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ORIGINAL ARTICLE

Ambulance Response Time at Three Selected Tertiary Hospitals in Malaysia: Performance of Hospital-Based Ambulance Equipped with Computerized Call Centre System

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Abstract

The importance of rapid ambulance response to emergency medical crises is undeniable. An early access to advanced care is crucial to saving a life. Modern computerised call centre and the hospital-based ambulance services are believed to enhance the quality of service delivery. However, whether it will further reduce the ambulance response time is still debatable. A cross-sectional study was conducted in June 2012 until July 2012 at three selected tertiary hospitals in Malaysia. The ambulance response time was expressed in a median and interquartile range (IQR) and Mann-Whitney U test was used to determine the associations between types of ambulance and computerised call centre system versus voice only. Wilcoxon Rank Sign Test was used to assess the significance of means difference. A hospital-based ambulance had the median time of 0.19 minutes while community-based ambulance had the median time of 0.20 minutes (The Z score - 0.916, p-value - 0.360). The hospital with computer call centre had the median time of 0.19 minutes while hospital without computer call centre had the median of 0.20 minutes (The Z score - 0.816, P value - 0.414).The response time of hospital-based ambulance equipped with computerised call centre system was comparable in three selected tertiary hospitals in Malaysia.

Keywords: Ambulance response time; Hospital-based ambulance; computerised call centre.

Introduction

Malaysian government effortlessly continued to improve the ambulance services throughout the country. In May 2007, the “999 - One Country One Number” project was launched and rebrand the Call Centre into Medical Emergency Call Centre (MECC). The seven MECCs in Klang Valley equipped with Computer Aided Dispatch (CAD) and geo-mapping which have been operational since February 2009. The CAD fitted with Pro-QA software which is used by paramedics to triage the calls and guide them in giving medical directives to the callers. The other eighteen MECC's were provided with four key phone lines each dedicated for communication of medical direction during the provision of medical emergency services.

It perceived that hospital-based ambulance equipped with CAD perform better than community-based. However, there was no published data to support this claim, and yet it remains uncertain. Multiple studies from Malaysia conducted to evaluates the satisfaction of the public regarding the Emergency Medical Service (EMS) delivery showed a discrete result (Anisah, Chew, Mohd Shaharuddin Shah, & Nik Hisamuddin, 2008; Hisamuddin, Hamzah, & Holliman, 2007; Said, Ahmadun, & Mohamed, 2001; Shah, Ismail, & Mohsin, 2008). The providers need to improve their services further and maintain the quality to enhance satisfaction and promotes the better perception of the public towards the EMS providers (A.A. & H., 2012). Constant evaluation of clinical and response performance indicators are critical components in ensuring that first response services are operating at maximum efficiency (Rahman et al., 2015).

Efforts have initiated in researching and developing multifunctional telemedicine systems which allow EMS teams to perform real-time teleconsultation with remote specialists or more advanced treatment facilities (Kyriacou et al., 2003; Pavlopoulos, Kyriacou, Berler, Dembeyiotis, & Koutsouris, 1998). Despite the rapid development of personal mobile communication devices, the use of telemedicine in prehospital environment in Malaysia is still at infancy stage with some delay in execution, but the government is in the right track in improving the telemedicine services in Malaysia (Som, Norali, & Ali, 2010).

According to Serpil A. et al, well-defined system requirements and the organisation of Emergency Medical Services must be sufficiently established to perform their roles as efficient pre-hospital care providers, especially in situations that required urgent intervention (Ates, Coşkun, & Çağdaş Aydınoglu, 2011). A study from King County, Washington discovered a survival rate to decrease by 2.1% per minute without intervention by Advanced Cardiac Life Support (Cummins, Ornato, Thies, & Pepe, 1991). Blackwell & Kaufman addressed that determining the case urgency and planning an ambulance rout is the most crucial activity for EMS at the moment of receiving an emergency call (Blackwell & Kaufman, 2002). Response time and service quality provide the most valuable performance indicators of EMS. The ambulance responds time (ART) varies ranging from 7 minutes to 15 minutes (Government, 8th April 2018; Seow & Lim, 1993). The Emergency Cardiovascular Care (ECC), did recommend that EMS systems attempt to achieve a response time of 8 to 10 minutes from collapse to provide the maximum potential for successful cardiac and cerebral resuscitation ("Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Part 6: advanced cardiovascular life support: section 1: Introduction to ACLS 2000: overview of recommended changes in ACLS from the guidelines 2000 conference. The American Heart Association in collaboration with the International Liaison Committee on Resuscitation," 2000) The primary objectives of the study are to measure the mean response time of the ambulance services of the selected hospitals namely Hospital Kuala Lumpur (HKL), Hospital Tengku Ampuan Rahimah (HTAR) and Hospital Raja Perempuan Zainab II (HRPZII). The secondary objectives were to determine the association of hospital-based ambulance versus community-based ambulance as well as the hospital with the call centre with computerised call centre system versus the call centre using voice only with regards to the ambulance response time.

Materials and Methods

Design

This cross-sectional retrospective study conducted at MECC of three selected hospitals in peninsular Malaysia; Hospital Kuala Lumpur (HKL), Hospital Tengku Ampuan Rahimah (HTAR) and Hospital Raja Perempuan Zainab II (HRPZII) from June 2012 to July 2012. HKL and HTAR are equipped with computerised system whereas HRPZII is using voice-only communication. The data taken from completed ambulance trip forms which were manually filled by dispatchers and ambulance personnel dedicated clock. A total of 1200 completed forms were collected and analysed. Ethical approval obtained from the institutional ethical committee prior conducting this study. The dependent variable in this study was total ambulance response time (call processing time, time to prepare the team and time to arrive at the scene). The independent variables in this study were the hospital-based ambulance (ambulance stationed at the hospital) and community-based ambulance (ambulance placed or located outside the hospital) and hospital with the computerised call centre (Call centre equipped with Computer Aided Dispatch (CAD) and Geographical Information System (GIS).

Statistical analysis

Descriptive analysis used to estimate the frequency of all qualitative variables such as types of ambulance, hospital with computerised call centre system and hospital with the call centre using voice only, distance from a hospital-based ambulance and community-based ambulance and variety of cases (according to Malaysian Triage Category).

Continuous variables of skewed distribution (ambulance response time) expressed in median and interquartile range (IQR). Mann-Whitney U test was used to determine the associations of continuous variables of skewed distribution (ambulance response time) with qualitative variables (such as types of ambulance, hospital with computerised call centre system and hospital with the call centre using voice only, distance from a hospital-based ambulance and community-based ambulance and variety of cases). Wilcoxon Rank Sign Test was used to assess the significance of means difference. A p-value of less than 0.05 was considered to be statistically significant. All the information obtained in this study analysed by using commercially available software, Statistical Program for Social Science (SPSS) Version 22.

Results

Types and ambulance location

There was 65.7% (n=788) of hospital-based ambulance compared with 34% (n=412) of community-based ambulance (Figure 1). The median ART of three selected hospitals HKL, HTAR and HRPZII was 0.19, 0.19 and 0.20 minutes respectively (Table 1). A hospital-based ambulance had the median of 0.19 minutes while community-based ambulance had the median of 0.20 minutes. The Z-score was -0.916 while P-value was 0.360 (Table 2). The two median of ambulance response time in the hospital-based ambulance and community-based ambulance are not significantly different.

Hospital based :
65.7% (n = 788)

Community based ambulance :
34.3 % (n = 412)

Figure 1. Ambulance location

Table 1. The median of ART response time in three selected hospital

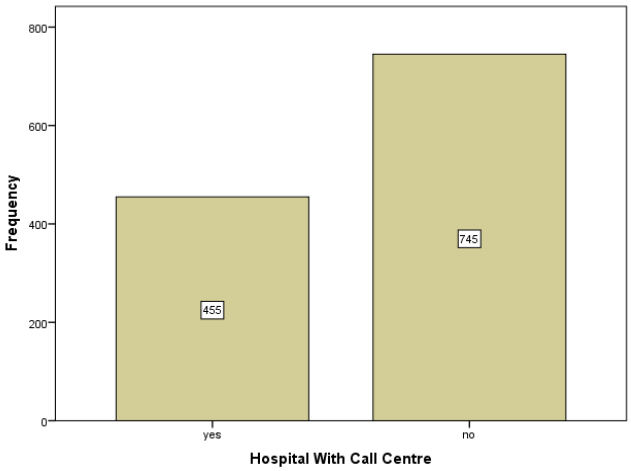
Hospital Name	Median (minutes)	Interquartile Range (minutes)
HKL	0.19	(0.14, 0.25)
HTAR	0.19	(0.13, 0.26)
HRPZ II	0.20	(0.15, 0.28)

Table 2. The median ART based on a type of ambulance service.

Types of ambulance service	Median (minutes)	Interquartile Range (minutes)	z-score	p-value
Hospital based	0.19	(0.14, 0.26)		
Community based	0.20	(0.15, 0.27)	- 0.916	0.360

Tertiary hospital with computerised call centre system versus voice only.

There was 37.9% (n= 455) call centre with computerised system whereas 62.1% (n = 745) of call centre using voice only (Figure 2). The hospital with computerised call centre had the median of 0.19 minutes while hospital without computerised call centre had the median of 0.20 minutes. The z-score was -0.816 while P-value was 0.414. The two median of ambulance response time in a hospital with computer call centre or hospital without call centre are not significantly different (Table 3)



Call centre with the computerised system: 37.9% (n = 455)
Call centre using voice Only : 62.1% (n = 745)

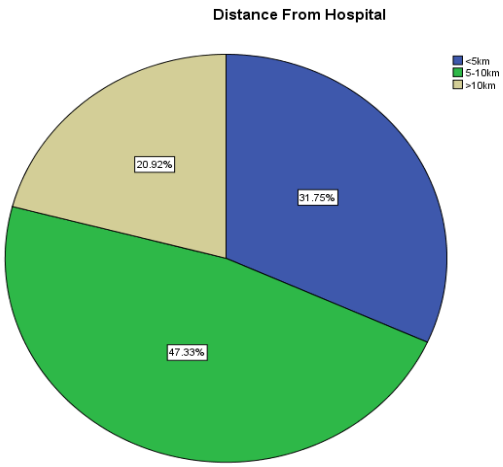
Figure 2. Frequency of hospital with computerised call centre system versus voice only

Table 3. The median ART between hospital with computerised call centre and hospital without computerised call centre

Hospital with computerised call centre	Median (minutes)	Interquartile Range (minutes)	z-score	p-value
Yes	0.19	(0.14, 0.26)	0.816	0.414
No	0.20	(0.14, 0.27)		

Distance from a hospital-based ambulance.

Our study showed a different distance of ambulance response by hospital-based ambulance team (Figure 3). The critical, semi-critical and non-critical cases had a median time of 0.19, 0.20 and 0.19 minutes respectively. There was no significant difference in median ART for severity of cases (Table 4).



Less than 5 kilometers: 31.8% (n = 381)
5 to 10 kilometers : 47.3% (n = 568)
More than 10 kilometers: 20.9% (n = 251)

Figure 3. Distance from the hospital-based ambulance

Table 4. **Severity of the cases and median ART**

The severity of the cases (Malaysian Triage category)	Median (minutes)	Interquartile Range (minutes)	p-value
Critical	0.19	(0.14, 0.26)	0.205
Semi-critical	0.20	(0.15, 0.27)	
Non-critical	0.19	(0.13, 0.25)	

Discussion

A growth in Malaysian population is increasing at an average rate of about 3-4 % per year. The increment had indirectly enhanced the rapid development of the road network, and the escalating number of vehicles on Malaysian roads. It subsequently caused the increasing number of road accidents involving severe and fatal injuries (Hisamuddin et al., 2007). Nevertheless, the public demanding a better emergency response so that the total number of victims caused by the road accidents will decrease although the total number of the accident increases keep increasing annually (Law, Radin Umar, & Wong, 2005). Emergency medical service (EMS) providers serve in the fragile environment which is uncertain, fast-paced and rapidly change. In the dynamic situation, they have to accurately assess the need and initiate treatment based on treatment priority. Those with the most significant threat to life will be prioritised, stabilised and transported to the appropriate centre for definitive care. It can take years to gain the experience, factual knowledge and understanding that are essential for quick documentation (*Proceedings of the 40th Annual Hawaii International Conference on System Sciences*, 2007). The decision-making process posted a challenge to the EMS personnel by the excitement, high level of concentration, and high expectations for performance by the public at the scene. Therefore they may require guidance, online direction, monitoring and accurately recorded documentation of the management given to the victims.

Our study showed that the median ART in HKL and HTAR was 0.19 whereas HRPZII was 0.20 minutes (Table 1). Factors which cause these long time intervals include traffic congestion, inadequate public education, and location of a patient (whether on ground level or high rise) and distance from the site of an emergency (Shah Che Hamzah et al., 2005). Ministry of Health and Social Affairs of Norway proposed the standard ART interval in emergencies if performed, would be able to assess the current ART. The interval recommended in the urban area suggests the ambulance should cover 90% of the population within 8 minutes, whereas in the rural area; ambulance should cover 90% of the population within 25 minutes (Folkestad, Gilbert, & Steen-Hansen, 2004). ART that was longer than 15 minutes is unacceptable. Statistically, the twenty-six MECC in Malaysia manages to reduce ART to 30 minutes (Shah et al., 2008). Report from Road Safety Department in Malaysia stated that the current average ART is 30-40 minutes, compared to the international standard of 8-10 minutes. The ambulance response time in Malaysia was comparable to Singapore (Seow & Lim, 1993). Even though the response time is improving but it is still beyond the international standard.

The two median of ambulance response time in the hospital-based ambulance and community-based ambulance are not significantly different (Table 2). Delay of ambulances to arrive at the scene for immediate medical attention may cause undesired consequences to the patients. The number and imperative location of ambulance stations need to be determined to meet the demand of the services. Non- strategic ambulance location will result in reduced ambulance coverage and subsequently will affect the ambulance accessibility. For instance, rural clinic ambulance services cover the small number of demands and usually located far from most likely emergency locations. Thus, whenever an emergency occurs, the ART taken would be longer than the specified response time. However, our result showed that position

of an ambulance does not significantly affect the response time of the three selected hospitals in Malaysia.

Technology to enhance clinical care is widely accepted and beneficial in many settings. Specialized telemedicine applications have shown the improvement of patient care in different inner clinical settings. The benefit has been demonstrated in various pre-clinical uses (Bergrath et al., 2012; Cummins et al., 1991; Dhruva et al., 2007). Our study showed, the two medians of ambulance response time in a hospital with computer call centre or hospital without call centre are not significantly different. The hospital with computerised call centre had a shorter response time, but it was not statistically significant (Table 3). The current study showed that the computerised call centre is a way forward in the improvement of the pre-hospital care quality, even though the response time is not significantly shorter, it helped in documentation as all the information given by the caller will be recorded in the computer. Besides, it can be a monitoring system of an ambulance movement and location of the emergency situation.

Based on our study, the critical and non-critical cases had the median of 0.19 minutes while semi-critical cases had the median of 0.20 minutes (Table 4). The three median of ambulance response time based on a type of cases are not significantly different. Cordell W.H. et al., address the measurement of time is vital in both clinical care documentation and research, especially for medical events that are rapidly evolving and time critical such as cardiac arrest resuscitation and thrombolytic therapy (Cordell, Olinger, Kozak, & Nyhuis, 1994). There is a need to have a systematic system that can monitor the procedure of ambulance response services. The critical cases need to be seen promptly, and specific measures should be implemented accordingly. This failure will result in significant morbidity and mortality.

Study Strength

Our study used a validated data from MECC in three selected tertiary hospital. The samples were taken from standardised and completed ambulance trip forms which were able to reduce the biases. This study able to collect an extensive data and it can be reflecting the robust data analysis

Study Limitation

Data collection was performed retrospectively, and it was dependent on the samples which were manually filled by dispatchers and ambulance personnel using a dedicated clock. The study was conducted in short period. Therefore it may not reflect exact targeted population size. The accuracy of dispatch coding has not been evaluated, and it is possible that cases in which the response mode was changed en-route were not identified.

Conclusion

The ambulance response time in three selected tertiary hospitals hospital in Malaysia namely HKL, HTAR and HRPZII were below the international standard. At present, there were no statistically significant differences and an association between ambulance response time versus availability of computerised call centre, the severity of the case responded based on Malaysian Triage Category and whether the ambulance is the station at the hospital or outside the hospital. It is therefore recommended to implement a specific strategy to improve ambulance response time, and it must be individually judged for benefit and cost-effectiveness to meet the needs of healthcare to the community.

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