Global Positioning System application in Ambulances and Pre-Hospital Response Time: Case of EMS in Tehran

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Introduction: Identification of effective factors in reduction of response time in pre-hospital Emergency Medical Service (EMS) can help a system to improve its services. This study aimed to study the effect of using Global Positioning System (GPS) in ambulances on the average of response time.

Methods: Among 132 Tehran's EMS stations, 24 ones were randomly selected and data of response time in all missions in 2009 (without GPS) and in 2011 (with GPS) and number of daily calls in each center were gathered. According to the average number of daily calls centers were divided to three categories: (I) centers with ten and less calls, (II) centers with ten to fifteen calls, and (III) centers with more than fifteen calls. Paired t-test was used to analysis the data.

Result & Conclusions: Findings show that the average of response time in 2009 for three groups (I-III) was 10.11, 11.25, and 10.92 minutes respectively. The time was 9.86, 10.71, and 11.58 in 2011 that is significantly ($p<0.001$) less that of it in 2009.

Keywords: Pre-hospital, EMS, GPS, Ambulance, Response Time, Tehran

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Introduction

In Iran, pre-hospital EMS (as a subdivision of Center for Disaster Management and Emergency Medicine (1)) is an important part in the Health system of medical services (2). Moreover, Prehospital EMS plays a vital role in medical Health system (3), in transporting patient to the closest hospital (4). The aim of Prehospital EMS is to provide proper treatment in three right place and time by employing the available reources (5). Its services begins with the medical care and end in emergency Department of hospital (6) (7). The main duty of prehospital EMS is to handle emergency medical cases, which if not treated on time, they would have irrecoverable physical and mental consequences for patients and casualties. Every year over 50 million people worldwide are injured and 2.1 million are killed in traffic accidents (2). Moreover, cardiac arrest is one of the most prevalent fatality causes in the world (8), claiming near 17 million soul (3). Among them, more than 50% die because of cardiac and respiratory arrest without being resuscitated (9). The index of successful cardiopulmonary resuscitation in the best emergencies worldwide is between 10% and 15%, while for Iran reports shows the average of 5% to 7% which can be greatly due to the EMS response time (10). One of the new means of connection between ambulances and Computer-aided dispatch (CAD) is Global Positioning System (GPS) (11), one of the most important and reliable systems in showing location in every moment and reporting it to the CAD to use, analysis and show it on the base map (12). Since May of 2010, all ambulances of Tehran Emergency 115 are equipped with GPS, and their information is reported via satellite to CAD. Equipping ambulances with GPS can result in saving time, reducing the possibility of Emergency Medical Technician's (EMT) offenses (1), and accurate monitoring of ambulances (13). Many factors can effect on the average time of ambulance response like: local traffic, the average distance travelled by ambulance, type of event, and the average number of calls (14). By searching on Pub Med, studies of Ota (2000) (15) and Gonzalez (2009) (16) prove the positive influence of GPS on the ambulance response time. In the present study, we compared the average time of ambulance response in 2009 (when ambulance were not equipped with GPS) and 2011 (when ambulance were equipped with GPS), to answer the question whether there is a causal relation between the effect of GPS in reducing the response time of ambulance or not.

Methods

The present study is retrospective descriptive, aiming at comparing the average time of ambulance response in 2009 (without GPS) to 2011 (with GPS). Considering 132 EMS station in Tehran, confidence level of 95%, standard deviation of 6 minutes (17) and margin of error of 1 minute, 24 stations was randomly calculated for sample size. Data related to the average time of ambulance response (1-96 (measured in seconds) and 10-97 (measured in minutes)) as well as the number of daily calls of each emergency centers over 365 days of 2009 and 2011were personally gathered from Tehran emergency information and communication center. According to the system of Tehran emergency 115, the time of 10-96 is calculated from the moment of mission report to the CAD to the moment of ambulance dispatch, and the time 10-97 is calculated from the moment of ambulance dispatch to the moment of ambulance presence at the event location (both times were recorded by technicians of CAD via wireless telephone). By converting the time data of 10-96 (measured in seconds) to minute and adding it to the time data of 10-97, the average time of ambulance response according to the number of calls was calculated for each centers which were categorized in three groups: group one: ten and less than ten calls, group two: ten to fifteen calls, group three: more than fifteen calls. The data were analyzed by SPSS 16 and the Paired t-test. ۰.۰۵ $\alpha=$ is determined the meaningfulness of the result.

Results

The results show that by comparing the year 2009 with 2011, in the first group (ten and less than ten calls) the average time of ambulance response had a meaningful increase from 11.25 to 11.58 (p<0.001). (Table 1)

Table 1: the comparison of new min measured in minutes (the total time of 10-96 (measured in seconds) converted to minutes, plus the time of 10-97 (measured in minutes)) for 24 emergency centers in years 2009 and 2011based on ten calls or less than ten calls.

Paired Samples Test					
	Mean	N	Std. Deviation	t	Sig. (2-tailed)
Pair 1 New min 90	11.5842	2875	3.86980	3.700	.001
New min88	11.2571	2875	3.05111		

By comparing years 2009 and 2011 for the second group (ten to fifteen calls), the average time of ambulance response had a meaningful decrease from 10.92 to 10.71 (p<0.001). (Table 2)

Table 2: the comparison of new min measured in minutes (the total time of 10-96 (measured in seconds) converted to minutes, plus the time of 10-97 (measured in minutes)) for 24 emergency centers in years 2009 and 2011based on ten to fifteen calls.

Paired Samples Test					
	Mean	**N**	**Std. Deviation**	**t**	**Sig. (2-tailed)**
New min 90 Pair2	10.7117	3633	2.98899	-3.474	.001
New min 88	10.9240	3633	2.70925		

The comparison between year 2009 and 2011 for the third group (more than fifteen calls) evinced that the average time of ambulance response had a meaningful decrease from 10.11 to 9.86 (p<0.001). (Table 3)

Table 3: the comparison of new min measured in minutes (the total time of 10-96 (measured in seconds) converted to minutes, plus the time of 10-97 (measured in minutes)) for 24 emergency centers in years 2009 and 2011based on more than fifteen calls.

Paired Samples Test					
	Mean	**N**	**Std. Deviation**	**t**	**Sig. (2-tailed**
New min 90 Pair 1	9.8649	2188	2.15705	-4.199	.000
New min 88	10.1153	2188	2.29002		

Conclusions: response time is a main factor in reducing the irrecoverable injuries in emergency accidents and illnesses, in which employing new technologies can be considerable effective. Our study accords with the study of Ota (2000), in which using GPS and display map in ambulance can effectively reduce both the response time and the travelled distance (15). The GPS system employed in Tehran prehospital emergency is only used for monitoring ambulances, while other services of GPS like: the guiding system, and equipping ambulances with a display monitor for showing the

nearest and most appropriate rout for reaching to the event location, can reduce the time and other expenses in medical services and improving the quality of EMS. In line with our findings, Pelege and his colleagues indicates that using Geographic Information System (GIS) for making models of the ambulance location, can reduce response time, though such project demands many infrastructures (17).Additionally, Gonzalez's study (2009) (16) illustrates that using GPS in suburban missions can positively effects response time. Since in suburban mission we have lighter traffic and longer distance, and in contrast to city where traffic is considered as the main factor, focusing on the factor of distance seems logical. Apart from these issues, since in Tehran emergency each centers has a defined territory, and only in the event that adjacent centers were on mission they would go out of their territory and in this way they should travel longer distances, hence the response time would increase. This problem is also evident in the present study, where the use of GPS is more effective when the number of missions is more than ten. It is possible that before installation of GPS, technicians for the fear of proceeding controls had reported an early time of dispatch than the real one, the issue which may have been reduced after the installation of GPS. Therefore, the meaningful reduce in our study can be due to the use of GPS or reduce in the number of spurious reports of dispatch time. This issue can be investigated in the following study.

We have been restricted in our study The research team couldn't find a criteria for considering traffic load and volume for including that in the, the shortcoming which can be obviated in the following studies. Other shortcomings like: the increase of city population, (different distances between technician's locations from ambulances, some cases of GPS connection failure, the difference between EMS stations with one ambulance and the EMS stations with two ambulance.

This study showed that applying GPS in the ambulances may reduce the response time especially in the stations with more average mission numbers GPS in Iran is used only for monitoring, applying other services of GPS like road map, showing closest rout with lighter traffic, and identifying closest ambulance to the event location and its dispatching, can positively demonstrate the use of GPS.

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