From table 1, we can also see that from 2011 to 2015, the number of CVD patients tended to increase.

Table 2 shows the characteristics of patient distribution in three different time categories: a response time < 8 min had the fewest cases, a response time between 8 and 15 min had the most cases and a response time >15 min contained the intermediate number of cases. Of all emergency calls, the cumulative proportion for the ERT of less than 8 min was just 8.20%, while 70.74% of the EMS responses met the guideline of 15 min. The geospatial visualization in fig. 2 provides preliminary observations, showing that the average ERT tended to be longer in the regions of Baiyun and Luogang compared with the other regions of the Guangzhou city centre.

A “Short” ERT was used as a reference in the multivariable logistic regression model and the statistical analysis of these results are shown in table 3. The goodness-of-fit test based on the likelihood ratio test demonstrated that the model’s prediction was statistically better than the null model (P<0.001). Moreover, the lack of significance in the deviance-based goodness-of-fit measure revealed that the model’s fit was acceptable. Results for the likelihood ratio test of all the significant effects are shown in the last column of table 3.

Among the risk factors, “Distance”, “Level of hospital”, “Site”, “Holiday”, and “Traffic” were more statistically significant across all levels of risk factors than the reference. The likelihood of a “Long” ERT for distances >10 km was found to be the most significant, at approximately 14 times more than that with a distance ≤5 km (OR=13.72, 95% CI=11.75–16.02). The OR declined by 2.34 times (95% CI=2.01–2.72) for an “Intermediate” ERT. The OR of a “Long” ERT for “Secondary hospital and below” (OR=1.57, 95% CI=1.40–1.75) was higher than that for the incidents for “Tertiary hospital” (P<0.001). Furthermore, regarding the incidents occurring at “Home”, we observed a 53% increase in the odds of experiencing a “Long” ERT when compared with the odds for “Non-home” incidents (OR=1.53, 95% CI=1.38–1.69). In addition, the odds of “Long” ERT for “Non-holiday” incidents were approximately 1.33 times more than those for “Holiday” incidents (OR=1.33, 95% CI=1.15–1.53). Traffic conditions also appeared to have an important effect, with “Rush hour” having a slightly higher chance (OR=1.20, 95% CI=1.10–1.30) of falling into the “Long” ERT category than “Non-rush hour” incidents.

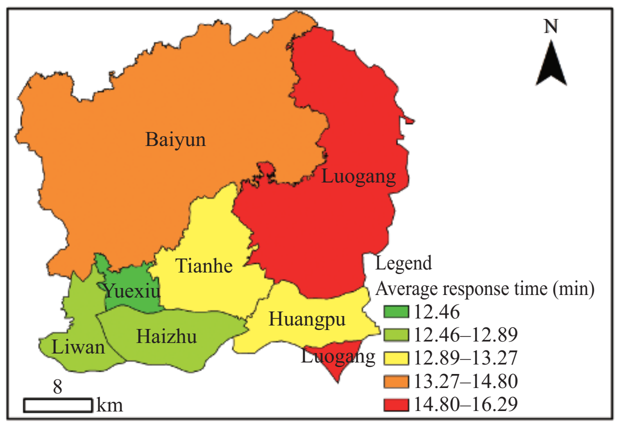

Fig. 2 Geospatial temporal patterns of emergency medical service response time

Table 1 Characteristics of data included in the study

Characteristics	All patients (N=44 383)	
	n	%
Sex		
Female	19 022	42.86
Male	25 361	57.14
Age (years)		
≤17	281	0.63
18–65	18 468	41.61
66–79	12 039	27.13
≥80	13 595	30.63
Site of the incident		
Home	36 453	82.13
Others	7 930	17.87
Caller		
Relatives	40 894	92.14
Others	3 489	7.86
Traffic		
Rush hour	13 418	30.23
Non-rush hour	30 965	69.77
Level of hospital		
Secondary hospital and below	14 795	33.33
Tertiary hospital	29 588	66.67
Holiday		
Non-holiday	41 035	92.46
Holiday	3 348	7.54
Distance (km)		
>10	7 194	16.21
6–10	13 662	30.78
≤5	23 527	53.01
Region		
Luogang	522	1.18
Haizhu	8 519	19.19
Tianhe	6 536	14.73
Liwan	7 332	16.52
Baiyun	7 835	17.65
Huangpu	1 563	3.52
Yuexiu	12 076	27.21
Year		
2015	9 885	22.27
2014	9 636	21.71
2013	9 042	20.37
2012	8 177	18.42
2011	7 643	17.22
Day of the week		
Sunday	6 173	13.91
Monday	6 617	14.91
Tuesday	6 340	14.28
Wednesday	6 393	14.4
Thursday	6 340	14.28
Friday	6 347	14.3
Saturday	6 173	13.91
Season		
Winter	13 124	29.57
Autumn	10 073	22.7
Summer	9 949	22.42
Spring	11 237	25.32

3 DISCUSSION

Cardiovascular-relevant morbidity and mortality in the Chinese population has increased quickly. With greater pressure being placed on the EMS, there is an increasing need to identify factors associated with ERT to improve patient outcomes. To the best of our knowledge, this was the first study to examine the potential risk factors affecting ERT for patients with CVD in China. The strength of our study is its large sample size, analysing over 40 000 cases across a five-year period from a busy EMS system.

Among the significant factors, "Distance" was found to be the most important. The odds of a long ERT with distance >10 km was approximately 14 times higher than with a distance ≤5 km. Similar findings have previously shown that distance significantly affects ERT[12]. The findings of the current study suggest that a targeted effort to develop possible interventions that can help to get responders on scene despite longer distances will likely help in reducing the ERT. Building an ambulance base within 5 km of every area of housing throughout the city might be a simplistic approach. However, it cannot be recommended due to the lack of economic, medical or logistical viability. Developing the procedures and policies that make the best use of the considerable resources already available could be another choice. For instance, the ERT can be improved by increasing the number of ambulance teams or by equipping additional first-line responders, such as the police and fire services.

From the multivariable logistic regression analysis, the study revealed that ERT for CVD incidents handled by "Tertiary hospitals" was shorter than for those by "Secondary hospitals and below". This was probably because of the characteristics of the Guangzhou "command type" mode, which relies on the hospital and sub-regional assumption of responsibility. Since the distribution of network hospitals in the city centre of Guangzhou is basically concentrated in the old urban areas such as Yuexiu, Haizhu, and Liwan, the network hospitals in these areas are not far from each other; thus, the emergency radius is short. In contrast, not only are secondary and primary hospitals distributed throughout the region of Baiyun, Huangpu, and Luogang, but the scope of the service area also is wider, resulting in an increased ERT.

Regarding incident site, the study discovered that CVD incidents that happened at home tended to be more numerous and had higher odds of experiencing "Long" ERT for CVD incidents relative to the baseline outcome of "Short" ERT; this was consistent with results from previous studies[13, 14]. Given that the seven regions in this study are all urban centres of Guangzhou and that the majority of urban residents dwell in high-rise buildings or private housing areas,

Table 2 Distribution of factors by emergency medical service response time

Factors	Short (<8 min)		Intermediate (8–15 min)		Long (>15 min)	
	n	%	*n*	%	*n*	%
Sex						
Female	1 570	8.25	11 968	62.92	5 484	28.83
Male	2 068	8.15	15 787	62.25	7 506	29.60
Age (years)						
≤17	20	7.12	163	58.01	98	34.88
18–65	1 417	7.67	11 371	61.57	5 680	30.76
66–79	962	7.99	7 634	63.41	3 443	28.60
≥80	1 239	9.11	8 587	63.16	3 769	27.72
Site of the incident						
Home	2 952	8.10	22 994	63.08	10 507	28.82
Others	686	8.65	4 761	60.04	2 483	31.31
Caller						
Relatives	3 300	8.07	25 677	62.79	11 917	29.14
Others	338	9.69	2 078	59.56	1 073	30.75
Traffic						
Rush hour	1 069	7.97	8 156	60.78	4 193	31.25
Non-rush hour	2 569	8.30	19 599	63.29	8 797	28.41
Level of hospital						
Secondary hospital and below	865	5.85	8 310	56.17	5 620	37.99
Tertiary hospital	2773	9.37	19 445	65.72	7 370	24.91
Holiday						
Non-holiday	3332	8.12	25 567	62.31	12 136	29.57
Holiday	306	9.14	2 188	65.35	854	25.51
Distance (km)						
>10	210	2.92	2 753	38.27	4 231	58.81
6–10	514	3.76	8 425	61.67	4 723	34.57
≤5	2 914	12.39	16 577	70.46	4 036	17.15
Region						
Luogang	20	3.83	212	40.61	290	55.56
Haizhu	558	6.55	5 751	67.51	2 210	25.94
Tianhe	421	6.44	4 274	65.39	1 841	28.17
Liwan	868	11.84	4 490	61.24	1 974	26.92
Baiyun	359	4.58	4 039	51.55	3 437	43.87
Huangpu	111	7.10	998	63.85	454	29.05
Yuexiu	1 301	10.77	7 991	66.17	2 784	23.05
Year						
2015	671	6.79	5 916	59.85	3 298	33.36
2014	754	7.82	6 049	62.78	2 833	29.40
2013	758	8.38	5 788	64.01	2 496	27.60
2012	782	9.56	5 324	65.11	2 071	25.33
2011	673	8.81	4 678	61.21	2 292	29.99
Day of the week						
Sunday	519	8.41	3 884	62.92	1 770	28.67
Monday	524	7.92	4 118	62.23	1 975	29.85
Tuesday	551	8.69	3 985	62.85	1 804	28.45
Wednesday	523	8.18	3 924	61.38	1 946	30.44
Thursday	491	7.74	4 007	63.20	1 842	29.05
Friday	527	8.30	3 966	62.49	1 854	29.21
Saturday	503	8.15	3 871	62.71	1 799	29.14
Season						
Winter	1 132	8.63	8 308	63.30	3 684	28.07
Autumn	818	8.12	6 281	62.35	2 974	29.52
Summer	812	8.16	6 146	61.78	2 991	30.06
Spring	876	7.80	7 020	62.47	3 341	29.73
Total	3 638	8.20	27 755	62.54	12 990	29.27

Table 3 Multivariable logistic regression output (baseline outcome: "Short" emergency medical service response time)

Factors	Intermediate (8–15 min)				Long (>15 min)				Likelihood ratio test
	Odds ratios (OR)	95% confidence interval		*P*-value	Odds ratios (OR)	95% confidence interval		*P*-value	
		Lower	Upper			Lower	Upper		
Intercepts				<0.001				0.016	
Sex									
Female	1.03	0.96	1.11	0.359	1.05	0.97	1.14	0.217	0.460
Male	1	–	–	–	1	–	–	–	
Age (years)									
≤17 years old	1.11	0.69	1.79	0.659	1.42	0.85	2.35	0.179	0.106
18–65 years old	1.08	0.99	1.18	0.082	1.07	0.97	1.17	0.185	
66–79 years old	1.09	1.00	1.20	0.055	1.04	0.94	1.15	0.427	
≥80 years old	1	–	–	–	1	–	–	–	
Site									
Home	1.28	1.17	1.41	<0.001	1.53	1.38	1.69	<0.001	<0.001
Others	1	–	–	–	1	–	–	–	
Caller									
Relatives	1.18	1.04	1.33	0.012	1.09	0.94	1.25	0.255	0.015
Others	1	–	–	–	1	–	–	–	
Traffic									
Rush hour	1.02	0.95	1.10	0.581	1.20	1.10	1.30	<0.001	<0.001
Non-rush hour	1	–	–	–	1	–	–	–	
Level of hospital									
Secondary hospital and below	1.42	1.29	1.57	<0.001	1.57	1.40	1.75	<0.001	<0.001
Tertiary hospital	1	–	–	–	1	–	–	–	
Holiday									
Non-holiday	1.09	0.96	1.24	0.187	1.33	1.15	1.53	<0.001	<0.001
Holiday	1	–	–	–	1	–	–	–	
Distance (km)									
>10	2.34	2.01	2.72	<0.001	13.72	11.75	16.02	<0.001	<0.001
6–10	2.99	2.71	3.30	<0.001	6.80	6.12	7.56	<0.001	
≤5	1	–	–	–	1	–	–	–	
Region									
Luogang	0.92	0.57	1.48	0.716	1.42	0.88	2.30	0.156	<0.001
Haizhu	1.49	1.34	1.66	<0.001	1.46	1.30	1.64	<0.001	
Tianhe	1.41	1.25	1.59	<0.001	1.42	1.25	1.63	<0.001	
Liwan	0.54	0.48	0.60	<0.001	0.41	0.36	0.46	<0.001	
Baiyun	1.12	0.97	1.29	0.121	1.42	1.22	1.65	<0.001	
Huangpu	1.21	0.98	1.49	0.082	1.28	1.02	1.61	0.037	
Yuexiu	1	–	–	–	1	–	–	–	
Year									
2015	1.19	1.06	1.34	0.003	1.31	1.15	1.48	<0.001	<0.001
2014	1.10	0.98	1.23	0.116	1.01	0.89	1.14	0.868	
2013	1.07	0.95	1.19	0.265	0.92	0.81	1.04	0.188	
2012	0.96	0.86	1.07	0.437	0.74	0.65	0.84	<0.001	
2011	1	–	–	–	1	–	–	–	
Day of the week									
Sunday	0.96	0.84	1.10	0.584	0.93	0.80	1.07	0.313	0.442
Monday	1.03	0.90	1.17	0.709	1.04	0.90	1.20	0.601	
Tuesday	0.93	0.82	1.06	0.303	0.89	0.77	1.03	0.119	
Wednesday	0.98	0.86	1.12	0.736	1.02	0.88	1.18	0.808	
Thursday	1.06	0.93	1.21	0.398	1.02	0.88	1.18	0.773	
Friday	0.98	0.86	1.12	0.770	0.98	0.85	1.13	0.784	
Saturday	1	–	–	–	1	–	–	–	
Season									
Winter	0.93	0.85	1.03	0.147	0.89	0.80	0.99	0.029	0.251
Autumn	0.95	0.86	1.05	0.304	0.95	0.85	1.07	0.413	
Summer	0.93	0.84	1.03	0.176	0.95	0.84	1.06	0.322	
Spring	1	–	–	–	1	–	–	–	

ambulances may be asked to travel through networks of smaller roads before reaching the patient's side. Compared with non-home sites, such as roads and business centres, homes could be more easily reached by paramedics, and thus, the emergency team may have a higher chance of arriving on the scene in less time. According to Singapore studies, the time required for an EMS team to climb stairs and/or board an elevator leads to emergency delays in high-density urban environment[15, 16]. Therefore, developing community-based first aid programmes to provide immediate assistance before the arrival of the EMS paramedics should be taken into consideration[17]. Such immediate assistance has been shown to have a significant impact on out-of-hospital cardiac arrest incidents[18]. Generally, effective community-based first aid programmes can not only potentially improve CVD survival rates but also increase community awareness of the importance of emergency responses for CVD patients.

We also observed that traffic has a significant effect, since the odds of a "Long" ERT in rush hour were higher than those in non-rush hour. Similarly, Lam and co-workers[19] pointed out that, among the factors affecting ERT, traffic has the greatest impact, especially in the city centre. Traffic problems in China are increasingly common, particularly in a city such as Guangzhou, which, as a typical "first-tier" Chinese city, is populous and has a growing tendency toward increasing traffic saturation and congestion[20]. The significance of "Rush hour" implies that, in spite of congested traffic, interventions should be developed to help paramedics arrive on the scene more quickly. Some possible ways to reduce ERT involve taking into consideration anticipated travel time and traffic congestion at different times of the day, and pre-positioning ambulances at optimal locations[21, 22]. Previous studies have shown that responders using motorcycles can significantly reduce ERT during periods of heavy traffic[23, 24]. Additionally, traffic management systems that are targeted to support the delivery of EMS services may be effective for the purpose of achieving a shorter ERT. Most importantly, more efforts should be taken to educate the public about the awareness of "ambulances first".

Remarkably, this study found that "Holiday" was a significant factor associated with ERT. The results illustrated that the ERT on holidays was shorter than on non-holidays. There are two possible reasons for this. On the one hand, with the improvement of people's living standards, especially in large cities such as Guangzhou, many people travel to other cities or countries on legal holidays. This phenomenon had led to a reduction of traffic in the city. On the other hand, the special composition of Guangzhou's population may play a vital role. As one of the most developed cities in China and as one with rapid economic development, Guangzhou has attracted migrant workers from all over the country; these new residents tend to return home on holidays such as Spring Festival. This results in a population decline in Guangzhou and improved traffic conditions.

Several investigators have reported a significant relationship between age and long ERT[25, 26]. Moreover, another two studies have reported that long ERT was significantly more frequent among women compared with men[27, 28]. Nonetheless, neither age nor sex was found to be associated with longer ERT in our study. One possible reason for these results may be that, in our study, the proportion of males and females with CVD was similar, as can be seen from table 1, with 25 361 males (57.14%) and 19 022 females (42.86%).

Furthermore, it has long been established that the shorter the time between symptom onset and early treatment, the better the patient outcomes. However, the median ERT of 12.58 min (IQR=9.98–15.67) is much longer than that reported by developed countries[29–31]. A suggested target response time of ≤8 min for at least 90% of emergent responses has evolved into a guideline that has been incorporated into operating agreements for many EMS providers[32]. Of emergency calls in urban areas, 44% of calls received a response within 9 min as Breen *et al*[12] reported in Ireland. The median ERT is 7.6 min in USA[33] and 7.08 min in Singapore[21], but it is even shorter in Denver, whose ERT is 5.8 min[34]. In this study, the median ERT is almost twice longer than that in Japan (6.4 min)[35]. Only 8.20% of emergency ambulance calls in Guangzhou responded within 8 min. These findings suggest significant opportunities for improvement in ERT and highlight the need for the promotion of strategies to reduce ERT for CVD patients in Guangzhou. Based on our understanding of the predictors of prolonged ERT, it is important to implement interventions that target the risk factors to shorten ERT.

As ambulance crews are usually the EMS system's first point of physical contact with patients, reduction in response time can foreseeably increase the probability of receiving early defibrillation, cardio-pulmonary resuscitation (CPR), and other medical interventions[36]. Therefore, implementing strategies, such as providing additional detailed information to EMS responders about the importance of rapid ERT or using quick response vehicles, could reduce ERT and improve morbidity and mortality outcomes for CVD patients. It is worthwhile to explore the use of trained lay first responders (such as those with appropriate CPR or first aid training) and professionals such as general practitioners, firemen or policemen. Furthermore, motorcycle-based first responders have been effectively implemented in developed countries. The primary objective of motorcycle-based first responders is to reach the patient and provide timely first aid in anticipation of the arrival of ambulances for conveyance to hospitals. In view of traffic congestion, such intervention can also be considered by Guangzhou EMS system. Additionally, dynamic allocation of ambulances can be considered to reduce ERT.

Several limitations of this study should be taken into consideration. First, the present analysis of the database is limited by a number of factors. The entire response time includes time components such as the dispatch time interval and the action time interval. Minimizing the intervals for each of these time components has been proven to provide a more complete approach towards the improvement of patient outcomes. Moreover, since computer-aided dispatch relies on the accuracy of paramedic input at the completion of each case interval, it is plausible that our ERT may have erroneous or outlying observations. However, given the size of our sample population, it is difficult to estimate the magnitude of human error it might contain. We hope that the EMS system will adopt more sophisticated methods of data capture that may improve the accuracy of data collection in future studies.

In conclusion, this study has investigated factors affecting the ERT of CVD cases. Distance had the largest effect, while two other significant factors were the level of the hospital and the site of the incident. These findings suggest opportunities for improvements in ERT, and they highlight effective interventions and suggestions that should be considered for further development to reduce the ERT.

Conflict of Interest Statement

The authors do not have any possible conflicts of interest.

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