Improved Response Times with Motorcycle Based Fast Response Paramedics in an Urban Setting*

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ABSTRACT

Background. Pre-hospital response times are an important factor affecting patient outcomes, especially in pre-hospital cardiac arrest. In big cities, response times are known to be long due to traffic and accessibility problems. This study aimed to see if response times could be improved with the use of motorcycle-based Fast Response Paramedics (FRPs) compared to standard ambulances in an urban setting.

Methods. A prospective, observational study was carried out. Motorcycle-based FRPs and standard ambulances were simultaneously dispatched for consecutive cases. Event timings were recorded by the central computer system and retrieved for this study.

Results. Twenty-four FRPs and 24 ambulance runs were recorded. The locations involved were homes (41.7%), workplace (29.2%), road accidents (20.8%) and others (8.3%). Ambulances took on average 4.96 minutes longer than motorcycles to respond ($p<0.001$, 95% CI 2.61 to 7.31). Adjusting (via multiple regression) for the day of the week, location, station, traffic and case, ambulances took on the average 4.71 minutes ($p<0.001$, 95% CI 2.45 to 6.98) longer to respond. Improvements in response times were greater when overall response times were longer (weekdays, residential/office location, moderate or heavy traffic).

Conclusion. The use of motorcycle-based paramedics allowed faster response times and earlier intervention, especially for early defibrillation in cardiac arrest. Larger follow-up studies are being planned to assess the impact of the implementation of more FRPs on mortality and morbidity.

Keywords: motorcycle, paramedics, pre-hospital cardiac arrest, response times, survival

INTRODUCTION

Pre-hospital response times are an important factor affecting patient outcomes in any Emergency Medical Services (EMS) System, especially for pre-hospital cardiac arrest.[1] In the chain of survival concept, provision of early access, early cardio-pulmonary resuscitation (CPR), early defibrillation and early advanced care will improve survival in sudden cardiac arrest.[2] Chances of survival are thought to decline by 7 to 10% with every passing minute after a collapse occurs.[2]

Survival rates for pre-hospital cardiac arrest vary in published reports from 2 to over 20%.[3] Faster response times have been shown to lead to earlier CPR, earlier defibrillation and earlier advanced care, resulting in improved survival.[3]

In big cities, response times are known to be long, owing to traffic and accessibility problems. Traffic congestion, especially during rush hours, high-rise buildings and limited lift access can delay response times significantly. This results in correspondingly lower survival rates.[4]

Of the approximately 15 000 deaths that occur in Singapore every year, about 25% will be from a cardiac

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cause, of which some 12 to 16% will occur suddenly, outside of a hospital.[5] The mechanism of death is usually a fatal dysrhythmia, most often ventricular tachycardia or fibrillation.[6] Similarly, in the USA, 300 000 people die every year from sudden cardiac arrest, which constitutes about one-third of all cardiovascular deaths.[7]

In Singapore, the Singapore Civil Defence Force (SCDF) operates the public Emergency Ambulance Service. At the time of this study, there were 27 ambulances running, based in 14 fire stations and 1 satellite station. These emergency ambulances are manned by paramedics trained in basic cardiac life support (BCLS) and are equipped with automated external defibrillators (AED). An earlier study conducted in Singapore reported that it took an average of 11.40±4.88 minutes for an ambulance team to reach a patient.[8]

We conducted a prospective case-controlled observational study to see if response times could be improved with the use of motorcycle-based FRPs compared to standard ambulances in an urban setting.

METHODS

This study was conducted from July to September 2001. Paramedics for prospective ambulance calls in which both an FRP and a standard ambulance were dispatched recorded the relevant data using standardised forms. Centralised dispatch timing and information was also recorded using standard forms.

Both vehicles were based at the same fire station. When a "995" call that was received met the activation criteria, both vehicles were simultaneously dispatched. However, if one vehicle was already out on a call or unavailable, a vehicle from the next nearest station to the scene would be dispatched. This applied to both ambulance and FRP.

Response time was defined as the time from when the call was received by the "995" dispatcher to the time the vehicle arrived at the scene (time the vehicle engine was turned off). This was in accordance to the Utstein style of reporting.[9] All timings were synchronised to the emergency dispatcher's computer-based clock. This centrally-based computer system automatically records the time a member of the public calls "995". Subsequent timings are also automatically logged in, including the time the dispatcher activates an ambulance and the time the ambulance leaves the fire station. Paramedics are required to report via radio the moment the vehicle arrives at the scene (time the vehicle engine was turned off). This is then logged in to the central computer system according to the central clock. These timings were retrieved subsequently for the study and recorded to the nearest minute. Centralised recording of timings was chosen to ensure standardisation and consistency for all ambulance runs.

Table 1. Descriptive data.

Type of Cases	n (%)
Trauma	13 (54.2%)
Cardiac	2 (8.3%)
Respiratory	6 (25.0%)
Cardiac Arrest	2 (8.3%)
Others	1 (4.2%)
Location of Call	n (%)
Road accidents	5 (20.8%)
Home	10 (41.7%)
Work	7 (29.2%)
Others	2 (8.3%)
Day of Call	
Weekday	21 (87.5%)
Weekend	3 (12.5%)
Calls by Time of Day	
Morning (0700–1000h)	5 (20.8%)
Lunch (1000–1300h)	4 (16.7%)
Afternoon (1300–1600h)	5 (20.8%)
Evening (1600–1900h)	5 (20.8%)
Night (1900–2200h)	5 (20.8%)

Other data recorded included date, time of day, location at which the patient was found, the type of case attended (chief complaint) and whether traffic was light, moderate or heavy. The attending paramedic subjectively recorded traffic conditions according to the following definitions: light traffic was defined as minimal vehicles on the road with smooth traffic flow; moderate was defined as smooth traffic flow despite a large number of commuters; and heavy traffic was defined as road congestion leading to significant traffic delays.

FRPs are fully trained paramedics who have to undergo additional training in defensive riding before being allowed to operate. They operate alone (1-man crew) and are equipped with basic life support equipment including bag-valve-mask device, intravenous fluids, a trauma bag and an AED. They work in 2 shifts from 0700–1500h and 1400–2200h. No motorcycles are dispatched after 2200h and in wet weather. During the study period, FRPs were only dispatched for cases of cardiac arrest, chest complaints including chest pain, breathing difficulties or motor vehicle collisions.

Data was entered into Excel 97 (Microsoft Inc, Redmond) and all analyses were carried out using SPSS version 10.0. The mean difference in response time between subgroups was assessed by t test or ANOVA

Table 2. Response times (all runs) (mins).

	Mean±sd	Range	Median	p-value
Type of Vehicle				
FRP	5.5±2.0	3.0–11.0	5.0	p<0.001
Ambulance	10.4±5.4	4.0–27.0	9.5	(Mann Whitney U test)
Time of Day				
Morning (0700-1000h)	8.7±5.8	3.0–21.0	5.5	
Lunch (1000-1300h)	7.12±3.1	4.0–13.0	6.0	
Afternoon (1300-1600h)	6.2±3.6	3.0–14.0	5.0	p=0.458
Evening (1600-1900h)	8.1±3.7	4.0–14.0	8.0	(Kruskal Wallis Test)
Night (1900-2200h)	9.4±6.4	5.0–27.0	7.5	
Time of week				
Weekday	8.2±4.8	3.0–27.0	7.0	p=0.133
Weekend	6.0±4.0	3.0–14.0	4.5	(Mann Whitney U test)
Location of call				
Road accident	6.8±3.1	3.0–14.0	6.0	
Home	8.8±5.6	3.0–27.0	7.5	p=0.205
Work	8.6±4.7	4.0–21.0	6.5	(Kruskal Wallis test)
Others	4.5±1.0	3.0–5.0	5.0	
Traffic conditions				
Light	6.4±3.4	3.0–10.0	5.0	p=0.155
Moderate	7.9±5.0	3.0–27.0	6.0	(Kruskal Wallis test)
Heavy	10.0±3.3	7.0–14.0	9.0	
Station				
Same	7.8±4.8	3.0–27.0	6.0	p=0.471
Different	8.8±4.2	4.0–14.0	8.0	(Mann Whitney U test)

if the normality assumption was satisfied otherwise Mann Whitney U or Kruskal Wallis tests were applied. A multiple regression analysis was also performed to take into account all relevant factors affecting the response time between ambulances and FRPs.

RESULTS

Twenty-four FRPs and 24 ambulance runs were recorded (24 calls for a total of 48 runs). For 20 patients, the FRP and ambulance were dispatched from the same station. For 4 patients, the ambulance at the station was unavailable and another was dispatched from the next nearest station. The locations involved were homes (41.7%), workplace (29.2%), road accidents (20.8%) and others (8.3%). The type of cases attended to, day and time of day of calls are shown in Table 1.

Response times in minutes for the various subgroups are shown in Table 2. The median response times were 7.0 mins on a weekday and 4.5 mins on a weekend (p=0.133). The calls were about evenly distributed throughout the day, with median response times tending to be longer at lunch time (6.0 mins), in the evenings (8.0 mins) and at night (7.5 mins), compared to those for mornings (5.5 mins) and afternoons (5.0 mins) (p=0.458).

Median response times according to location of call were 6.0 mins (road accidents), 7.5 mins (homes), 6.5 mins (workplace) and 5.0 mins (others: usually public places) (p=0.205). Median response times according to traffic conditions were 5.0 mins in light traffic, 6.0 mins in moderate traffic and 9.0 mins in heavy traffic (p=0.155).

A simple linear regression with response times as dependant and vehicle as independent revealed that ambulances took on average 4.96 mins longer than motorcycles to respond to calls (p<0.001, 95% CI 2.61 to 7.31). Adjusting for the day of the week (weekday vs weekend), location of call (home and workplace vs public place (road and others)), from which station the vehicle was dispatched (same vs different) and traffic conditions (heavy vs moderate and light), the adjusted difference value of 4.85 (p<0.001, 95% CI 2.58 to 7.13) minutes did not vary much from the unadjusted difference value. There was also a significant difference in response time between home/office location and public place, which were 2.74 (95% CI 0.06 to 5.41, p=0.045) minutes faster.

Sub-analysis of response times by vehicle types and the difference in response times are shown in Table 3. FRPs responded significantly faster than ambulances during weekdays, in residential/office cases and in

Table 3. Response times by vehicle type (mins).

		Ambulance	FRP	Difference in response time	p-value*
Time of week					
Weekday	Mean±sd	10.8±5.4	5.7±2.0	5.1	
(n=21)	Range	4.0–27.0	3–11		p<0.001
	Median	10.0	6.0	4.0	
Weekend	Mean±sd	8.0±5.3	4.0±1.0	4.0	
(n=3)	Range	4.0–14.0	3.0–5.0		p=0.2
	Median	6.0	4.0	2.0	
Station					
Same	Mean±sd	10.0±5.8	5.6±2.1	4.4	
(n=20)	Range	4.0–27.0	3.0–11.0		p=0.001
	Median	8.5	5.0	3.5	
Different	Mean±sd	12.5±1.7	5.0±1.2	7.5	
(n=4)	Range	10.0–14.0	4.0–6.0		p=0.029
	Median	13.0	5.0	8.0	
Location of call					
Home/work	Mean±sd	7.3±3.5	5.0±1.5	2.3	
(n=7)	Range	4.0–14.0	3.0–7.0		p=0.259
	Median	6.0	5.0	1.0	
Road/others	Mean±sd	11.7±5.5	5.6±2.2	6.1	
(n=17)	Range	4.0–27.0	3.0–11.0		p<0.001
	Median	11.0	5.0	6.0	
Traffic conditions					
Light	Mean±sd	7.0±4.2	6.0±3.6	1.0	
(n=3)	Range	4.0–10.0	3.0–10.0		p=0.8
	Median	7.0	5.0	2.0	
Moderate	Mean±sd	10.5±5.8	5.2±1.8	5.3	
(n=19)	Range	4.0–27.0	3.0–11.0		p<0.001
	Median	9.0	5.0	4.0	
Heavy	Mean±sd	12.0±2.6	7.0±0.0	5.0	
(n=2)	Range	9.0–14.0	7.0–7.0		p=0.2
	Median	13.0	7.0	6.0	

* Mann Whitney U test

moderate traffic. The non-significance for the rest of the sub-groups was due to small sample sizes. Improvements in response times were greater when overall response times were longer (weekdays, residential/office location, moderate or heavy traffic).

DISCUSSION

Our study showed that motorcycle-based FRPs can significantly reduce EMS response times by an average of almost 5 minutes. This can be critical in a cardiac arrest.[2] This improvement in response time was independent of traffic conditions, location of call, day of the week or from which station the vehicle was dispatched. Improvements in response times were greater when overall response intervals were longer, such as on weekdays, in moderate or heavy traffic and incidents in residential/office locations.

In a Scottish study, Pell *et al* calculated that a reduction in target response to 90% of calls from 14 minutes to 8 minutes would increase cardiac arrest survival from 6 to 8% and a response of 5 minutes would increase survival by up to 11%.[1]

Faster response times mean earlier initiation of CPR and earlier defibrillation. Survival after pre-hospital cardiac arrest has been shown to be determined mainly by time from onset of ventricular fibrillation to electrical defibrillation.[10] The advent of the AED allows paramedical and even laypersons to perform defibrillation safely, making pre-hospital and public access defibrillation feasible.[11,12] Survival rates of 74% have been reported where defibrillation has been performed within 3 minutes from collapse.[13] Likewise, early initiation of CPR has been shown to improve survival.[14]

Survival to hospital discharge from pre-hospital cardiac arrest has been reported as 3.5% in a study at one Singapore hospital.[15] The published national figure in 1999 was 2.65%.[16] This is comparable to figures reported in other large cities such as Hong Kong (1.25%), Chicago (2%) and New York (1.4%).[4,17,18] It is known that large cities tend to have lower survival rates for cardiac arrest.[4] This is thought to be related to prolonged response times due to problems of traffic congestion and high rise buildings.

The improvement in response times seen in our study was most likely due to the ability of motorcycles to negotiate congested traffic conditions better. Motorcycle- based nurses in Taiwan who responded to EMS calls were able to reduce response times by an average of 4 minutes.[19] However, they were carrying trauma kits and not defibrillators.

Before the advent of FRPs, motorcycle-based Fast Response Medics (Emergency Medical Technicians) had been deployed for road traffic accidents since 1992. This has evolved to the current FRP concept, which has been in use since December 2001. At the time of this study, there were 6 motorcycles based in 6 fire stations. Other advantages of FRPs include the ability of FRPs to provide early scene survey, control of the scene and directing the ambulance, especially at motor vehicle collisions. This is important if the police have yet to arrive at scene, and there is potential danger not only to victims but also on-lookers and arriving emergency crews. The presence of an additional trained paramedic at the scene, especially for cardiac arrests, is certainly useful. Standard ambulances currently have a crew of 3, a paramedic, an ambulance attendant with minimal medical training and a driver. We see the FRPs playing a first responder role in calls that possibly require advanced life support. There are also plans to open more satellite fire stations and position FRPs in each of these in an attempt to reduce response times further.

The limitations of FRPs include their limited crew number, amount of equipment that can be carried and inability to transport patients. Safety issues are also important. Currently, FRPs are not allowed to be deployed in wet weather, and from 2200–0700h, and must observe speed limits and traffic lights at all times. They are only deployed for specific indications including cardiac arrest, chest pains, breathing difficulties and motor vehicle collisions where traffic congestion is expected. Trained paramedics are a limited resource and optimal deployment of FRPs needs to be carefully considered.

A larger follow-up study is currently being conducted to assess the impact of deploying more FRPs on patient outcomes in pre-hospital cardiac arrest. This phase 2 study will compare outcomes with and without FRP response using randomisation by geographical location. It has a planned sample size of 1 000 cardiac arrest cases and will also measure intervals from time of call to time at the patient's side, time to defibrillation and initiation of CPR. These will more accurately predict patient outcomes than the traditional response times measured in this study. It will also follow-up on the rates of return of spontaneous circulation, survival to hospital admission and survival to discharge. This study will determine whether improved response times by using FRPs will also improve patient outcomes in pre-hospital cardiac arrest.

CONCLUSION

The use of motorcycle-based paramedics allows for faster response times and earlier intervention, especially for early defibrillation in cardiac arrest. A larger follow-up study is currently being conducted to assess the impact of implementation of more FRPs on mortality and morbidity.

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