Emergency medical service response and mission times in an African metropolitan setting

Wynand van der Net[1,*], Craig Vincent-Lambert[1], Kevin Govender[2]

[1]Department of Emergency Medical Care, University of Johannesburg
[2]Department of Emergency Medical Care & Rescue, Durban University of Technology

[*]Corresponding author: wynandvdn@gmail.com, 57 West Park Drive, Montgomery Park, Johannesburg, 2195

ARTICLE INFORMATION

Received: 17 May 2023
Revision received: 18 August 2023
Accepted: 13 September 2023

Keywords:
keywords

ISSN:2709-3786

ABSTRACT

Background: Emergency Medical Services (EMS) aim to respond to emergencies, treat and transport patients efficiently thus ensuring the ambulance call or "mission" is completed with ambulances available to service the next call as soon as possible. A typical mission may be divided into activities, each linked to a set time interval. The response time interval starts from the time a call is received by the call centre until the ambulance arrives on scene. The patient care interval includes the time taken to treat and transport the patient to hospital. The total mission time can be viewed as the time from when a call is first received by the call centre until the ambulance dispatched to that incident is again available to service the next call. The aim of this study was to describe response interval, patient care interval and total mission times routinely associated with servicing emergency incidents within a metropolitan public sector EMS in South Africa.
Methods: A quantitative, prospective, descriptive design was followed wherein time intervals associated with 784 missions were analysed to document and describe response time interval, patient care interval and total mission times.
Results: On average crews took 0h 23:16 to respond to incidents before spending an additional 0h 43:20 treating and transporting their patients. Lengthy delays were noted between arrival at hospital and crews booking available for the next call. This led to total mission times averaging 2h 11:00.
Conclusion: Average response and patient care time intervals noted in our study were longer than national and international norms and standards. Delays between arrival at hospital and crews booking available to service the next call led to average mission times of over 2 hours. This negatively impacts on availability of ambulances. Further studies are recommended to explore factors that may be contributing to the lengthy response and mission times reported in this study.

Van der Net W, Vincent-Lambert C, Govender K. Emergency medical service response and mission times in an African metropolitan setting. South African Journal of Pre-hospital Emergency Care. 2023; 4(1):7-12. doi:10.24213/4-1-5879

BACKGROUND

It is well documented that the primary role of the Emergency Medical Service (EMS) is to respond to an emergency by dispatching appropriate resources to the incident, providing medical care and transportation to a suitable medical facility/ hospital.[1–4] The time taken for emergency services to complete calls or missions is a commonly used measure of EMS efficiency. Authors have described the different activities and time intervals associated with an ambulance mission and rightfully position the patient as being at the centre of these activities, hence references to terms such as "The Patient Journey" (Figure 1).[5,6] According to a 2008 study conducted by Castren *et al*., delays during any time along "The Patient Journey" may have a negative impact on patient outcome.[5,7–9]

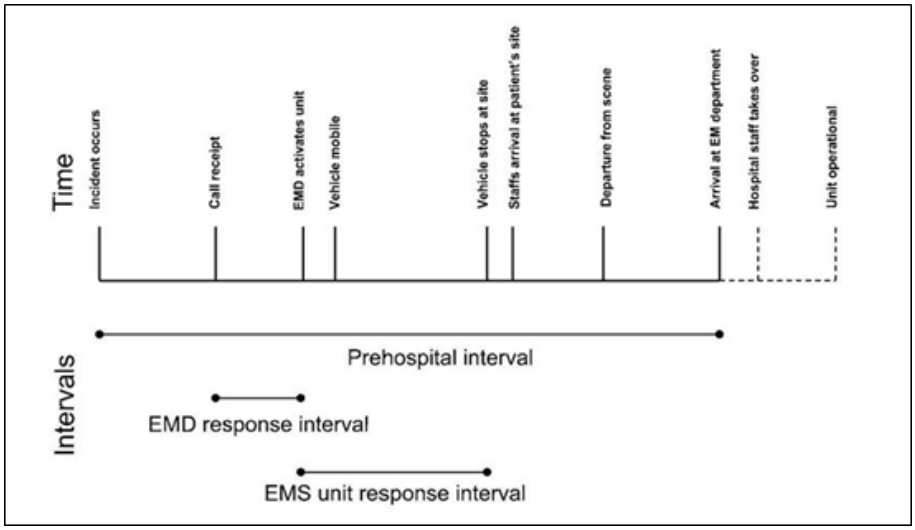

Figure 1: The Patient Journey[5]

In a South African EMS context, it is thought that several factors may result in a delay in EMS response times.[10–12] These factors include a lack of a single national EMS number, the scarcity of appropriate hospitals in many areas resulting in EMS vehicles (ambulances) having to drive large distances between ambulance bases, the scene of the emergency and hospitals. Furthermore, the lack of available resources (EMS vehicles and staff), the uneven distribution of resources and factors relating to on-scene incident command and control have also been found to play a role in EMS delays.[1,12–14]

Taking the above into account it is unsurprising that one of the most widely accepted criteria historically used for measuring EMS efficiency globally and in South Africa was that of response time, particularly to cases in which the patient's condition was thought to be life-threatening.[2,3,10,15] MacFarlane and Benn highlighted that in the injured patient there is a statistically significant increased risk of death with a pre-hospital time over an hour.[10] In a study conducted by Al-Shaqsi in 2010,[15] it was highlighted that "the ultimate goal of any Emergency Medical Service (EMS) is to improve the outcome of the patients," and this can be accomplished through the reduction in the overall patient journey time, i.e. by getting patients to a hospital in the shortest possible time.

Although several similar research studies have been conducted that describe various aspects of response-time intervals, the focus has normally been to either describe the dynamic placement of ambulances to reduce response times to scenes[1,11] or the reduction in response times through the addition of vehicles and resources.[16] Whilst dynamic placement of ambulances can assist in reducing mission times, in resource constrained settings there remain instances where all the ambulances are busy when an emergency call comes in. This means the call centre must wait for an ambulance to become available to service the call.

In Figure 1, Castrén *et al's* , "The Patient Journey" theoretically ends when the patient arrives at the hospital.[5] However, there is acknowledgment that the time taken for patient handover and the subsequent activities of the crew to return to operational readiness is also important.[17] It is well known that there are several processes involved in handing the patient over to the medical staff at the receiving hospital, and then making sure the ambulance is ready for the next call.[18,19]

Considering the above, it was noted that a typical

mission comprising of different activities, could be linked to a set of time intervals. The response time interval - starting from the time a call is received by the call centre until the ambulance arrives on scene. The patient care interval - the time taken to treat and transport the patient to hospital. The total mission time - the time from when a call is first received by the call centre until the ambulance dispatched to that incident is again available to service the next call. Limiting total mission times and identifying factors that may be contributing to increases in total mission times are important in settings where there are limited resources.

The aim of this descriptive study was to describe response interval, patient care interval and total mission times routinely associated with servicing emergency incidents within a metropolitan public sector EMS in South Africa

DESIGN & METHODS

A prospective, quantitative descriptive design which allowed for accurate documentation, analysis and description of predetermined response-time intervals contributing to the total mission times was used.

The study was conducted in the City of Johannesburg (CoJ), Gauteng; one of only eight metropolitan municipalities, covering an area of 1,645km^2 with a population of over 5.4-million inhabitants. Johannesburg is the largest and most densely populated city in South Africa.[20] At the time of the study the participating service was operating 70 ambulances and 6 primary response vehicles. In addition to the ambulance service the participating service was also operating a fire brigade and rescue service from the 30 fire stations within the metropolitan city.

The 12-hour operational shift structures within the service were from 07:00 to 19:00 and from 19:00 to 07:00, and this applied to the operational vehicles as well as the call centre staff. To access the EMS a member of the public makes a call to the EMS call centre where the call is answered by the first available call taker. During this time the call taker will ask a series of questions to determine the type and severity of the emergency, as well as the details of the location of the actual incident. The EMS service had no proprietary telephone triage system in place, rather incoming calls are screened based on the information provided by the caller, which requires the call taker to prioritise the call for dispatching. Priorities used are Priority 1 for life-threatening emergencies; Priority 2 for patients requiring urgent attention but not life-threatening emergencies; Priority 3 for non-urgent patients; and Priority 4 for those identified as having no breathing and no pulse.

Once the details are captured by the call taker, the call is transferred to the EMS dispatcher who will forward the details to the EMS crews who will respond to the incident location. Emergency vehicles within the service are dispatched based on the proximity of the closest fire station and vehicles allocated to the station.

The EMS call centre received around 16,000 emergency calls per month during the study with many of the incoming calls unrelated to the focus of the study. All incoming calls received by the EMS communications centre were screened by the call takers. Once the call taker identified the call was an emergency requiring EMS assistance, the call was included in the study and the predetermined time intervals documented. Within the constraints and limitations of the study, the target population was then a sample that was representative of the entire population.

A sample of 784 missions, over a one-month period were purposefully selected from different days of the week and times of the day therefore providing data from a range of calls that included both peak times as well as off-peak times, weekdays as well as weekends. Each mission was then analysed to document and describe the response interval, patient care interval and total mission times.

Having identified the need to document the response-time intervals to emergency calls and based on the time intervals required for the research study, the researchers developed a data collection tool that was used in the study. To determine the validity of the data capture tool, the data capture tool was used in a trial test before the actual study took place. The test consisted of following several calls and capturing the required information using the tool and then reflecting on whether the tool adequately captured the required data. This provided the researcher with confirmation that the tool was in fact a valid and reliable instrument, which produced the required data for the research study.

The time intervals described in this paper were informed by those mentioned by Castrèn *et al*. (Figure 1).[5] These time intervals included a response time interval, patient care interval and total mission time, described below:

- The response time interval was defined as "the time the first call is received by the call centre, until the responding ambulance arrives on scene".[5,6,21,22] The National EMS regulations[23] supports the fact that response

times are measured from the time an emergency call is received to the time the first emergency vehicle arrives on the scene. The Gauteng Provincial Government Department of Health has adopted the national norms for response times of 15 minutes to 90% of the emergency incidents in urban areas.[24]

- The patient care interval was taken to be the time interval from the ambulance crew's arrival at the scene of the emergency until they arrive at the receiving facility.[12,14,25]
- The total mission time was the total time taken for an emergency call being received by the call centre until the ambulance is again available to service the next emergency call.[5,6,13,16,26] Several factors may influence this time. These may include the response time, the time spent on scene stabilising the patient before transportation,[14] the distance to a medical facility that can manage the patient's condition,[12] the availability of the hospital staff to receive the handover which is influenced by how busy the receiving facility is at the time of the vehicle arriving at the receiving facility, the type of facility where the patient is being handed over or delivered, and the local protocols in place regarding the accepting of new patients into the facility.

Ethical Approval

Ethical clearance was obtained from the Durban University of Technology, Institutional Research Ethics Committee, with reference number: REC150/17.

RESULTS

Data was captured manually on a pre-approved data collection sheet, and on completion of each shift, the raw data was transferred to a Microsoft Excel© spreadsheet from which the results were reported on. Data was collected by following a single incoming call that met the criteria for inclusion in the study. The research team manually recorded the time taken to complete the activities for the time intervals (Table 1) from the time of the incoming call until the EMS vehicle is available for another call. Manually capturing the times ensured the validity of the data, while not interfering with the work of the EMS call-takers or dispatchers.

Table 1: Response time, patient care and total mission time intervals

Time	**Response Time Interval**	**Patient Care Interval**	**Total Mission Time**
Minimum Time	0h 04:20	0h 01:18	0h 36:00
Median Time	0h 23:16	0h 43:21	2h 11:00
Maximum Time	2h 48:55	4h 58:59	8h 41:00

DISCUSSION

The response time interval

The median response time interval of over 23 minutes is noted to be almost three[3] times the EMS response time of less than 8 minutes expected for a developed EMS service operating in a metropolitan area.[5] It is also more than the South African norms and standards for response to high priority emergency cases, which at the time of our study was 15 min.[16,26] More work needs to be done to explore the different factors that may be contributing to the response time interval noted in the study. Given the fact that the distance covered to incidents and between incidents and receiving facilities are not excessive in the urban setting where the study took place, notwithstanding delays due to traffic congestion, we suspect that reasons for lengthy response time intervals may be linked to inefficiency in the call centre. The instance where response time intervals are very long was linked to an increase in emergency call volumes where there were no ambulances available to service the call at the time the calls were received.

The patient care interval

There is much written about the virtues and evils of the "stay and play" vs the "load and go" approach to patient care in pre-hospital emergency care contexts.[14,25,27] In the South African context, a patient care interval, averaging just over 40 minutes may be seen by some as acceptable. This said, our study did not get into the granular detail of each case to determine if the time the crew spent with the patient was indeed medically warranted or excessive, thus we are unable to comment further on this aspect.

The total mission time

The study showed a median total mission time of more than 2 hours. This finding was unexpected given the urban metropolitan setting. The current research points to delayed ambulance availability

after arrival at hospital. In this regard it is acknowledged that several factors may influence the time taken to return the ambulance to a state of operational readiness. It is only once the patient has been handed over safely that the EMS crews can focus on making sure the vehicle is fully operational and available to attend to the next emergency incident. This requires the completion of all the necessary clinical records and documentation and (in the case of some hospitals) the need to provide the hospital staff with the necessary information to open a hospital admission file. Only once this is complete can the vehicle be cleaned and disinfected according to the local protocols and guidelines, and equipment replaced and restocked. Although these activities do not form part of "The Patient Journey", they do play a large part in the following emergency incident, as the vehicle is not available to attend to an emergency incident during this time, resulting in emergency incidents received by the central communications being delayed due to the unavailability of vehicles.

When one considers that the mean response time records was 23 minutes and a patient care interval of 40 minutes, the crews and vehicles are unavailable for an additional hour following each emergency call. Although cleaning and equipping EMS vehicles is important, it should not consistently result in an hour of unavailable time for any EMS, as this has a direct impact on the availability of limited resources, particularly in a resource constrained service where there are only 70 ambulances operational, which is already well below the World Health Organisation (WHO) recommendation of 1 ambulance per 100,000 people.[28,29] The impact is evident in the time intervals for the identified activities of this research study when the EMS dispatchers are possibly unable to find EMS available crews and vehicles, resulting in emergency calls being delayed with a potential impact on patient mortality and morbidity.

Limitations

It is acknowledged that the participating service may have completed more calls than the sample size presented in the study. However, the approach we followed must be pragmatic in that the participating EMS service lacked a reliable electronic database or call screening system for accurately determining priority. Despite the small sample size in terms of calls logged, the sample size was sufficiently powered to achieve the aim of the study. A further limitation was the separate call taking and dispatch functions, with separate time database, for the EMS call centre used in this study. This limitation meant that the research team was required to manually record the times for each of the intervals required for the study.

CONCLUSION

Achieving a response time of less than 8 minutes is desirable for many time-dependent medical emergencies such as cardiac arrest and stroke.[3,5] Delays in trauma patients receiving prompt pre-hospital and definitive care can result in increased morbidity.[2,30] EMS should strive to respond to emergencies, treat and transport patients efficiently thus ensuring missions are completed timeously, resulting in increased ambulance availability. The response intervals, patient care intervals and total mission times noted in this study were longer than national and international norms and standards. Delays between arrival at hospital and crews booking available to service the next call negatively impacts on availability of ambulances. Further studies are recommended to explore factors that may be contributing to the lengthy response and mission times reported in this study.

CONFLICTS OF INTEREST

The authors report no conflicts of interest.

AUTHOR CONTRIBUTIONS

WVDN conceptualised the study, conducted data collection, analysis and interpretation and drafted the manuscript. CVL and KG supervised the research and assisted with analysis and interpretation of data and edited the manuscript for intellectual content.

REFERENCES

1. Stein C, Wallis L, Adetunji O. The effect of the Emergency Medical Services vehicle location and response strategy on response times. South Afican Journal of Industrial Engineering 2015;26:26–40.
2. Newgard CD, Schmicker RH, Hedges JR, et al. Emergency medical services intervals and survival in trauma: assessment of the "golden hour" in a North American prospective cohort. Ann Emerg Med 2010;55:235–46.
3. Weiss S, Fullerton L, Oglesbee S, Duerden B, Froman P. Does ambulance response time influence patient condition among patients with specific medical and trauma emergencies? South Med J 2013;106:230–5.
4. Nolan JP, Maconochie I, Soar J, et al. Executive Summary: 2020 International Con-

sensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Circulation 2020;142:S2–S27.

5. Castren M, Karlsten R, Lippert F, et al. Recommended guidelines for reporting on emergency medical dispatch when conducting research in emergency medicine: the Utstein style. Resuscitation 2008;79:193–7.
6. Meislin HW, Conn JB, Conroy C, Tibbitts M. Emergency medical service agency definitions of response intervals. Ann Emerg Med 1999;34:453–8.
7. Bigdeli M, Khorasani-Zavareh D, Mohammadi R. Pre-hospital care time intervals among victims of road traffic injuries in Iran. A cross-sectional study. BMC Public Health 2010;10:406.
8. Sanchez-Mangas R, Garcia-Ferrrer A, Juan A de, Arroyo AM. The probability of death in road traffic accidents. How important is a quick medical response? Accid Anal Prev 2010;42:1048–56.
9. Sasaki S, Comber AJ, Suzuki H, Brunsdon C. Using genetic algorithms to optimise current and future health planning–the example of ambulance locations. Int J Health Geogr 2010;9:4.
10. MacFarlane C, Benn CA. Evaluation of emergency medical services systems: a classification to assist in determination of indicators. Emerg Med J 2003;20:188–91.
11. Stein C. Emergency Medical Services response system performance in an urban South African setting: a computer simulation model. Thesis. University of Cape Town, 2014.
12. Budge S, Ingolfsson A, Zerom D. Empirical analysis of ambulance travel times: the case of calgary emergency medical services. Management Science 2010;56:716–23.
13. Newton PR, Naidoo R, Brysiewicz P. The appropriateness of emergency medical service responses in the eThekwini district of KwaZulu-Natal, South Africa. S Afr Med J 2015;105:844–7.
14. Vincent-Lambert C, Mottershaw T. Views of emergency care providers about factors that extend on-scene time intervals. Afr J Emerg Med 2018;8:1–5.
15. Al-Shaqsi SZ. Response time as a sole performance indicator in EMS: Pitfalls and solutions. Open Access Emerg Med 2010;2.
16. Stein C, Wallis L, Adetunji O. Meeting national response time targets for priority 1 incidents in an urban emergency medical services system in South Africa: More ambulances won't help. S Afr Med J 2015;105:840–4.
17. Gkritza K, Collura J, Tignor S, Teodorovic D. An analysis of the characteristics of emergency vehicle operations. In: Transport science and technology. Ed. by Goulias K. 2006:327–42.
18. Vandeventer S, Studnek JR, Garrett JS, Ward SR, Staley K, Blackwell T. The association between ambulance hospital turnaround times and patient acuity, destination hospital, and time of day. Prehosp Emerg Care 2011;15.
19. Fahim Yegane SA, Shahrami A, Hatamabadi HR, Hosseini-Zijoud SM. Clinical Information Transfer between EMS Staff and Emergency Medicine Assistants during Handover of Trauma Patients. Prehosp Disaster Med 2017;32:541–7.
20. Statistics South Africa. City of Johannesburg Metropolitan Municipality. 2011. (`https://www.statssa.gov.za/?page_id=1021&id=city-of-johannesburg-municipality`) (visited on 08/18/2023).
21. Wong B, Blandford A. Analysing ambulance dispatcher decision making: trialing emergent themes analysis. In: HF2002 human factors conference: design for the whole person. Ergonomics Society of Australia. 2002.
22. Lim CS, Mamat R, Braunl T. Impact of ambulance dispatch policies on performance of emergency medical services. IEEE Transactions on Intelligent Transportation Systems 2011;12:624–32.
23. Department of Health (South Africa). (2021, 16 February). National Health Act, 2003(Act no 61 of 2003) Regulations relating standards for Emergency Medical Services (Notice 64). Government Gazette, 44161, pp 3-20.
24. Department of Health Province of Gauteng. Annual Report 2016/2017. 2017.
25. Waseem H, Naseer R, Razzak JA. Establishing a successful pre-hospital emergency service in a developing country: experience from Rescue 1122 service in Pakistan. Emerg Med J 2011;28:513–5.
26. Finlayson M. An analysis of emergency response times within the public sector emergency medical services in KwaZulu-Natal. Dissertation. Durban University of Technology, 2017.

27. Peyravi M, rtenwall P, Khorram-Manesh A. Can Medical Decision-making at the Scene by EMS Staff Reduce the Number of Unnecessary Ambulance Transportations, but Still Be Safe? PLoS Curr 2015;7.
28. Kobusingye OC, Hyder AA, Bishai D, Hicks ER, Mock C, Joshipura M. Emergency medical systems in low- and middle-income countries: recommendations for action. Bull World Health Organ 2005;83:626–31.
29. Razzak JA, Kellermann AL. Emergency medical care in developing countries: is it worthwhile? Bull World Health Organ 2002;80.
30. Kue RC, Temin ES, Weiner SG, et al. Tourniquet Use in a Civilian Emergency Medical Services Setting: A Descriptive Analysis of the Boston EMS Experience. Prehosp Emerg Care 2015;19:399–404.