Emergency versus standard response: time efficacy of London's Air Ambulance rapid response vehicle

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ABSTRACT

Objective The potential increased risk of an emergency response using a rapid response vehicle (RRV) should only be accepted when it allows a clinically significant time saving for management of patients who are critically injured or sick. Air ambulance services often use an RRV to maintain operational resilience. We compared the RRV response time on emergency versus standard driving to inform emergency services of time efficacy of emergency response in an urban environment.

Methods Prospective observational controlled study of response data of emergency and standard driving. An identical RRV shadowed the medical team until the team was dispatched to a job (emergency driving). The shadow RRV then drove to the same given location from the same origin location in equal traffic conditions being compliant with all traffic signals, road signs and speed limits (standard driving).

Results The emergency response resulted in an estimated reduction in median response time of 14 min (95% CI 9 to 19) which represented a time saving of 54.9%. The estimated difference in distance travelled (0.6 km) was not statistically significant. Median speed was significantly higher when using an emergency response (46.1 IQR 39–53.4 km/hour) versus standard response (20.1 IQR 16.3–24.7 km/hour), with an estimated difference of −24.5 km/hour (95% CI −28.8 to −20.5).

Conclusions The current study found RRVs to be significantly quicker when responding with lights, sirens and traffic rule exemptions compared with a response being compliant with all traffic signals, road signs and speed limits.

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Key messages

What is already known on this subject?

- Emergency medical vehicle collisions are an inherent risk for healthcare providers, patients and other road users.
- Whether the benefits of an improved clinical response time are justified by the potential increased risks of an emergency road response is controversial.

What this study adds

- The London's Air Ambulance rapid response vehicle is significantly quicker when responding with warning lights, sirens and traffic rule exemptions compared with a response being compliant with all traffic signals, road signs and speed limits.
- An emergency response represents a time saving of 54.9% that is likely to be clinically significant for the patients with major trauma attended by London's Air Ambulance.

INTRODUCTION

A safe and timely emergency medical service (EMS) response to patients with time-dependant conditions is imperative to reduce mortality and morbidity. Although an emergency response using warning lights, sirens and road traffic rule exemptions is generally quicker, the additional potential risk is of concern for EMS personnel, passengers and other road users. Whether the benefits of an improved clinical response time are justified by the potential increased risks of an emergency road response is controversial.[1–8] Many air ambulance services use rapid response vehicles (RRV) as a supplement to aircraft to maintain resilience when weather, light and technical issues prohibit flying.[9 10] Many services also use the RRV for incidents close to their operating bases where responding by car is faster than by air.

We conducted a prospective observational controlled study comparing response time for RRVs on emergency versus standard driving to inform emergency services of time efficacy of emergency response in an urban environment.

METHODS

Study setting

London's Air Ambulance is a doctor-paramedic prehospital trauma service covering an urban area of approximately 5000 km^2 with a population of approximately 8.5 million people.[11] A flight paramedic working in the emergency operations centre (EOC) dispatches the doctor-paramedic team using a helicopter during daytime and Skoda Octavia vRS Estate RRVs at night, in the proximal footprint of the helipad where a response by car is assumed quicker than using the aircraft or whenever the aircraft is unavailable.[12] Doctors are experienced anaesthetists or emergency physicians with prehospital clinical training. In addition, the doctors undergo a standardised navigation training programme focusing on navigation equipment, routes, communication and road safety. Flight paramedics are experienced London's Ambulance Service staff with additional prehospital clinical and driving training. The average speed in London for normal traffic is low even at night due to the heavily congested urban traffic environment. To maximise time efficacy, the flight paramedic drives using warning lights and sirens while the doctor uses a satellite navigation system, the London A-Z map book and moving map to navigate to the scene. All navigation aids are concealed from the paramedic driver to ensure focus on driving. The doctor calls out directions using standardised phrases for navigational command. London's Air Ambulance has an internal training programme managed by a dedicated driving instructor to prepare the team for efficient and safe emergency driving.[10]

Study design

We conducted a prospective observational controlled study. The driving instructor shadowed the medical team alone in an identical RRV until the team was dispatched to a job. The team then set off with the doctor navigating towards the given location. The paramedic applied emergency driving tactics using warning lights, sirens and emergency exemptions from traffic regulations ('emergency response'). The shadow RRV also drove to the same given location from the same origin location in equal traffic conditions being compliant with all traffic signals, road signs and speed limits. Sirens and warning lights were not used and satellite navigation with automatic voice navigational commands was applied ('standard response'). Given that emergency exemptions from traffic regulations were unavailable for the standard response, the two RRVs potentially followed different routes to scene. Geographical data (postcodes), dispatch and response times were synchronised with the EOC dispatch system and were calculated using 'mobile to scene' (wheels running) and 'arrive to scene' (wheels stopped) intervals (min). Distances (km) were calculated from vehicle trip counters. Responses to complex road traffic collisions causing significant static traffic were excluded. In these incidents, access routes to the scene are completely blocked by vehicles and a response by foot would probably be quicker for the standard response RRV not having emergency exemptions from traffic regulations. In cases where the emergency response RRVs were cancelled by dispatch en route, the location of the RRV at the time of cancellation was considered the destination for the run. Average speed during response was derived by dividing the total distance (km) with response times (min).

Data were collected in the 8-month period from May to December 2016 during various hours of the evening, night and days of the week, and entered in Excel spreadsheets V.14.4 (©Microsoft, USA).

Statistical analysis

Data are presented as numbers, range, median with IQR or estimated differences with 95% CIs. Comparison of groups of continuous variables was analysed using the Wilcoxon signed-rank test. Statistical significance was assumed for $p<0.05$. Data were analysed using STATA/SE V.11.2 (StataCorp) and R V.3.3.1 (R Foundation for Statistical Computing, Austria).

Ethics

The London's Air Ambulance research and development committee considered the project protocol. It met local criteria for, and was registered as, a hospital service evaluation project (ID 7116). No additional interventions were carried out and the study recorded only normal practice with a view to service improvement. Ethical approval was therefore not sought.

RESULTS

During the study period, a total of 41 responses were timed, of which one was excluded due to static traffic caused by a road traffic collision, leaving 40 responses for the analyses. Among the included responses, 25 (62.5%) were conducted on weekdays and 15 (37.5%) on weekends. We included 16 (40%) responses where the units were stood down en route to a job. The units were mobile to scene between 18:50 and 05:45 (range). The team responded to 19 (47.5%) assaults, 10 (25%) road traffic collisions, 9 (22.5%) falls, 1 (2.5%) underground incident and 1 (2.5%) hanging. Table 1 depicts operational comparisons of response times, distances and speed between emergency and standard responses. The estimated reduction in response time of 14 min (95% CI 9 to 19) with an emergency response represents a clinically and statistically significant time saving of 54.9%. The estimated distance was 0.6 km greater for standard response, which was not statistically significant. Median speed for the emergency response was 46.1 km/hour vs 20.1 km/hour for standard response, estimated difference −24.5 km/hour, 95% CI for difference −28.8 to −20.5 km/hour. Figure 1 depicts operational comparisons of response times, distances and speed between standard and emergency responses.

DISCUSSION

We found London's Air Ambulance RRVs to be significantly quicker when responding with warning lights, sirens and traffic rule exemptions compared with a response being compliant with all traffic signals, road signs and speed limits. The distances covered by the response vehicles were similar, but speed was significantly higher when using an emergency response. The estimated reduction in response time of 14 min with an emergency response represents a significant time saving of 54.9% that is likely to be clinically significant for the patients with major trauma attended by London's Air Ambulance.

Risk of an emergency response

Emergency driving is a privilege granted to the emergency services that may compromise public safety. The time saved using an emergency response should have a significant effect on outcome for patients who are severely injured. Ho and Casey performed a prospective controlled analysis of emergency responses in a metropolitan area in Minneapolis, USA. They found the average

Table 1 Operational comparison. Standard and emergency responses

	Standard response		Emergency response		Difference		
	Median	**IQR**	**Median**	**IQR**	**Estimate**	**95% CI**	**p Value***
Response time (min)	25.5	17–34	10.5	6.5–15	14	9 to 19	<0.001
Distance (km)	8.2	5.1–12	7.9	4.8–11.5	0.6	−1.8 to 2.9	0.613
Speed (km/hour)	20.1	16.3–24.7	46.1	39–53.4	−24.5	−28.8 to −20.5	<0.001

*Wilcoxon signed-rank test.

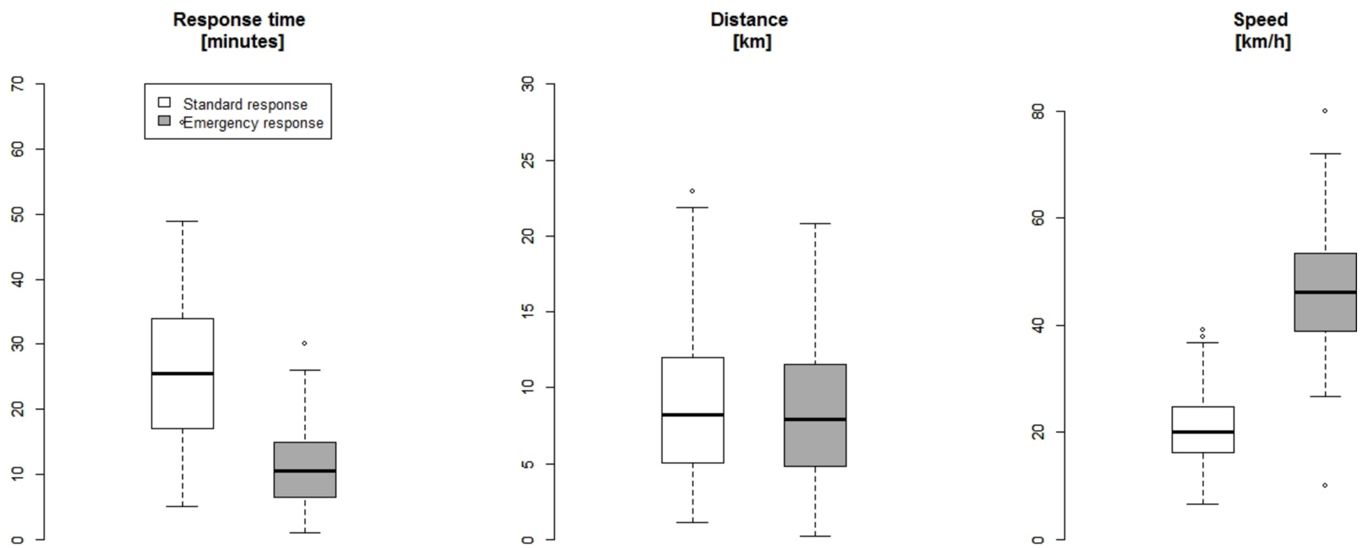

Figure 1 Operational comparison. Standard and emergency responses. Box plots depict medians and IQR; whiskers represent 10th and 90th percentiles.

emergency and standard response intervals to be 4.5 and 7.5 min, respectively. There was an average of 3 min saved when driving on warning lights.[4] The same authors conducted a similar study some 3 years later and found an average 3.6 min saved, representing a significant time saving of 30.9%.[5]

Several emergency response studies describe risk patterns for EMS personnel, passengers and other road users. A North American analysis of occupational fatalities among EMS personnel found at least 67 ground transportation-related deaths, including EMS personnel struck by moving vehicles. The all-cause occupational fatality rate for EMS workers found in this analysis exceeded that of the general population and was comparable to other emergency services.[13] A similar analysis of fatal ambulance crash characteristics reported to the North American Fatality Analysis Reporting System database found that most crashes and fatalities occurred during an emergency response and at intersections. Unrestrained rear occupants were most at risk for severe injuries.[14] Becker *et al* analysed data from two large national North American databases and found that ambulances at a non-emergency response had greater risk of injury and death if involved in a crash. They questioned whether sirens and warning lights might protect EMS personnel through their warning functions, highlighting the need for more research into emergency response patterns.[15] Weiss *et al* analysed North American EMS data and found that the rate of ambulance injuries was greater in urban settings; whereas injuries were more severe in rural settings where collisions occurred at higher speeds.[16]

Mitigating risk to ensure clinically significant response

Given the potential increased risk during an emergency response, London's Air Ambulance has instigated strategies to mitigate hazards and improve safety. The London's Air Ambulance RRV concept involves car design, coupe ergonomics, special driving tactics and navigation strategies. This study does not isolate which of these factors contribute the most to the improved time efficacy of an emergency response, but acknowledge the possibility that these factors synergistically may improve response efficacy, while maintaining safe operations. Moreover, it argues that translating lessons from aviation and motor sports enables safe and time-efficient practice.[10] Emergency response using warning lights, sirens and road traffic rule exemptions should only be applied in cases where the condition of the patient is assumed critical and time saved by emergency response may influence outcome.[6] London's Air Ambulance has instigated a system where flight paramedics are manning the EOC and systematically seek to identify serious injury, aiming for accurate dispatch while avoiding unnecessary activations thereby reducing exposure to the risk of an emergency response.[12] In systems with more heterogeneous case mix, protocols for tiered dispatch may ensure that emergency responses are only applied to those with assumed high severity of their condition. Such protocols may reduce unwarranted use of warning lights and sirens.[17]

London's Air Ambulance only responds to trauma and historically the injury severity of the attended cases is very high.[18 19] The current study found time saved using warning lights, sirens and road traffic rule exemptions to be significantly faster than standard driving, carrying a potentially significant clinical impact for the London's Air Ambulance patient cohort.

Limitations

The present study observes one urban service and as such has several limitations. The selection of shifts was not formally randomised, but based on driving instructor availability. Given the 8-month study period and spread of days of the week, we consider the lack of randomisation not to introduce any significant selection bias. Local factors such as geography, demography, street architecture and traffic patterns influence response times. The current study investigated relatively short responses in an urban environment with frequent traffic stop signs, traffic lights and intersections. This may potentially reduce transportability to more rural services with longer responses where traffic obstructions may influence the difference in response times to a lesser degree. An emergency response analysis conducted in Sweden found a mean time saved of 2.9 and 8.9 min in urban and rural areas, respectively.[7] This indicates that the presented time efficacy of an emergency response might be even larger in rural areas. Future studies could investigate response patterns in urban and rural areas to identify impact of an emergency response on response time efficacy.

All responses occurred during evening or night, echoing the main operational hours for this RRV. No journeys were conducted during peak traffic hours, arguing for further studies of daytime emergency response efficacy. Although the vehicles were identical and the runs were started simultaneously, the emergency and standard responses were not completely matched. Navigation was automatically provided by satellite navigation with automatic voice commands to identify the optimal legal route for the standard response, compared with an emergency response having a dedicated navigator using multisource navigational aids. The emergency and standard response cars used different routes to scene due to the possibility to exempt traffic regulations for the emergency response RRV to avoid static traffic, construction work, bridge lifts, and so on. Lastly, we did not quantify the time critical in-hospital interventions that could not be performed in the prehospital setting and whether these interventions were performed in the average time saved through the emergency response. We only assumed potential improved outcome through reduced response time.

CONCLUSION

The potential increased risk of an emergency response should only be accepted when it allows a clinically significant time saving for patients who are critically injured or sick. The current study found London's Air Ambulance RRVs to be significantly quicker when responding with warning lights, sirens and traffic rule exemptions compared with a response being compliant with all traffic signals, road signs and speed limits.

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Competing interests None declared.

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