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A Review on Development and Optimization of Emergency Medical Services in Malaysia

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Abstract

This paper presents a review on emergency medical services delivery in Malaysia. The background and the development of emergency medical services in Malaysia are highlighted. Emergency medical services delivery in Malaysia is currently categorized as in developing phase. The efficiency of the delivery in Malaysia is lagged behind other developed countries. Moreover, we also explain the current problems of emergency medical services in Malaysia. The related works to optimize the delivery of emergency medical services in Malaysia are also discussed.

Keywords: Emergency medical services; ambulance location model; ambulance dispatch policy

1.0 INTRODUCTION

Emergency medical services (EMS) is an out-of-hospital emergency medical care to sick and injured patients. In most of the real-life applications, coverage and response time are commonly used by EMS providers to evaluate delivery efficiency. An emergency call is considered covered if it is served within a defined time threshold. Generally, EMS response time can be defined as the interval from the time the call was received by the EMS provider to the arrival of the ambulance to the emergency scene [1-5]. A number of studies have found the important relationship between response time and mortality rate. Delivery efficiency of EMS is critical in reducing mortality and disability rates [6-8].

Ambulance response time (ART) and coverage percentage are used together as a standard preset in Key Performance Indicator (KPI) for EMS delivery [9]. Every country has a different standard KPI for its EMS delivery. The standard stated in The United States Emergency Medical Services Act is that in urban areas 95% of requests should be served within 10 minutes, while in rural areas they should be served within 30 minutes [10]. In Montreal, the implemented standard for ambulances runs by "Urgences Santé" states that 90% of requests should be served within 7 minutes [11].

Some countries use different response times for certain categories of calls. In United Kingdom, 75% of category A call should be served within 8 minutes, and 95% of category B and C calls should have a response time within 14 minutes (urban areas) and 19 minutes (rural areas) [12]. Note that Category-A, -B and -C calls are respectively for a life-threatening case, a serious but not life-threatening case and a non-serious and not life threatening case.

In the next section, the background of EMS in Malaysia is reviewed. EMS related research in Malaysia is presented in Section 3.0. Finally, the discussion and conclusion of this work are presented in Sections 4.0 and 5.0.

2.0 EMERGENCY MEDICAL SERVICES BACKGROUND IN MALAYSIA

EMS is divided into two major models in the world today: the Anglo-American and the Franco-German model [11-13]. The concept of Anglo-American model is "bring the patient to the hospital" as contrast Franco-German model is "bring the hospital to the patient". EMS in Malaysia is under Anglo-American model. The medical equipment in the ambulance under Anglo-American model is limited compares to Franco-German model. As a result, the efficiency of EMS in Anglo-American model is more important compare to Franco-German model to ensure the survival rate of the patient. Malaysia EMS system is using Anglo-American model [16, 17] that is why optimization of EMS in Malaysia is vital.

EMS is the most neglected clinical area of the hospital for many years since the country gained independence from British rule in 1957 [16]. EMS delivery in Malaysia is classified into underdeveloped phase and far behind compared with advanced countries [13]. In 2000s, EMS in Malaysia is still in the

"developing" phase as compare to EMS delivery in other developing countries [16, 18]. Several researches [18, 19-21] show EMS delivery in Malaysia does not have any uniform medical control, communication systems, system management and quality assurance policies among the EMS providers.

The earliest EMS research, performed by Hauswald and Yeoh in the 1990s [22], found out that there is no pre-hospital care system available in Malaysia. This research looked into the cost and benefits of setting up EMS in Kuala Lumpur. The research found that the development of pre-hospital system in Kuala Lumpur to cost approximately RM 2.5 million per year but it might only save seven lives (6%), three of which would be marred by significant neurological injury.

In 1999, Malaysia was categorized into an underdeveloped emergency care systems country since the academic activities regarding the emergency care systems do not yet exist [13]. From the review by Hisamuddin *et al*. in 2007 [18], as Malaysia economy state has improved, the demand of the citizen for a better health care system has increased. Currently, ambulance services are provided by The Ministry of Health, Ministry of Education, Civil Defense, and non-governmental organizations such as Red Crescent and St. John's Ambulance. Ambulances in Malaysia follow the Anglo-American model. Physicians, nurses or medical assistants are dispatched together with the ambulances to emergency scene.

One of the major limitations of pre-hospital care in Malaysia is the deficient integration between agencies such as ambulance services, police and fire departments during an emergency situation. Besides, there are no uniform medical control or treatment protocols, communication systems, system management, training or education, or quality assurance policies for the pre-hospital care services in the entire country. Each EMS provider has its own communication and ambulance dispatching system [20-22]. Due to a lack of integration, two ambulances may arrive at the same place. It is a waste of resources and it ends with a lot of confusion [23]. The current background of EMS in Malaysia is summarized in Table 2.0.

Table 2.0 Summary of the current background of EMS in Malaysia

Researches	Outcome
Hauswald and Yeoh [22]	No EMS available at the capital of Malaysia.
Arnold [13]	In the 1990s, emergency medical of Malaysia was categorized as an underdeveloped emergency care system.
Hisamuddin *et al.* [19], Hameed *et al*. [20-21]	No uniform medical control or treatment protocols, communication systems, system management, training or education, or quality assurance policies for the pre-hospital care services.
Rahman *et al.* [16], Hisamuddin *et al.* [18]	EMS in Malaysia is still in the "developing" phase.

■3.0 EMERGENCY MEDICAL SERVICES RESEARCH IN MALAYSIA

Currently, there is still lacking of optimization study on Malaysia EMS delivery. The previous research related to EMS delivery optimization in Malaysia [20-22, 24, 25] mostly focus on Kuala Lumpur and Pulau Pinang. There are only two researches [26, 27] on Malaysia south area. Lim *et al.* [28] propose free ambulance exploitation dispatch that is suitable for Malaysia EMS background.

The researches on emergency care system in Malaysia are very limited. In 2004, a local medical school (School of Medical Sciences, Universiti Sains Malaysia) initiated the first Emergency Medical Dispatcher (EMD) program and preliminary outcome has shown that it has improved ART. The presence of the EMD has resulted in a 45% reduction in ART. This program is the foundation for the initiation of a paramedic training program in Malaysia [18]. In 2007, Ng and Abdul Ghani develop an ambulance location model (ALM) that can be used to predict the average ambulance service travel times in Penang [24]. However, the optimization of EMS delivery is not addressed.

In [19-21], integrated medical emergency model has been developed to work as a centralized medication and emergency management system utilizing information technology. But again, the optimization of EMS delivery is not taken into account. Thus, a lot of effort is still required to improve EMS delivery in Malaysia.

Lim *et al*. [28] have proposed a new ambulance dispatch policies decomposition method. Based on the analysis on the mentioned dispatch policies and real-life ambulance dispatch processes, an ambulance dispatch policy must include the method of calls queuing and the way of assigning an ambulance to answer an emergency call in the queue. This information can be regarded as the core of the ambulance dispatch policy which summarizes the complicated processes involved in real-life ambulance dispatch system. Add-on dispatch is a supplementary method used in ambulance dispatch policy to achieve a specific objective.

In [28], free ambulance exploitation dispatch, a new add-on dispatch that enables free ambulance exploitation to improve the response time of urgent call is introduced. The new add-on dispatch has been tested with commonly used ambulance dispatch policies. The proposed free ambulance exploitation dispatch is computationally proven to work for the commonly used ambulance dispatch policy. The obtained results also show that the process of diverting ambulances has a low impact on total calls coverage and the average response time for all calls. However, urgent calls optimization using both dispatches can lead to lower performance for less urgent calls.

Other researches related to Malaysia EMS are carried out by researchers Azizan [26] and Hatta [27] from Universiti Teknologi Malaysia. In [26], Maximal Covering Location Problem (MCLP) and OpenStreetMap (OSM) are used to simulate the real map covered by the area of Majlis Perbandaran Johor Bahru Tengah (MPJBT). OSM was edited by using Java-based application and an open-source software. On the other hand [27], Hatta's EMS simulation is comparing two ALMs which are MCLP and gradual Maximal Coverage Location Model (GMCLP) based on gridded MPJBT map. The location model is solved by using Particle Swarm Optimization (PSO) algorithm.

ALM is used to find strategic ambulance location sites. By using difference ambulance fleet size for a set of potential ambulance location sites, a set of strategic ambulance location sites can be identified through ALM. Strategic ambulance location sites are very important in optimizing ambulance travel distance and response time. Although extra ambulances can be placed to reduce ART, it is not a resource optimized solution. It leads to higher idle time of ambulances and thus underutilizes the resources. Good ALM is important to reduce ART and also the cost of providing EMS. The mentioned research work in EMS is summarized in Table 3.0.

Table 3.0 Summary of EMS research in Malaysia

Researches	Outcome
Hisamuddin [18]	School of Medical Sciences, Universiti Sains Malaysia, initiated the first EMD program. Preliminary outcome has shown that it has improved ART. The presence of the EMD resulted in a 45% reduction in ART.
Ng and Abdul Ghani, [24]	Develop an ALM that can be used to predict the average ambulance service travel times in Penang Island. However, the optimization of EMS delivery is not addressed.
Hameed and Shabnam [19]; Hameed *et al.* [20]; Hameed and Miho, [21]	Integrated medical emergency model has been developed to work as a centralized medication and emergency management system utilizing information technology. Again, the optimization of EMS delivery is not addressed.
Lim *et al*. [28]	Proposed a new ambulance dispatch policies, Free Ambulance Exploitation dispatch enables free ambulance exploitation to improve the response time of urgent call is introduced.
Azizan *et al.* [26]	Real map EMS delivery simulation in MPJBT area using OSM
Hatta *et al*.[27]	EMS simulation based on gridded MPJBT area map using GMCLP. The location model is solved by using PSO algorithm.

4.0 DISCUSSION

Since efficiency of EMS delivery is important in reducing mortality and disability rates, research in improving EMS delivery efficiency is indispensable. From several review mentioned, EMS delivery in Malaysia is still in developing phase. For example there are lacking of uniform medical control, treatment protocols, communication systems, system management, training or education, and quality assurance policies. More researches are needed to improve EMS delivery performance in Malaysia.

Although several EMS delivery optimizations based on simulation are performed for Malaysia background, real-time traffic condition is not considered. For example, a dispatched ambulance may get stuck in a traffic jam. EMS control system needs to be integrated with the software and hardware that are capable to provide real-time traffic condition data like Waze running on a smart phone to make sure EMS delivery is optimized. Besides, ALM and dispatch policies with real-time condition consideration are important to optimize EMS delivery in real-life application.

5.0 CONCLUSIONS

Research in EMS is essential to improve EMS performance in Malaysia. The Ministry of Health must be aware and proactive in implementing any measure to improve the EMS performance in Malaysia. Simulation is an important tool to predict the EMS performance before the actual implementation. Optimization based on simulation without real-time traffic data and other real-life considerations cannot guarantee the actual efficiency gain in EMS delivery. More researches involving hardware and software are needed to have more real-time data integrated into the EMS simulator.

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