

**A COMPARATIVE STUDY OF EMERGENCY SERVICE
RESPONSE INTERVALS IN JOHANNESBURG, SOUTH AFRICA,
AND THE NORTH WEST AMBULANCE SERVICE, UNITED
KINGDOM**

A dissertation submitted in fulfilment of the requirements for the degree of
Master of Health Sciences in Emergency Medical Care
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DECLARATION OF ORIGINALITY

This is to certify that this work is entirely my own and not that of any other person, unless explicitly acknowledged (including citations of published and unpublished sources). The work has not previously been submitted in any form to the Durban University of Technology or to any other institution for assessment or for any other purpose

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Date: _____

ETHICAL CLEARANCE

This is to certify that the research studies conducted for the purposes of this dissertation have the approval of the Institutional Research Ethics Committee of the Durban University of Technology (DUT) in KwaZulu-Natal.

Institutional Research Ethics Clearance Number: REC150/17

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ABSTRACT

Background: The primary role of an Emergency Medical Service (EMS) is to respond to an emergency incident within the shortest possible time. As a consequence, response times have historically been used as a key indicator of EMS performance. The City of Johannesburg Emergency Management Services (CoJEMS) provides an EMS to the citizens of the greater Johannesburg metropolitan area in South Africa. The CoJEMS are expected to respond to emergency incidents within 15 minutes, which is the national norm. Before this study there was no complete up-to-date data set or literature describing the extent to which the CoJEMS were meeting this target. The absence of accurate data relating to response-time intervals was seen as problematic as it limits EMS managers' abilities to make informed decisions concerning quality management, benchmarking and improvement strategies.

Aim: The aim of the study was to investigate, document and describe the time taken by the CoJEMS to complete activities routinely associated with the activation of and response to an emergency incident and to compare these with the response times achieved by the North West Ambulance Services (NWAS) in the United Kingdom.

Methods: The research methods included a literature review to identify generic activities that occur from the moment an emergency happens until the patient arrives at a medical facility for treatment. Following this a spreadsheet that was designed to capture the time taken to complete each of the identified activities. Data from 784 calls for the CoJEMS and 786 calls for NWAS were recorded onto the spreadsheet and analysed descriptively.

Results: The NWAS had a median overall response time of just 10 min 45 seconds. The median overall time for COJEMS was over twice as long, at 23 min 16 seconds.

Conclusion: The NWAS outperformed the CoJEMS in the majority of response-time intervals and the CoJEMS median of 23 min 16 seconds exceeded the national norm and standard of 15 min. Many of the extended CoJEMS response times could be linked to delays in communication between the call-taking department and the EMS dispatch, coupled with a lack of availability of EMS vehicles. Further studies are recommended to determine the reason for the lack of available CoJEMS vehicles, as well as ways to encourage a closer relationship between the different departments within the CoJEMS central communications centre.

DEDICATION

First, to the Lord Jesus Christ, who continually reminded me that the only person who is able to prevent me from accomplishing great things is me. That I can accomplish all things, that His strength inside me is more than I will ever need.

To all those who have walked this path with me, I really do appreciate your patience, your faith in me, and your constant motivation.

Most importantly I would like to thank my wonderful wife, Annelise, and my two gorgeous girls Megan and Veronique. Your loving support during the prolonged project is really amazing, thank you.

To the rest of my family, you all played an amazing role in guiding me, and pushing me to complete this research. Sometimes nagging, and annoyingly, but it was always appreciated and got me through some difficult times.

To my friends and colleagues, keep your focus on what is good and what is right, despite what is happening around you. People will always be there to point out what they perceive are your limitations, but love them regardless and be the better person. We all have skeletons in our cupboards, but never have two for the same reason,

ACKNOWLEDGEMENTS

To my supervisor, Prof Craig Vincent-Lambert, you are really an inspiration and what I can have learned in the past two years from you has really helped me grow as a person and hopefully a professional as well. You have shown me that hard work, and persistence is what really pays off in the end.

To my co-supervisor, Dr Kevin Govender, thank you for setting the standard so high. Sometimes it seemed unattainable, but you have supported me through this which is really appreciated.

To all the EMS personnel out there, remember that you are all working towards a common goal, not to seek glory, not to seek what will make you look good, but to constantly seek to become better at what you do, so that you can treat people with respect and dignity, and can provide the people who trust their lives into your hands with the best possible care.

Remember, among all the politics, all the struggles, all the frustrations, when you dig down to the bottom of it all, there is actually a patient who needs and depends on you doing what is right for them.

To all the Emergency Services central communications centre and call centre agents working behind the scenes where very few people acknowledge your work and understand your frustrations, keep up the good work, it is really appreciated.

Spending time with the City of Johannesburg Emergency Management Service central communications centre staff during this project really gave me a new perspective of the challenges you face and made me appreciate what you go through, and in so doing developing a newfound respect for the work that you do.

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LIST OF TERMS

Central Command Centre: The City of Johannesburg Emergency Management Services 24-hour communications centre that provides access to the fire, rescue, ambulance and metro police for the City of Johannesburg.

The Patient Journey: The time taken from the occurrence of the incident, until the patient arrives at the treating medical facility or hospital (Meislin *et al.* 1999; Castren *et al.* 2008).

Response time: The time the first call is received by the central command centre, until the first responding vehicle arrives on scene (Castren *et al.* 2008).

Emergency Medical Service (EMS): A registered ambulance service, private, provincial or local government, which provides an EMS service to the members of public.

Emergency vehicle: A vehicle that is used as part of a response system to transport patients to hospital and to respond to incidents. These vehicles are dedicated to EMS use and are custom-built and equipped for this purpose (Stein 2014).

Patient priority: The City of Johannesburg Emergency Management Services use a numeric scale for prioritising a call or patient. Priority 1 (One) refers to an immediately life-threatening incident. Priority 2 (Two) is a patient who is seriously injured with no immediately life-threatening injuries. Priority 3 (Three) is a patient who can wait for an ambulance as their injuries are minor injuries. Priority 4 (Four) is a patient who is thought to be without a chance of survival.

Emergency Medical Services (EMS): “a person, organization or body that is dedicated, staffed and equipped to offer emergency medical care, inter-health facility medical treatment, or transportation of the ill or injured.” (Health 2015).

CHAPTER ONE - BACKGROUND AND CONTEXT

1.1 INTRODUCTION

This first chapter provides the background and context to this study, which focused on documenting, describing and comparing response-time intervals of an emergency service in Johannesburg, South Africa, to an emergency service operating within a similar context in the United Kingdom UK). The chapter begins by providing the background to and motivation for the study. The chapter continues by introducing the problem statement, central aim, objectives and value of the study. The chapter concludes by providing an outline of the dissertation and the chapters to follow.

1.2 BACKGROUND AND CONTEXT

The South African National Health Act 61 of 2003 aims to realise the rights set out in the Constitution by providing a framework for a structured and quality healthcare system in South Africa. It outlines the laws that govern national, provincial and local government with regards to health services. According to the Act, in the event of an emergency, provision must be made for a patient to gain access to a suitable medical facility. The provision of an ambulance, by Emergency Medical Services (EMS) within each province, forms part of providing patients with access to healthcare facilities in the event of an emergency (Health 2003). As such, the primary role of the EMS is to respond to an emergency incident when notified of such and, upon arrival at the incident, provide the appropriate medical care prior to, and during, transportation to a suitable medical facility. This is often referred to as The Patient Journey (Meislin *et al.* 1999; Castren *et al.* 2008). According to Castren, delays during any time along The Patient Journey may have a negative effect on the outcome of the patient (Castren *et al.* 2008; Bigdeli, Khorasani-Zavareh & Mohammadi 2010; Sanchez-Mangras *et al.* 2010; Sasaki *et al.* 2010).

With regard to the South African EMS context, it is thought that a number of factors may result in a delay in EMS response times (MacFarlane & Benn 2003; Stein 2014; Stein, Wallis & Adetunji 2015a; Stein, Wallis & Adetunji 2015b). Two of these factors include a lack of a single national EMS number and large distances between EMS locations and hospitals in certain areas. In addition, there is currently no single, well-known, national EMS activation number. This results in members of the public often calling many, often incorrect, numbers in an attempt to activate the emergency services. Such factors and actions may result in unnecessary delays in EMS activation and consequently lengthen response times to emergency incidents. Another factor that may impact EMS response times is a lack of resources and poor placement of ambulance bases. This may result in long distances that

ambulances need to travel to get to the incident location. These are just some of the challenges that may result in a delay in patient's accessing definitive care, which may negatively impact patient morbidity and mortality (Stein 2014; Vincent-Lambert & Mottershaw 2017).

Taking the above into account it is unsurprising that one of the most widely accepted criteria historically used for measuring an effective and efficient EMS in South Africa was that of response time, particularly to cases in which the patient's condition was thought to be life threatening (MacFarlane & Benn 2003). MacFarlane further highlighted the fact that there is a "statistically significant increase risk of death" with a pre-hospital time over an hour. A more recent study (Al-Shaqsi 2010b), highlights 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, by getting patients to a suitable medical facility in the shortest possible time. Response times are therefore still used as a primary (and in some cases the sole) indicator of performance when measuring the effectiveness of an emergency service. This study focuses on investigating response-time intervals in Johannesburg, South Africa.

The City of Johannesburg Emergency Management Services (CoJEMS) is the service in which this study took place. The CoJEMS provides an emergency medical service to the citizens of the greater Johannesburg metropolitan area for the Gauteng provincial government Department of Health, and includes the provision of a fire and rescue service as well as a primary response and ambulance service to ill or injured citizens.

At the time of the study, the researcher was the Principal of the City of Johannesburg Emergency Management Services (CoJEMS) medical training academy. The researcher has a broad understanding of the EMS, having worked operationally in both the private and public EMS sectors in South Africa since qualifying as an Advanced Life Support (ALS) paramedic in 1995. At the time of the study the researcher was working within an EMS training environment. A component of the researcher's work involves the mentoring and supervision of emergency medical care students during pre-hospital clinical learning shifts.

It was the researcher's experiences of being confronted by members of the public who expressed their disappointment in the time taken for the EMS to arrive at emergency incidents that first stimulated the researcher's interest in the area of response times within the city and to try and find possible reasons for delays in getting the CoJEMS EMS vehicles to emergency scenes faster. Given this context, the researcher felt it would be a valuable undertaking to explore current response times to emergency incidents within the CoJEMS, as this would allow for the identification of potentially avoidable delays that may be occurring throughout the emergency response cycle, beginning with the time a call is

received by the central communications centre until the first responding EMS vehicle arrives at the scene.

Although a number of 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 incidents (Stein, Wallis & Adetunji 2015a) or the reduction in response times through the addition of vehicles and resources (Stein, Wallis & Adetunji 2015b). While these studies have provided some answers to important questions regarding improving response times, they do not provide clear information regarding all the processes involved in the response time. These processes include obtaining the necessary incident information by the central command centre, or control centre, sourcing the appropriate vehicles and resources that will then be able to respond safely and quickly to the incident location. While one could argue that the processes involved before the actual dispatching of the EMS response units are fairly generic and should have little impact on overall response times, in a unique country like South Africa, a number of challenges exist in this domain.

The main aim and purpose of this study therefore became to document, analyse and describe the time intervals taken to complete each of the activities routinely associated with EMS activation and response to emergency incidents within CoJEMS. The study included a comparative component during which the researcher attempted to benchmark the findings relating to the CoJEMS response times with a similar EMS service in an international city.

1.3 THE RESEARCH PROBLEM

The research problem that was identified focused on the fact that response times to emergency incidents within the CoJEMS have been anecdotally reported to, in many instances, exceed nationally accepted times. However, before this study there was no complete up-to-date dataset nor any literature confirming this by properly documenting and describing each of the current response-time intervals making up the overall response times to emergency incidents for the CoJEMS.

The absence of up-to-date scientifically accurate data was seen as problematic as it limits EMS managers' abilities to make informed decisions or to properly understand the nature of the problem. A second problem was that, despite benchmarking being a well-recognised method of gauging the efficiency of an organisation, benchmarking response times without scientifically correct data would be meaningless.

Furthermore, it was also noted that before this study there was no existing data or literature describing how the CoJEMS response times compare to those of other EMS services operating in a similar context.

1.4 AIM

The aim of this study was to describe time intervals taken to complete selected activities routinely associated with the activation and response of the CoJEMS and compare them with the time intervals achieved by the North West Ambulance Service (NWAS) in the UK.

1.5 THE RESEARCH QUESTIONS

In light of the research problem and aim, the researcher identified the following core questions:

- a) What are the individual time intervals involved in EMS activation and which make up the overall EMS response time?
- b) What are the response-time intervals making up the overall response times for the CoJEMS?
- c) How do the response-time intervals for the CoJEMS compare to those of the NWAS in the UK?
- d) What recommendations can be made to reduce the overall response times for the CoJEMS?

1.6 STUDY OBJECTIVES

The objectives of this research study included:

- a) Through a literature review, to investigate and describe the generic response-time intervals making up the overall response times for EMS.
- b) To describe and compare the identified time intervals taken to complete selected activities routinely associated with the activation and response of the CoJEMS and the NWAS.
- c) To investigate, document and describe the response-time intervals, as well as the overall EMS response times for the CoJEMS and the NWAS.

- d) To identify contextually appropriate and feasible strategies to improve selected activities routinely associated with the activation and response of the CoJEMS

1.7 RESEARCH DESIGN

An optimal study design is one that is best for the study purposes in terms of achieving its objectives (Aldous, Rheeder & Esterhuizen 2013). A prospective quantitative descriptive design was selected for this study. The research design was chosen in response to the type of data that was to be collected and necessary to report on. The data was collected prospectively because, at the time of the study, the CoJEMS call taking and dispatch computer systems did not accurately communicate with each other, and therefore accurate retrospective data was not available. The data sets required during the research were time and numbers; therefore, the data collection was quantitative.

1.8 RESEARCH METHODS

This section provides a brief overview of the process and methods followed. In Chapter 3 a more detailed description and discussion of the methods and procedures is provided.

The research followed a linear sequential approach to achieving the aim of the study (Figure 1). The researcher firstly conducted a literature review to identify the routine activities associated with the EMS dispatch and response-time intervals. This is discussed in further detail in Chapter 2. Following this, the researcher designed a Microsoft Excel spreadsheet that was used to accurately record the identified response. The researcher then identified the sample size that was sufficiently powered to be seen as representative of the total number of emergency calls received and responded to by both the CoJEMS and the NWAS. This led to the actual collection of the data for both the CoJEMS and the NWAS, which is detailed in Chapter 4. Using the data collected, the researcher was then able to compare and analyse the results, and make the necessary recommendations.

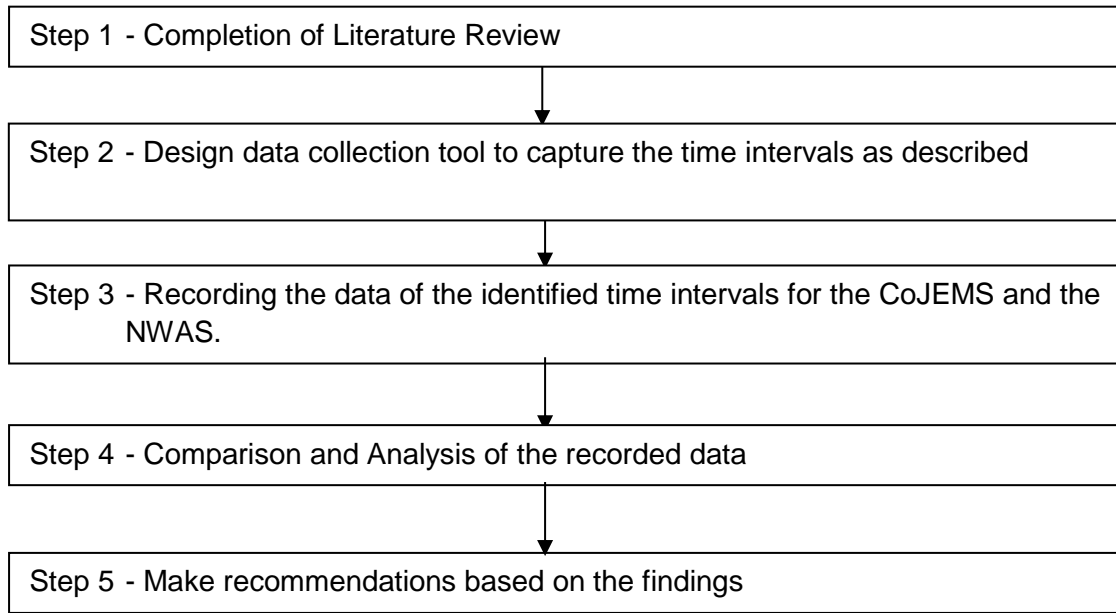


Figure 1.1 - Summary of research steps followed in this study

As mentioned above, in Chapter 3 the researcher provides a more detailed description and defence of the methods and procedures applied to achieve the aims and objectives of the study.

1.9 VALUE OF THE STUDY

This study is seen to be valuable in that it provides up-to-date data documenting and description of EMS response-time intervals within the City of Johannesburg. This allowed the researcher to accurately benchmark the CoJEMS response times to those of the NWAS in the UK. The results of this study contribute towards a better understanding of EMS response times and provide valuable information and recommendations for EMS managers as they strive to improve the effectiveness and efficiency of their services.

1.10 OUTLINE OF DISSERTATION AND CHAPTERS TO FOLLOW

This first chapter provided the introduction, background and context of the study, presenting the research focus, aim and purpose of the study, along with the design and methods used in this study. Chapter 2 presents the literature review through which the researcher was able to explore response times at an international and national level, including an investigation into the generic activities within the command centre that contribute to response times.

Chapter 3 describes in detail the design, and methods and procedures used in the study including a

discussion of the ethical considerations applicable to the research study.

Chapter 4 provides a description of the findings, outlining the results of the study.

Chapter 5 focuses on a discussion of the findings within the context of similar studies and exiting literature.

Chapter 6 provides a summary, recommendations, limitations and the conclusions of the research study. The researcher's reflections are also included in this chapter.

1.11 SUMMARY

This chapter provided the introduction, context and background to the study, which focused on documenting, describing, and comparing response-time intervals of the CoJEMS in Johannesburg, South Africa, to those of the NWAS in the UK. The following chapter deals with the literature that was reviewed.

CHAPTER 2 - LITERATURE REVIEW

2.1 INTRODUCTION

The intention of a literature review is to identify and then investigate the published literature and existing evidence on an identified area of research leading to the justification of the proposed research topic. In her book “*Doing a Literature Review in Health and Social Care: A Practical Guide*”, Helen Aveyard highlights the fact that, within the environment of health sciences, there is a growing need to provide evidence-based practice, and therefore conducting a detailed literature review is increasingly important (Aveyard 2014). The rationale for conducting a good literature review is to provide a basis to assist the researcher in answering the research questions that guide the study (Randolf 2009).

In this chapter, the researcher aims to introduce literature that was reviewed in order to frame the research problem, through the interpretation of existing evidence within the focus area. This chapter begins by providing the positioning of the ambulance services within the healthcare sector, the background to the EMS, as well as defining and describing pre-hospital time intervals for EMS and the process of EMS activation and response times. The chapter then concludes with the role of time in the EMS.

2.2 POSITIONING OF THE AMBULANCE SERVICES WITHIN THE HEALTH CARE SECTOR

Ambulance services play an important role in the healthcare sector worldwide. As this study focuses on the ambulance services in two countries, namely South Africa (SA) and the UK, this section will provide an overview of the current setting, and how these two ambulance services are positioned within their healthcare sectors and the impact they have on healthcare in their respective countries.

2.2.1 The United Kingdom

The UK comprises four geographical parts, namely, England, Scotland, Wales and Northern Ireland, with the capital London situated in the south eastern part of England. The health care system in the UK is offered independently in each of the four countries, offering their own private and public healthcare. In England, the National Health Service (NHS) provides the majority of healthcare, free-of-charge at the point of contact. One of the organisations within the NHS is the National Ambulance Service Trust. The North West Ambulance Service Trust is one of ten ambulance trusts in the UK,

with the head office based in Bolton, England (Figure 2.1).



Figure 2.1 – Map showing the ambulance services in the UK (NHS 2017; Centre 2018)

The NWAS was established in 2006 with the merger of four ambulance trusts, namely Greater Manchester, Cheshire, Merseyside, Cumbria and Lancashire (Figure 2.2). The NWAS trust serves a slightly smaller population than Gauteng, at just over 7-million people within a geographically smaller area of 14 000km² (NHS 2017).



Figure 2.2 – Map of the NWAS coverage area. (NHS 2017)

2.2.2 The Republic of South Africa

South Africa is a country on the southernmost tip of the African continent, covering a surface area of over 1.2-million km^2 , which is almost five times larger than the UK ($242\,495\text{km}^2$) but, with a population of just over 59-million people, has almost 10-million fewer than the UK (Worldbank 2018).

South Africa is divided into nine provinces (Figure 2.3), the largest of which is the Northern Cape making up almost 30% of the land area, at over $372\,000\text{km}^2$, but with the smallest population at only 1.1-million people. In contrast, the smallest province in South Africa is Gauteng making up just over 1% of the land surface area at just over $18\,000\text{km}^2$; however, Gauteng is the most populated province, with over 12-million residents, which equates to roughly 700 people per square kilometre (StatsSA

2009).

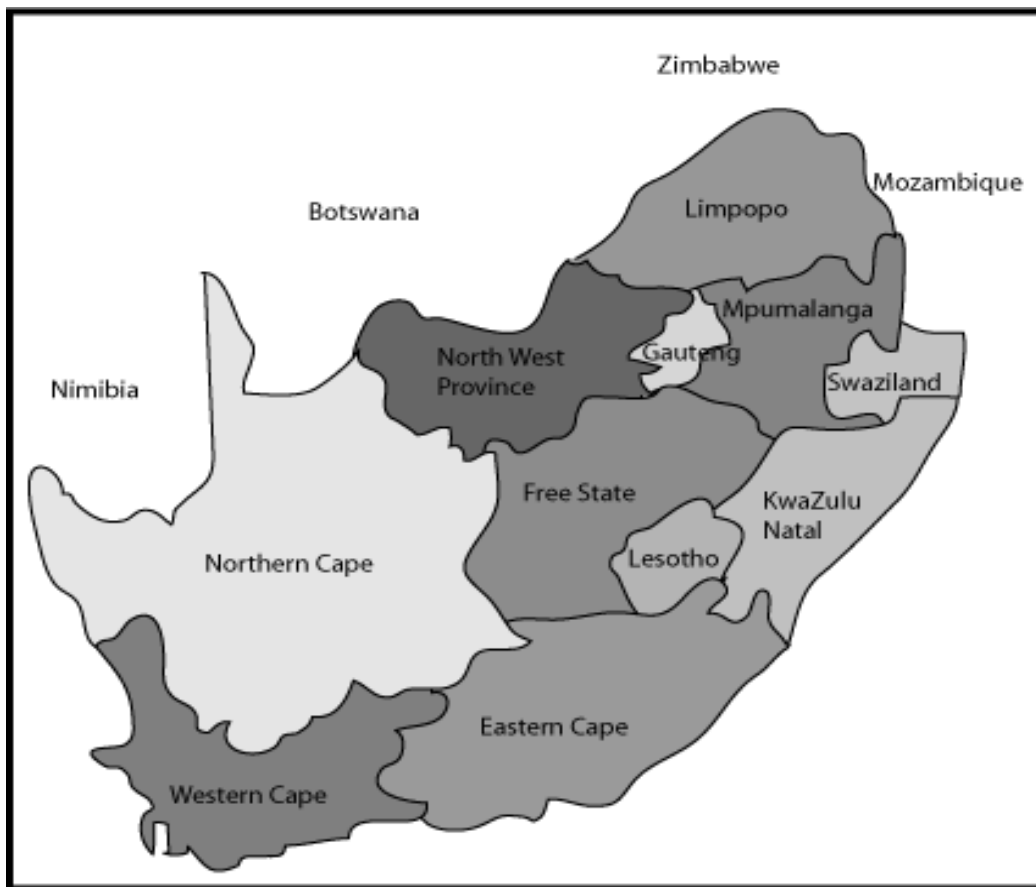


Figure 2.3 - Map of the provinces of South Africa (SouthAfrica 2018)

South Africa has three spheres of government; a national government that regulates through the constitution. The country is subdivided into nine provinces. Each province has its own provincial governance structure. Provinces are further subdivided into municipalities. These “local authorities” are responsible for rendering basic services such as roads, water and sanitation.

South Africa underwent major political changes following the first democratic elections in 1994 and is now a multicultural society with 11 official languages, all of which, in terms of the constitution, are guaranteed equal status. With the changes in the political climate of the country, changes in lifestyle followed, and with this was an inevitable change in the risk and burden of disease profile for South Africa (Bradshaw *et al.* 2003; Mayosi *et al.* 2012; Mayosi & Benatar 2014). The burden of disease is the assessment of mortality, morbidity, injuries, disabilities and other risk factors specific to a country (WHO 2017). Each country’s type of disease burden is determined in accordance with the relative percentage of deaths falling within each group using disability-adjusted life-years (DALYs), which is a metric for measuring the burden of disease in an area (Table 2.1). Table 2.1, which overlaps two

pages, outlines the global DALYs caused by the 25 leading diseases and injuries in 1990, and again in 2010 to identify the changes in the worldwide profile (Lozano *et al.* 2012).

Causes	Rank	2010 DALYs (95% UI) in thousands	Rank	1990 DALYs (95% UI) in thousands
Ischemic heart disease	1	129 795 (119 218 – 137 398)	4	100 455 (96 669 – 108 702)
Lower respiratory tract infections	2	115 227 (102 255 – 126 972)	1	206 461 (183 354 – 222 979)
Stroke	3	102 239 (90 472 – 108 003)	5	86 012 (81 033 – 94 802)
Diarrhoea	4	89 524 (77 595 – 99 193)	2	183 543 (168 791 – 197 655)
HIV-AIDS	5	81 549 (74 698 – 88 371)	33	18 118 (14 996 – 22 269)
Malaria	6	82 689 (63 465 – 109 846)	7	69 141 (54 547 – 85 589)
Lower back pain	7	80 667 (56 066 – 108 723)	12	56 384 (38 773 – 76 233)
Preterm birth complications	8	76 980 (66 210 – 88 132)	3	105 965 (88 114 – 120 893)
Chronic obstructive pulmonary disease (COPD)	9	76 779 (66 000 – 89 147)	6	78 298 (70 407 – 86 849)
Road traffic injury	10	75 487 (61 555 – 94 777)	11	56 651 (49 633 – 68 046)
Major depressive disorder	11	63 239 (47 894 – 80 784)	15	46 177 (34 524 – 58 436)
Neonatal encephalopathy*	12	50 163 (40 351 – 59 810)	10	60 604 (50 209 – 74 826)
TB	13	49 399 (40 027 – 56 009)	8	61 256 (55 465 – 71 083)
Diabetes mellitus	14	46 857 (40 212 – 55 252)	21	27 719 (23 668 – 32 925)
Iron deficiency anaemia	15	45 350 (31 046 – 64 616)	14	46 803 (32 604 – 66 097)
Sepsis and other infectious disorders in new-borns	16	44 236 (27 349 – 72 418)	17	46 029 (25 147 – 70 357)
Congenital anomalies	17	38 890 (31 891 – 45 739)	13	54 245 (45 491 – 69 057)
Self-harm	18	36 655 (26 894 – 44 652)	19	29 605 (23 039 – 37 333)
Falls	19	35 406 (28 583 – 44 052)	22	25 900 (21 252 – 31 656)
Protein energy malnutrition	20	38 874 (27 957 – 41 662)	9	60 542 (50 378 – 71 639)
Neck pain	21	32 651 (22 783 – 44 857)	25	23 107 (16 031 – 31 890)
Cancer of the trachea, bronchus or lung	22	32 405 (24 401 – 38 327)	24	23 850 (18 839 – 29 837)
Other musculoskeletal disorders	23	30 877 (25 858 – 34 650)	29	20 596 (17 025 – 23 262)

Causes	Rank	2010 DALYs (95% UI) <i>in thousands</i>	Rank	1990 DALYs (95% UI) <i>in thousands</i>
Cirrhosis of the liver	24	31 026 (25 951 – 34 629)	23	24 325 (20 653 – 27 184)
Meningitis	25	29 407 (25 578 – 33 442)	18	37 822 (33 817 – 44 962)

**The category of neonatal encephalopathy includes birth asphyxia and birth trauma*

**Table 2.1 – Global DALYs caused by the 25 leading diseases and injuries in 1990 and 2010
(Lozano *et al.* 2012).**

Table 2.2 shows how the DALYs change through different income categories, where South Africa falls within the Low Income category (Worldbank 2018), It is evident that the risk profile is slightly different to that of a high income country such as the UK.

Income Group	Rank	Disease or Injury	% of Total Deaths
World	1	Ischemic heart disease	13.4
	2	Cerebrovascular disease	10.6
	3	HIV/ AIDS	8.9
	4	COPD	7.8
	5	Lower respiratory infections	3.5
	6	Trachea, bronchitis, lung cancers	3.1
	7	Diabetes mellitus	3.0
	8	Road traffic accidents	2.9
	9	Perinatal conditions	2.2
	10	Stomach cancer	1.9
High-Income Countries	1	Ischemic heart disease	15.8
	2	Cerebrovascular disease	9.0
	3	Trachea, bronchitis, lung cancers	5.1
	4	Diabetes mellitus	4.8
	5	COPD	4.1
	6	Lower respiratory infections	3.6
	7	Alzheimer and other dementias	3.6
	8	Colon and rectum cancers	3.3
	9	Stomach cancer	1.9
	10	Prostate cancer	1.8
Middle-Income Countries	1	Cerebrovascular disease	14.4
	2	Ischemic heart disease	12.7
	3	COPD	12.0
	4	HIV/ AIDS	6.2
	5	Trachea, bronchitis, lung cancers	4.3
	6	Diabetes mellitus	3.7
	7	Stomach cancer	3.4
	8	Hypertensive heart disease	2.7
	9	Road traffic accidents	2.5
	10	Liver cancer	2.2
Low-Income Countries	1	Ischemic heart disease	13.4
	2	HIV/ AIDS	13.2
	3	Cerebrovascular disease	8.2
	4	COPD	5.5
	5	Lower respiratory infections	5.1
	6	Perinatal conditions	3.9
	7	Road traffic accidents	3.7
	8	Diarrheal disease	2.3
	9	Diabetes Mellitus	2.1
	10	Malaria	1.8

Table 2.2 – Global top 10 DALYs for countries categorised by income (Revue 2016)

This difference is evident in that the South African average life expectancy in 2017 was 61.2 years for males and 66.7 years for females, which is well below the UK of 75.8 years and 80.5 years respectively (WHO 2017). This is evidence that healthcare plays a vital role in a country.

Furthermore, the increase in violent crimes in South Africa, which frequently go unreported, has an impact on the healthcare system in the country. The first national burden of disease study for South Africa, conducted in 2000, found that homicide was estimated to be the second-highest cause of mortality, with road traffic accidents appearing as the fourth highest cause of mortality (Bradshaw *et al.* 2003). Enshrined in the South African constitution is the right to life and the right to healthcare, which is why health has been prioritised as an integral part of the 14 priorities identified by the National Development Plan (NDP) for implementation. The National Health Act 61 of 2003 outlines the foundational structure of the national, provincial and district healthcare systems. With just over 400 government hospitals in the country, the provincial health departments manage the regional hospitals within each province and the national health department taking responsibility for the ten teaching hospitals in the country. Before the amendments to the National Health Act, the White Paper for the Transformation of the Health System of 1997 placed a large focus on the primary healthcare approach, through the district (local) health system, but also to overcome the challenge of establishing an integrated health system and an effective referral system between the different levels of care. This change placed an increased focus on equipping the district healthcare system to provide the majority of healthcare services to the public within the communities, and only when the district healthcare is not able to provide the care required, where a specialist is required, the patients would be referred to the larger hospitals for definitive care. When the need for transportation between healthcare facilities has been identified, the provincial administration would then take responsibility for the movement of the patient, based on the level of care required at the time of transfer. This is done through the provision of an ambulance service by the provincial government. When one considers that the Northern Cape only has 16 public hospitals, dispersed throughout the province, the distances travelled between the district clinics and the regional hospitals are vast. Although the Gauteng province may have 39 public hospitals in a considerably smaller province, the disproportionate increase in the size of the population and a poor public transport system directly translates into more congestion on the road and therefore increased time spent travelling between healthcare facilities.

Combined with the responsibility of moving patients between healthcare facilities, the provincial government ambulance services are also responsible for the provision of emergency medical services to the community. An effective EMS is one that is able to respond to requests from the community in the event of an emergency, and once the patient has been located, and treatment is initiated, the ambulance is then responsible for the safe delivery of the patient to an appropriate facility. Anecdotal experiences of the researcher are that the expectation from the community is that the above will be done in the shortest possible time.

The provision of an emergency service within South Africa is based largely on the population within a specified area, which provides the basis for the number of vehicles and staff required to function effectively. If South Africa is to meet the minimum requirements of the World Health Organisation, that being one ambulance per 100 000 population (WHO 2017), then the Northern Cape at less than four people per km², with a population of only 1.1-million should only need 11 ambulances, covering the entire province. Gauteng however, will require a minimum of 120 ambulances, with close to 700 people per km².

The provision of an ambulance as part of an emergency medical service in South Africa was, for the most part of the previous century, linked to the fire brigade services, with the focus being primarily on the transportation of the ill or injured. It was only after the promulgation of the Health Act in 1977 that the provision of an ambulance service became the responsibility of the provincial administration (Kotze 1990).

A study conducted in South Africa in 2014 estimated that around 84% of the population relied on the government healthcare system (Mayosi & Benatar 2014). The remaining 16% of the population contribute towards private health insurance providing them with access to private healthcare. The high demand placed on the government EMS for providing an effective EMS to the South African population has resulted in several private EMS services operating in South Africa. In an attempt to regulate the EMS in South Africa, the National EMS regulations were promulgated in 2015. According to the South African National EMS Regulations (Health 2015), an EMS can be defined as “a person, organisation or body that is dedicated, staffed and equipped to offer emergency medical care, inter-health facility medical treatment or transport of the ill or injured”.

A study, conducted in 2010, highlighted the fact that “the ultimate goal of any EMS is to improve the outcome of the patients” (Al-Shaqsi 2010b). This statement may be widely accepted by EMS providers; however, EMS are expected to respond in various conditions to many emergency calls ranging from medical emergencies to various trauma emergencies, all of which may require different interventions in an emergency. The ultimate goal is still ensuring the patient arrives at a suitable medical facility, within an appropriate and acceptable time.

2.2.1 The City Of Johannesburg Emergency Management Services

The City of Johannesburg, situated in Gauteng (Figure 2.4), is one of only eight metropolitan municipalities in South Africa and is the most densely populated with close to 4.5-million inhabitants (StatsSA 2009), equating to over 2600 inhabitants per km².

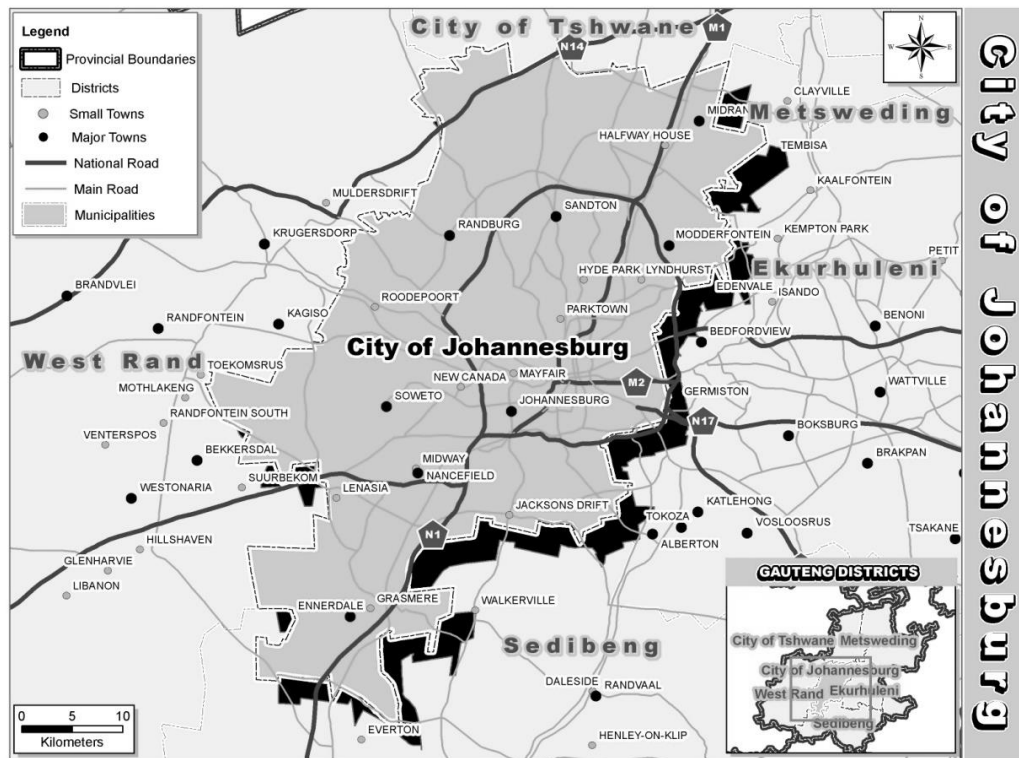


Figure 2.4 - Map of City of Johannesburg in Gauteng (mapsharing.org.za)

The City of Johannesburg (CoJ) had an estimated unemployment rate of 25% in 2011, which many believe to be directly linked to the city's high crime rate. In the recently published crime statistics for South Africa, three of the CoJ's police precincts were named as precincts reporting the top 10 (ten) most crimes in South Africa (www.crimestatssa.com). An increased crime rate, as well as the burden of disease statistics, places a huge demand on the healthcare services of any country and therefore an efficient and effective emergency medical service is vital as part of an over-worked healthcare system.

The CoJEMS provides an emergency medical service (EMS) for the Gauteng Provincial Government (GPG) Department of Health. The service forms part of the CoJ Public Safety Directorate, which includes the Johannesburg Metropolitan Police Department, the CoJEMS, and Disaster Management. The number of emergency medical vehicles supplied to the CoJEMS by the GPG is primarily determined by the population size and is currently around 70 ambulances and 6 primary response vehicles; however, the overall statistics of demand are also used to determine the number of vehicles that will be required. The CoJEMS are required to staff these vehicles with suitably qualified and

trained personnel, ranging from Basic Life Support (BLS), to Advanced Life Support (ALS) and Emergency Care Practitioners.

In addition to an EMS, the CoJEMS offer a multi-discipline service that includes a proactive service for the education and prevention of injuries or incidents, to a reactive service that includes the provision of a fire brigade, a rescue service as well as an emergency medical service. The CoJEMS central command centre received over 200 000 calls in the period 27 July 2014 to 1 July 2015 which equates to roughly 16 000 emergency calls per month. In a combined service such as COJ, multiple vehicles can be dispatched to emergency calls, often resulting in prolonged delays in transportation of the patient to the receiving facility, while waiting for an ambulance to arrive at the incident. The CoJEMS have 30 fire stations where emergency vehicles are placed and emergency vehicles within the CoJEMS are dispatched based on the proximity of the closest fire station and vehicles that are allocated to the station.

2.2.2 The North West Ambulance Service (NWAS).

The UK comprises four geographical and historical parts namely England, Scotland, Wales and Northern Ireland, with the capital London situated in the south eastern part of England. The health care system in the UK is offered independently in each of the four countries, offering their own private and public healthcare. In England, the National Health Service (NHS) provides the majority of healthcare, free of charge at the point of contact. One of the organisations within the NHS is the National Ambulance Service Trust. The North West Ambulance Service Trust is one of 10 ambulance trusts in the UK, with the head office based in Bolton, England (Figure 2.2). The NWAS was established in 2006 with the merger of four ambulance trusts, namely, Greater Manchester, Cheshire, Merseyside, Cumbria and Lancashire. The NWAS trust covers a slightly smaller population than Gauteng, at only 7-million people within a geographically smaller area of 14 000km² (NHS 2017).

The increasing volumes of road traffic, the changing weather patterns and increasing population size will all impact on the effectiveness of an ambulance service.

Irrespective of country, in the event of an emergency, the provision of a rapid, effective ambulance service forms an essential part of a national healthcare system, as the systems are focused on a reduction of mortality and morbidity.

2.3 DEVELOPMENT OF AMBULANCE SERVICES

The primary goal of an ambulance service is to provide the community within which it operates assistance in the shortest possible time following an emergency incident. Irrespective of what the

emergency is, whether trauma or medical related, the expectation is that an ambulance will arrive in the shortest possible time and provide rapid transportation to a medical facility for definitive care (Blackwell & Kaufman 2002; Sanchez-Mangras *et al.* 2010; Blanchard *et al.* 2012).

Throughout history people have engaged in conflict, and where countries are at war with one another, the result is undoubtedly people are injured, or lose their lives. Historically, those that were injured during conflict were transported by any means possible to a place of safety where they either recovered over time, or died as a result of their injuries. Although history has shown us that people will always engage in war, and acts of violence, history has also shown us that the very nature of the human is also to provide care and support to one another, particularly during periods of conflict. As the need to care for the sick and injured increased, the profession of medicine was established. The Greek physician Hippocrates, also known as the “father of medicine”, established the discipline of medicine as a profession between 300 and 500 BC (Britannica 2018). The medical profession grew to such an extent that individual specialties became necessary. The discipline of emergency medical care was established during the crusades of the 11th century, where it was thought Greek and Arab doctors would provide the nights of St John’s with medical training that they could then provide to the injured soldiers. This would later give birth to the St John’s ambulance brigade in 1887, and the establishment of the first civilian ambulance service (Shuja 2017).

The need to provide battlefield survivors with some medical attention was identified over a century prior, with the first documented ambulance service, used to transport injured men established by Dominique-Jean Larrey in 1792, during the French Revolutionary Wars (Britannica 2018). Specialised horse drawn carriages were designed to bring the surgeon to the battlefield, loading the injured and then transporting them off the battlefield, which resulted in the saving of many lives, and thereby improving the morale of the soldiers (Shuja 2017).

The role of the ambulance service was primarily limited to moving casualties of war and the value of transportation of ill or injured persons was again realised during the First and Second World Wars; however, the role of ambulance personnel was limited to basic first aid and rapid transportation out of harm’s way, off the battlefield. During the Korean War (1950-1953), the value of initiating pre-hospital emergency care was recognised but it was only during the Vietnam War (1955-1975) that there was a direct positive impact on patient outcomes linked with early administration of emergency care and rapid transportation of the injured persons to a medical facility, with a reduction in mortality from 8.5% during WW1 to 2.5% in the Korean War (King & Jatoi 2005). This concept would be extended into civilian society giving rise to pre-hospital emergency medical services with the first fully equipped and dedicated ambulance designed, built and operated from 1966 (King & Jatoi 2005; Shah 2006; Al-Shaqsi 2010a; Shuja 2017).

As the role of the ambulance service increased, and became more specialised, it became apparent that it could not function as a standalone service, and formed part of an emergency system. An emergency service system can be defined as a service that is able to provide emergency assistance in the case of incidents (Zhang & Jiang 2014; Rahman *et al.* 2015), ensuring public health and safety and can further be defined by the type of service it provides, either a response service where the service will come out to the community/incident location, or a service where customers need to go to the service location. One considers the police, fire brigade, ambulance services necessary to provide an emergency service. All of these would be situated within a community, placed at strategic locations in order to reduce the time taken from the time the “customer” calls in with the request, until the delivery of the service. With changes to how people live, and work, the concept of an emergency service has evolved to include additional services that people may require in an emergency. These may include the provision of an emergency locksmith, plumber, electrician and many other services that use the name “emergency response service”. It is therefore necessary to further define an emergency medical service (EMS) as “a comprehensive system which provides the arrangement of personnel, facilities and equipment for the effective, coordinated and timely delivery of health and safety services to victims of sudden illness or injury” (Zhang & Jiang 2014). The provision of an ambulance and pre-hospital emergency medical care forms an important part of the emergency medical service and includes the care and treatment of patients before their arriving at a hospital. Treatment will be initiated the moment the first responder or EMS personnel arrive at the side of the patient, and EMS personnel continue their treatment en route to the hospital and this ends when the patient is handed over to the staff at the medical facility. As mentioned above, the provision of care to the sick or injured before their arrival at a healthcare facility has been in place for many years.

Due to the very nature of the service provided, emergency medical services will form part of and work closely with the fire brigade, rescue as well as police services within a community. Furthermore, the EMS is closely integrated into the healthcare system in which patients who receive medical treatment by the EMS personnel are to be taken for further definitive care.

Worldwide, EMS is either a function of the public safety (fire brigade and police service), or a function of healthcare (hospitals). Irrespective of who the main driver of the EMS services are, whether it is public safety or healthcare, EMS should be provided by any community organisation that is capable of delivering the best healthcare for the community regardless of its nature as a public safety or a public health (Al-Shaqsi 2010a).

2.3.1 Models of Emergency Medical Services Delivery

Since the development of the EMS, there have been two main models around which EMS systems function, namely, the Anglo-American and the Franco-German models (Al-Shaqsi 2010a). The Anglo-American model is a model based on the principal of providing limited care to the patient at the scene of an emergency incident, and more focus is on rapid transportation of the patient to a suitable medical facility, where the patient is delivered to the emergency department for further assessment and definitive care. This is in contrast to the Franco-German model of EMS where the focus is on bringing a medical physician to the scene of the emergency, making a diagnosis and initiating the appropriate treatment to the patient, and then transporting the patient to a medical facility where the patient is often admitted directly into the ward or intensive care unit for further treatment.

Further adaptations to both of the above models have developed over the past couple of decades. The rapid improvement of pre-hospital emergency medical care training, increasing the scope of practice under which they may function, has enabled personnel to provide from a Basic Life Support (BLS) level of pre-hospital emergency care right up to Advanced Life Support (ALS) interventions and care. As the name insinuates, BLS would be able to provide basic assessment of a patient and then administer the appropriate basic level of medical care, which includes the administration of oxygen, bandaging of wounds and the placement of basic equipment. The ALS paramedic would have a broader scope of practice, allowing them to do far more invasive procedures, administer medications through different routes, place patients on an intra-venous fluid (drip) and medications, along with the possible clinical oversight required for the BLS personnel (Revue 2016).

Regardless of the model of EMS, whether the Anglo-American model or the Franco-German model, and the provision of the BLS service (load and go) or the ALS service (stay and stabilise), the main aim of any EMS model, when a request is received for a patient in need of emergency care and transportation, must still be on arriving at the side of the patient in the shortest possible time.

Worldwide EMS systems have found it necessary to adapt the different models to meet local needs and targets, taking into consideration the individual cultures, political demands financial factors and affordability in each community. Furthermore, the demographics of disease and the risk factors associated with the burden of disease will have an impact on healthcare systems, and the EMS will need to adapt the provision of their services to meet the changing needs of these diseases. Improved patient outcomes, a reduction of morbidity and mortality, should be the standard by which an EMS is measured. With many injuries and illnesses this is directly linked to the rapid provision of emergency care (Sanchez-Mangras *et al.* 2010; Blanchard *et al.* 2012; Weiss *et al.* 2013).

In an attempt to further reduce mortality and morbidity by reducing pre-hospital times, the helicopter emergency medical systems (HEMS) were introduced well over 40 year ago, with the intention of reducing patient time to hospital. In the South African EMS setting the HEMS services will only respond to emergency incidents once called by the on-scene EMS personnel with the added advantage of the HEMS service is that the vehicles and crews at the scene of the incident are available to service the next call. By doing so, the HEMS services indirectly contribute to a reduction in EMS vehicle response times in that the EMS vehicles do not need to transport the patient to a medical facility and can be available to service the next emergency incident.

2.3.2 The importance of time in emergency care

The global burden of disease and risk factors are documented in order for governments to acknowledge the changes in the lifestyle of communities, and then take the data received from such studies and develop strategies and plans to mitigate the risk factors, in an attempt to reduce the overall morbidity and mortality associated with each disease process. This also allows the healthcare industry to focus on preparing for the predicted changes and the increasing demands for healthcare. Campaigns for healthier lifestyles, safer communities and responsible road usage are all aimed at preventing injury and illness and are necessary proactive measures. While the prevention of accidents, injuries and illnesses are necessary, they are inevitable and therefore the need for an effective healthcare system will always be present. The sooner a person receives professional assistance, following the recognition of a medical concern or injury, the better the chances are for a full recovery (Lozano *et al.* 2012; Weiss *et al.* 2013; Kesinger *et al.* 2015).

Ischemic heart disease and cerebral vascular accidents (stroke) are among the top three global burden-of-disease risk factors worldwide, with treatment goals focused on early activation of the EMS, early access to initiate appropriate treatment, and then early transportation to definitive care (Weiss *et al.* 2013). The provision of early access to EMS and appropriate pre-hospital emergency care followed by the rapid transportation of a patient to a suitable facility within the “golden hour” following a traumatic injury has also been proven to save lives (Lerner, Billittier IV & Dorn 2003; Sanchez-Mangras *et al.* 2010; Weiss *et al.* 2013; Kesinger *et al.* 2015). In essence, the emergency service is primarily a reactive service, required to respond to a request for assistance in as short a time as is safely possible.

In the event of a traumatic injury, the idea of the “golden hour” has been taught and accepted for more than three decades. The teaching among EMS personnel is that patient outcomes improve if there is a

reduced time from the time of the incident, to the time of definitive care, and that this definitive care must be started within 60 minutes of the initial injury (Newgard 2010). Studies are now starting to produce evidence that challenge the concept of the “golden hour” which is so widely accepted among EMS personnel. A study conducted in the USA in 2003, and another in 2010 found that there is a very small reduction in mortality with a shorter pre-hospital time (Lerner, Billittier IV & Dorn 2003; Newgard 2010). The idea that a reduced out-of-hospital time following a traumatic injury has only been proven during the Vietnam and Korean Wars where an increase in survival rate of 2% was evident with a reduction in out-of-hospital time from five hours to two hours; however, there is currently no evidence to support this in the civilian environment (Lerner, Billittier IV & Dorn 2003; Rogers & Rittenhouse 2014).

In contrast a study conducted in Iran found that a reduction in the activation of the EMS and a faster response time may lead to a reduction in mortality following road traffic accidents (Bigdeli, Khorasani-Zavareh & Mohammadi 2010). Thus, while there may be ongoing debate about the clinical significance of reduced out-of-hospital time intervals following traumatic injuries, the same cannot be said for medical disorders such as stroke, myocardial infarction and associated cardiac arrest. The development of the updated “Recommended guidelines for uniform reporting of data from out-of-hospital cardiac arrest: The Utstein Style” provided the process that should be followed from the time a patient experiences a cardiac event to contacting the emergency call centre or dispatch centre to the crews arriving at the side of the patient and initiating treatment and continuing this treatment until the patient arrives at a suitable medical facility (Castren *et al.* 2008). The recommendations clearly found that in both the cardiac patient, as well as the stroke patient, a reduction in any of the above time intervals resulted in a reduced time in getting the patient to definitive care and ultimately an improved patient outcome.

2.4 DEFINING AND MANAGING PREHOSPITAL TIME INTERVALS

The ultimate goal of any emergency medical service is to ensure that the patient arrives at a suitable medical facility, within reasonable time, in order for definitive treatment to start, and thus relies heavily on early access to the EMS followed by a rapid, safe response time with appropriate resources that will be able to deliver the patient to a suitable medical facility (Blackwell & Kaufman 2002; MacFarlane & Benn 2003; Al-Shaqsi 2010b; Blanchard *et al.* 2012).

The time from the initial activation of the EMS, until the patient arrives at a suitable medical facility was first identified by Meislin and is known as “The Patient Journey” (Meislin *et al.* 1999; Castren *et*

al. 2008; Finlayson 2017), and there are many external factors that influence this. Figure 2.5 highlights the activities, outlined above, that form part of the continuum of patient care, from the time of the initial incident, until the patient arrives at the destination emergency department (ED).

There are also several time intervals that are identified as part of the pre-hospital interval of The Patient Journey, namely, the time that the patient realises that there is an emergency until the first contact is made with the EMS communications centre, the Emergency Medical Dispatch (EMD) response interval, and the EMS unit response interval, the time providing medical treatment to the patient at the incident location, and the time taken to load the patient into the ambulance and drive to the receiving medical facility. Each of these time intervals play an important role in the effective delivery of the patient to the ED.

A study conducted by the NFPA in 2010 (Upson & Notarianni 2010), based on the NFPA Standard 1710, found that there are several factors that contribute to the total patient journey and delays throughout the continuum are encountered and must be addressed in order to improve the response time. In trying to identify these delays, the study separated the response time into two areas, namely, EMS activation time (EMD time) and then mobilisation and travel time (EMS unit response time) and then identified the activities which took place during these time intervals and factors that may then influence response times.

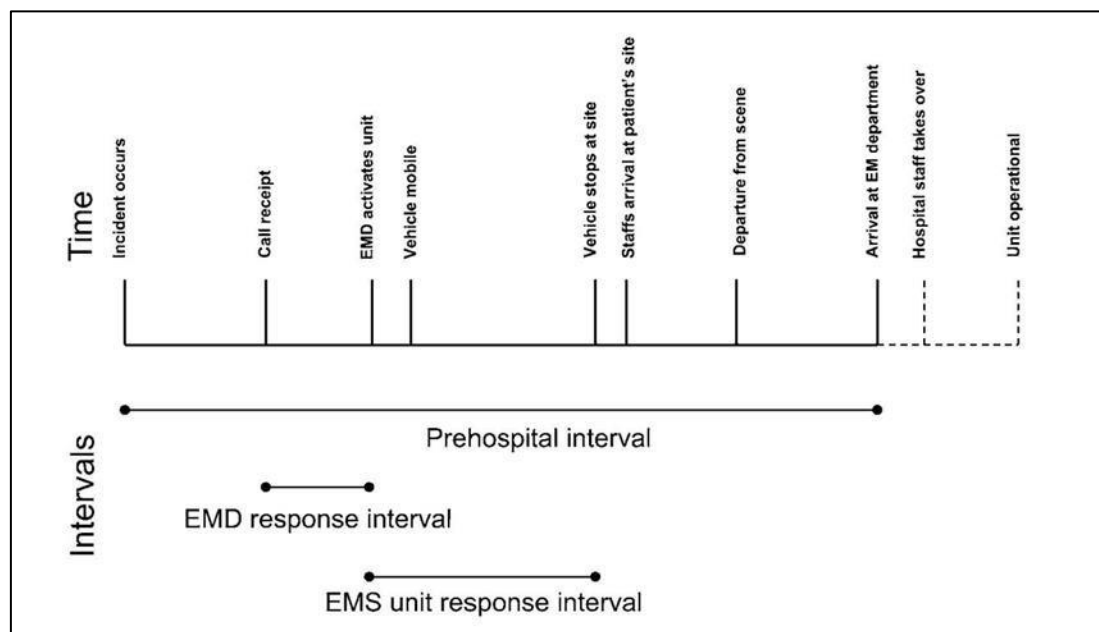


Figure 2.5 - The Patient Journey (Meislin *et al.* 1999; Castren *et al.* 2008)

Several studies have recently been conducted to determine if ambulance response times can be improved by dynamic placement of vehicles (Stein, Wallis & Adetunji 2015a), or whether an EMS

can improve response times by increasing the number of vehicles that can respond to emergencies (Stein, Wallis & Adetunji 2015b). Valuable information has been obtained from these studies, however, they focused on only a single part of The Patient Journey. That being from the time the EMS vehicle receives the call, until the vehicle arrives at the emergency incident. These studies do not focus on the activities that take place during the initial contact with either the patient or with people who are at the incident making the call to the emergency services.

It is during the initial contact with the people at the incident that valuable information needs to be obtained, including what the actual emergency is and the exact location of the incident and then determining where the closest available vehicle is that can be dispatched to the emergency incident. Although these are often thought of as generic activities that take place in an EMS central communications centre, all of these activities take time, and to date no study has focused on these activities, and the potential impact they may have on overall response times in South Africa.

As mentioned in the previous section, there are several distinct activities that are involved in the activation of the EMS and response times of EMS to the scene of the accident or patient. Whether an EMS system functions under the ambit of public safety or under healthcare, the basic processes by which members of the public who are ill or injured access the EMS will remain the same for most EMS systems and comprise four main areas, namely:

- a) Access to the EMS is vital, as it is during this time that valuable information is obtained about the emergency, what type of emergency it is, and from this it will be determined what resources are required at the site of the emergency, as well as what the closest vehicles are to the incident location.
- b) Care on scene is initiated once the EMS personnel and crews arrive at the incident location, and the patient is located; initial assessments must be performed to determine the severity of the injuries and medical condition and initiate treatment based on the EMS personnel capabilities, and the protocols that drive the specific EMS.
- c) Care en route is necessary and allows the patient to be transported to the receiving medical facility while a continuation of the medical care that was initiated at the scene is continued.
- d) Care on arrival at the receiving healthcare facility is vital and must be seen as a continuation of the initial assessment and emergency care provided.

Once it is realised that a person is ill or injured and a decision is made to access the EMS, there is an

expectation from the public that the above processes will occur within a reasonable time. The degree of attention and the speed of response a member of public will receive from the EMS is often based on the degree of illness or injury that the patient has sustained. From the perspective of the ill or injured person, the expectation is that the above processes will take place immediately or at least within the shortest possible time.

An increase in EMS activation and response times will increase the time taken for the patient to arrive at a suitable medical facility where definitive care can be provided, with many studies highlighting the fact that a pre-hospital time over 60 minutes will have an increased risk of death (MacFarlane & Benn 2003; Pons *et al.* 2005; Bigdeli, Khorasani-Zavareh & Mohammadi 2010; Sanchez-Mangras *et al.* 2010; Blanchard *et al.* 2012; Peyravi *et al.* 2013). Although studies focus on the initial call and subsequent arrival of the first medical personnel at the incident, it is important to note that the focus must remain on the result, which is the safe arrival of the patient at a suitable medical facility at which definitive care can be done.

2.4.1 The Emergency Medical Dispatch (EMD) time intervals

The Emergency Medical Dispatch (EMD) plays a crucial role in the overall response time. The first point of contact to the EMS, for a member of the public in the event of an emergency, is with the central communications, or call centre. This is where the initial information regarding the incident is received and captured. The medical information provided allows the call takers to assign a priority to the patient and the incident. Following this, a suitable EMS unit will be identified and dispatched to the incident location. Due to the very nature of these activities, time is taken to ensure that the correct details are captured, allowing for the dispatch of the correct vehicle and crews in the shortest possible time.

The value of the emergency call taking and dispatching is often overlooked. However, this process is arguably the most important link between the patient and the EMS. Different EMS systems prescribe different policies and procedures regarding the call taking and dispatching of vehicles and crews. For the majority of EMS, a call taker is required to answer the incoming call and accurately input the necessary information into a computer system in the shortest possible time. During an emergency, where the initial caller is experiencing immense stress, the EMS call taker is expected to remain calm and keep the caller calm, while trying to elicit appropriate details about the incident that will allow the EMS dispatcher to send the appropriate resources to the incident location. Due to the very nature of an emergency call, under stressful conditions, obtaining accurate details can be time consuming and, if done incorrectly, will result in valuable time being wasted. Once the information is captured, the

decision on which EMS vehicle and crews are to be dispatched is often left to the discretion of the dispatcher and is more often than not based on the closest available vehicle (Furniss & Blandford 2006; Lim, Mamat & Braunl 2011; Finlayson 2017). With the different models and types of EMS systems operational, these decisions have the potential to alter the outcomes of the patient. The decisions that the dispatcher must make are based on the accuracy of the details obtained by the call taker during the initial contact with the patient. The EMS dispatcher (if different) will need to make the decision on which crews and vehicles to send to the incident location. The decision to send the closest EMS unit to the incident location may not always be the correct decision (Wong & Blandford 2011). The decision to send a BLS crew to a call requiring ALS intervention or dispatching the fire brigade or police to an incident as first responders while waiting for an available ambulance may also be necessary. The EMS dispatcher must therefore make several decisions regarding the incident, within a very short period. Although call taking and dispatch protocols do exist, there is always a human element necessary and therefore it is key to allow a certain degree of interaction with the initial caller to address the specific needs of the incident. Each activity undertaken in the EMD centre is complex and key to getting the correct assistance to the patient, at the correct location, within the shortest possible time. The generic activities often involved in the EMD centre include (Castren *et al.* 2008; Lim, Mamat & Braunl 2011; Peyravi *et al.* 2013):

- a) Answering the incoming call, and obtaining the necessary information from the caller regarding the incident location, the number and type of patients at the given location, the perceived severity of the patients and any other information relevant to the patient or the incident.
- b) The incident information is then passed on to the person who will be dispatching the relevant EMS crews and vehicles. Based on the captured information, the EMS dispatcher must make a rapid decision of which vehicles must be sent to the incident, how many vehicles are required and what type of EMS personnel are required to manage the patient (BLS or ALS).
- c) Once a decision has been made by the EMD dispatcher, the information will be transferred to the EMS crews who will then be required to drive to the incident location, and access the patient, and initiate the emergency medical care.

The EMS dispatcher should remain in contact with the EMS crews driving to the incident location and record the time of arrival at the incident. The EMS dispatcher will then await feedback from the EMS crews regarding their departure from the incident, their arrival at the destination facility and when they have completed the call and are available for the next call (Budge, Ingolfsson & Zerom 2008).

An integral part of providing an effective and efficient service to the public, the CoJEMS have a

central communication centre which operates two separate units within a single building. The first unit consists of the call takers, where the incoming calls will be received by the call taker who will determine the type of assistance required (fire, police, or ambulance) and then capture the details of the incident and allocate an incident number and priority for the incident. Once this task has been completed, the call details are sent to the dispatcher.

The second unit consists of the dispatchers, who will receive the incident details from the call taker via a computer-generated message. Once the dispatcher acknowledges the incident, their responsibility is to then source an appropriate EMS vehicle, provide the crew with the necessary information regarding the incident, and dispatch them to the incident. The unit is then also responsible for monitoring the vehicle until it arrives at the incident location safely and then to continue monitoring the vehicle and crews until the patient arrives at the receiving facility and the unit is available for the next incident.

Several generic activities take place within the central communications centre and these include receiving the incoming call, capturing the information provided by the caller and allocation of an incident reference number, forwarding the incident details to the dispatcher who is then responsible for the sourcing of the appropriate vehicle and resources, dispatching the actual vehicle and crews, and following the vehicle and crews until their safe arrival at the incident location.

As the units work separately, under different management reporting structures, each unit only reports on their individual activities, and the combined EMD interval has historically been poorly reported on, and subsequently there is no consensus on the accuracy of the reported times within the CoJEMS. Furthermore, little data exists regarding what acceptable EMD time intervals are and if these have a direct impact on the delivery of an efficient and effective EMS by the CoJEMS. The NWS operates three emergency control centres that operate in a similar way to that of the CoJEMS, at which a call taker will receive the information regarding an emergency incident and a separate dispatch centre will source the closest most-appropriate vehicle to dispatch to the incident location.

2.4.2 The EMS unit response-time intervals

An EMS unit, or ambulance, can be defined as the emergency vehicle and crews who are appropriately equipped to safely respond to an emergency incident and to provide the necessary treatment and transportation of a patient to an appropriate facility (Castren *et al.* 2008; Health 2015). Meislin, *et al.* (1999) identified the differing definitions of response times among EMS personnel, and highlighted that more than half of EMS providers in the United States indicated that response time is

from the time the mobilising unit or vehicle is notified of the call until the vehicles arrives at the scene of the incident. In contrast, only 11% of the EMS systems involved in the study defined the response time from when the initial call is made to the emergency contact centre (Meislin *et al.* 1999). This despite that fact that, in 1991, the European Resuscitation Council as well as the American Heart Association (AHA) had already supported the uniform guidelines for reporting and documenting ambulance response times intervals, within the total patient journey time (Cummins *et al.* 1991).

The EMS unit response interval (Figure 2.5) is measured from the time the EMD or central communication centre notifies an appropriate vehicle and dispatches the vehicle to the incident location until the EMS unit arrives at the given incident location. Essentially this interval will start with the sourcing of the closest and most appropriate vehicle that is available to attend to the emergency call and will include the provision of the information regarding the patient and incident to the EMS crews and the actual driving to the incident location and finally to the side of the patient. Factors that may influence this decision and the availability of the EMS units may include large distances between hospitals to which patients are being transported, limited number of EMS units available to attend to the calls and distances between the EMS unit base stations and the incident locations (Budge, Ingolfsson & Zerom 2008; Stein, Wallis & Adetunji 2015b; Finlayson 2017). Several studies have determined that the EMS unit response time is only measured from the time the EMS unit starts moving to the incident until such time as the unit arrives at the incident location (Myers *et al.* 2008; Finlayson 2017). It can be argued, from the point of view of the patient that the EMS response time must ultimately end when the EMS crews arrive at the side of the patient where assessment and patient care can be initiated. The time taken from the moment the EMS vehicle stops at the incident location and the EMS crew arriving at the side of the patient to start treatment may have many time delays, all of which have a potential impact on the outcome of the patient. Examples may include the arrival of the EMS unit at a building with security access, where the permission to enter has not been provided, resulting in the EMS crew needing to wait for this access, or in shopping malls or complexes at which the patient may not be close to the entry point of the EMS crews. Due to the many factors that may delay the time taken to locate the patient following the arrival of the EMS crews at the incident location, particularly in the South African EMS context, this has not been investigated as part of this study and the time of the vehicle arriving at the given incident location is included in this study.

As mentioned above, there are many factors that have a direct impact on the driving of the EMS unit to the incident. Several studies have been conducted to determine what these factors are and how they can be mitigated. They include the road conditions, traffic congestion, distances between hospitals, and placement of the EMS units in relation to the incidents (Su & Shih 2003; Stein 2014; Kesinger *et al.* 2015; Stein, Wallis & Adetunji 2015b; Finlayson 2017). Although they do play a significant role

in overall response times, the focus of this study was not to explore the factors that will impact the actual driving time of the EMS units.

2.5 TIME AS A MEASURE OF EMS PERFORMANCE

Reed defines a Measure of Performance (MOP) as “any convenient measure of what a system achieves in operation” (Reed & Fenwick 2010). Reed further defines the Measure of Effectiveness (MOE) as the extent to which the MOP satisfies a declared user requirement. Although similar, the two are distinct from one another and are often confused with one another. Where the MOP assesses the actual performance of a task, and will ask the question, “Are we doing things right?” the MOE can be measured in either a qualitative or quantitative measure, and assesses the impact of the actions for a specific service or individual, measuring the purpose and may ask the question, “Are we doing the right thing?”. The measure that one would be able to determine will be against a change of behaviour or the change in the capability of a service or individual and effectively attempt to measure what is accomplished and if the objectives or goals are being met.

It is becoming increasingly important to measure the effectiveness of a product or service and people are generally looking at ways of improving the effectiveness of a product or service. Whether it is to improve sales or to improve demand for a particular service, the idea remains the same, with an increase in choices, products and services comes the need to improve to ensure that your product is generally the first choice. The measure of a service provided to the public can be broken into two separate components, looking at the performance of the service and the effectiveness of the service.

The healthcare and public safety industry must continually find ways to measure their performance and must be driven to provide an improved service to members of their communities. An improved service delivery to the public is often associated with a political incentive.

As there is a close link between the EMS, fire and police services within the public service, the measurement of performance may often be similar. The measurement of performance by which these services function are independent of each other however, in the view of the public requesting these services, the only measurable link between these services is that of time.

When one considers, the measurement of performance for a police service may be to reduce crime in a target area, this will be accomplished through a series of actions both proactive (crime prevention awareness programmes), by visible policing to create an awareness, as well as reactive by a reduced response time to incidents, which would result in an increase in the number of arrests made (Vidal &

Kirchmaier 2017). Although there does not appear to be a minimum standard response time, the average response time in the USA is less than 11 minutes, which appears to be similar to those of the UK (Galagher 2014; LondonGov 2018). The outcomes, once measured, would be used to provide feedback to key role players (politicians, public, and business) and this would allow the provision of funding streams towards improving service delivery.

Similar models of performance have been adopted by the fire brigade, with a fire prevention drive for homes, schools, business or communities. Furthermore, early recognition and activation of the service may also reduce the amount of fire-related damage to structures, as well as preventing a loss of life. This will need to be coupled to the fire brigade response times.

In the USA, the National Fire Prevention Association 1710 (NFPA 1710) refers to different emergency incidents, and the times from the initial call, until the fire brigade arrives at the incident. The NFPA 1710 is the “Standard for the organization and deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments”. The NFPA 1710 requires that (Upson & Notarianni 2010):

- a) Incoming calls are answered and processed in less than 60 seconds for 90% of the incoming emergency calls.
- b) A turnout time for fire vehicles is less than 80 seconds
- c) Arrival of the first fire engine at the incident should be four minutes or less.

The healthcare sector is no different, where the demand for evidence-based performance for healthcare organisations and individual providers is increasing. Evidence-based performance indicators are necessary within the healthcare system and must consider several aspects of healthcare. Although the focus should be primarily towards the best patient outcomes, looking at all aspects of clinical care and medicine, it is also necessary to consider the cost effectiveness of the system combined with the quality of the service being provided.

As well as defining the fire brigade response times to emergencies, the NFPA adopted the findings of the AHA into their 1720 standard, requiring the EMS response times as 59 seconds from time the call is received to the dispatch of the first responding EMS unit; EMS vehicles are to be mobile within 60 seconds of receiving the emergency information, followed by an 8-minute response time for the vehicle to arrive at the incident. The 8:59 is used as the accepted response-time standard throughout the USA.

With the close link between the public safety services (EMS, fire and police) and the healthcare sector, performance measures have been included into the EMS. The need to improve the quality of care provided to a patient and a reduction in the cost of providing that care has driven EMS systems to implement performance management principles, which involve quality control and quality improvement programmes that continually monitor the overall performance of the EMS, as well as the effectiveness of the service. As far back as 1998, the Emergency Medical Services Outcomes Project (EMSOP) tabled the key performance indicators by which an EMS could be measured (Table 2.3). This provided the first holistic view of how one would measure both the Performance (are we doing the right thing?) as well as the effectiveness (are we doing things right?) of an EMS.

Indicator type	Definitions	EMS systems performance index examples
Structure	Characteristics of the different components of the system	(i) Facilities (ii) Equipment (iii) Staffing (iv) Knowledge base of providers (v) Credentials (vi) Deployment (vii) Response times
Process	Combination of sequence of steps in patient care intended to improve patient outcome	(i) Medical protocols (ii) Medication administration (iii) Transport to appropriate facility
Outcome	Changes in health and well-being related to antecedent care (6 Ds) (i) Death (ii) Disease (iii) Disability (iv) Discomfort (v) Dissatisfaction (vi) Destitution	(iv) Out of hospital cardiac arrest survival (v) Patient satisfaction (vi) Improvement in pain score

Table 2.3 - EMS outcomes defined by Emergency Services Outcomes Project (EMSOP) (Maio *et al.* 1999; Rahman *et al.* 2015)

The EMSOP guidelines for measuring the performance of an EMS published in 2001 refer to several factors by which an EMS will be measured, one of which is response times (Table 2.3).

While there are currently no internationally accepted guidelines for ambulance response times to all types of emergencies (medical and trauma), several studies have been conducted and several recommendations have been published outlining and defining response times to individual system illness or injury profile.

As far back as 2003, MacFarlane identified response times as one of the most widely accepted criteria used for measuring an effective and efficient EMS in South Africa (MacFarlane & Benn 2003). The

recently published National EMS regulations (Health 2015) 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. Response times are therefore still being used as the primary, and often sole, indicator of performance when measuring the effectiveness of an emergency service. The Gauteng Department of Health has adopted the national norms for response times of 15 minutes to 90% of the emergency incidents in urban areas. In a city as densely populated as the CoJ, there are many factors that will have a direct impact on meeting the national response times.

Evidence is in support of a quicker response time when responding to patients experiencing a sudden cardiac event. Target response times of less than eight minutes were originally published as far back as 1979 (Mayer 1979) (Upson & Notarianni 2010) and these times have been widely accepted as a standard for the measurement of an effective emergency service. Pons, et al., (2005) researched the need for a more uniform response time guideline as cardiac arrest may account for less than 1% of emergency calls. Other studies have investigated the value of a reduced response time to motor vehicle collisions or road traffic accidents to determine whether there is any statistical evidence in support of a quicker response time in the trauma patient (Bigdeli, Khorasani-Zavareh & Mohammadi 2010). It is evident that a single component is still used as the sole indicator of performance for an EMS system, without much evidence to support this. Price (2006) highlighted that there are unrealistic response times that may place crews and public at greater risk.

2.6 SUMMARY

Worldwide the EMS provides an essential service to a community with the aim of providing a service in the shortest possible time following an emergency incident. Although widely debated, there are currently still no standard acceptable response times to emergency calls and, with the unique challenges of the South African emergency services environment, identifying and eliminating some of these challenges may reduce not only response times but also the total patient journey time, resulting in improved patient outcomes. With rapidly expanding populations in major cities worldwide, there will always be factors that prolong response times, many of which cannot be acted on. An improvement in EMS response times in the CoJEMS is not possible without accurate data and benchmarking. There are, however, several factors that can be investigated that would reduce the time taken to access the patient in need of assistance. This study aims to produce current accurate data describing response-time intervals of a local EMS service (CoJEMS) and benchmarking these against those of the NWS in the UK.

CHAPTER 3 - RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter discusses the research design and the research methodology used to collect the data required for the study. The chapter presents an overview of the study setting, describes the population and sample used in the study, justifies the study design that was deemed appropriate, and discusses the ethical considerations taken into account during study.

The chapter also describes the research methods which were used during the study in order to realise each interconnected research objective. The aim of the chapter is to provide a clear understanding of the research process which was undertaken during the study by describing how the requisite data was collected, validated and analysed and then applied to achieve the aim of the study.

3.2 AIM

As mentioned in Chapter 1, the aim of this study was to describe time intervals taken to complete selected activities routinely associated with the activation and response of the CoJEMS and compare them with the time intervals achieved by the NWAS in the UK.

3.3 OBJECTIVES

In pursuit of the aim described above, the study identified the following objectives:

- a) Through a literature review, to investigate and describe the generic response-time intervals making up the overall response times for EMS.
- b) To describe and compare the identified time intervals taken to complete selected activities routinely associated with the activation and response of the CoJEMS and NWS
- c) To investigate, document and describe the response-time intervals, as well as the overall EMS response times for the CoJEMS and NWAS.
- d) To identify contextually appropriate and feasible strategies to improve selected activities routinely associated with the activation and response of the CoJEMS.

3.4 RESEARCH DESIGN

An optimal study design is one that is best for the study purposes in terms of achieving the objectives (Aldous, Rheeder & Esterhuizen 2013). A prospective quantitative descriptive design was selected for the completion of the study. The research design was chosen due to the type of data that was to be collected and reported on. Considering the fact that “qualitative data are based on the assumption that research problems are complex and interwoven and cannot be reduced to single isolated variables”, (Yilmaz 2013). Given the focus and scope of this study which was descriptive in nature, qualitative methods were not employed. In contrast to this, quantitative data is seen as having a numerical value that can be documented, analysed, and reported on with mathematical statistics (Yilmaz 2013). The aim of this study as stated in Chapter 1, paragraph 1.4, is to describe time intervals taken to complete selected activities routinely associated with the activation and response of the CoJEMS and compare them with the time intervals achieved by the NWAS in the UK. The data sets required during the research were time and numbers, therefore, the data collection was quantitative.

The data was collected prospectively because, at the time of the study, the CoJEMS call taking and dispatch computer systems did not accurately communicate with each other. Therefore, accurate retrospective data was not available.

3.5 RESEARCH METHOD AND PROCEDURE

In order to achieve the central aim of the study, the researcher needed to approach the main objectives in a logical and systematic manner. Seven steps conducted in the completion of the study are detailed below.

- a) The first step was to approach the CoJEMS management. This was done not only to seek permission to conduct the study within the CoJEMS, but also to inform the CoJEMS management of the purpose of the study and the potential benefits of benchmarking CoJEMS response times internationally (Annexure A). Once permission was obtained by the CoJEMS management (Annexure B), the researcher then identified an international EMS to which a comparison could be made.
- b) For the second step, during the identification of a suitable international EMS, the researcher needed to do an in-depth analysis of the study setting for CoJEMS, and then look at international EMS models that operate within a similar setting. The study setting for both CoJEMS and the NWAS are detailed in this chapter.

- c) In the third step, once the NWAS in the UK was identified, a letter seeking permission to benchmark the CoJEMS with the NWAS was addressed to the management of the NWAS. (Annexure C), and a letter of approval was subsequently received from the NWAS (Annexure D). The researcher was then able to begin with the fourth step.
- d) Through a comprehensive literature review, as outlined in Chapter 2, the researcher identified the importance of response times to emergency incidents and the value of each individual activity that make up the overall response times (Al-Shaqsi 2010b; Rahman *et al.* 2015; Finlayson 2017). During the literature review it was evident that many studies had been conducted to identify and reduce overall response times to emergency incidents. Through the literature review the researcher found that many of the studies previously conducted sought to address external factors associated with the response times, such as vehicle location or increasing the number of vehicles (Budge, Ingolfsson & Zerom 2008; Stein, Wallis & Adetunji 2015b; Stein, Wallis & Adetunji 2015a). The specific activities that make up the overall response-time intervals required for this research study were identified through the literature review (Castren *et al.* 2008; Bigdeli, Khorasani-Zavareh & Mohammadi 2010; Finlayson 2017).
- e) In the fifth step, the need to accurately record each of these time intervals were analysed and discussed. The researcher then designed a data collection tool (Annexure E) reflecting the time intervals required for the research study. The next step in determining the research design was to identify the most appropriate time to collect the data. As mentioned in Chapter 2, the central communications centres used in this study have a call taking department and an EMS dispatch centre. Although these two functions are closely linked, they function separately. The CoJEMS call taking and dispatch computer systems do not accurately communicate with each other, and therefore accurate retrospective data could not be gathered. To ensure validity of the data collected for the CoJEMS, the researcher determined the need to collect this data prospectively. The dates identified for the data collection were then given to the NWAS to ensure that data sets originate from the same date and time.
- f) Once the data was collected from CoJEMS, the sixth step in achieving the research objectives was to compare this data to a similar data set obtained from the NWAS in the UK.
- g) In the final step, in comparing the data, the researcher was then able to document, analyse and describe the differences between the data sets and make recommendations in support of the data. By making use of a quantitative design, the researcher was able to produce data that is

statistically valid for a specific population group.

For this reason, a quantitative study using a prospective descriptive design was chosen for this study that allowed the researcher to accurately describe, analyse and compare the response-time intervals for the CoJEMS and the NWAS.

3.6 STUDY SETTING

This study was conducted in the CoJEMS, which is a public EMS. The data collected from the CoJEMS was then analysed and compared to the NWAS, which is a similar public-service EMS based in the UK.

3.6.1 The City of Johannesburg Emergency Management Services

The CoJEMS provides an EMS for the GPG Department of Health. The service forms part of the CoJ Public Safety Directorate, which includes the Johannesburg Metropolitan Police Department, the CoJEMS, and Disaster Management. The CoJEMS offer a multi-disciplinary service that includes a proactive service for the education and prevention of injuries or incidents together with a reactive service that includes the provision of a fire brigade, a rescue service as well as an emergency medical service. The CoJEMS have a total of 30 fire stations, each of which provides a fire and rescue service as well as an ambulance service. All CoJEMS vehicles are dispatched through the CoJEMS central command centre, where the incoming calls are received, screened, prioritised and then dispatched accordingly.

The operational shift structures within the CoJEMS are from 07:00 to 19:00 and again from 19:00 to 07:00, and this applies to the operational vehicles as well as the command centre staff. When a member of the public makes a call to the CoJEMS central command centre, the call is automatically 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 CoJEMS central command centre received over 200 000 calls in the period 27 July 2014 to 1 July 2015, which equates to roughly 16 000 calls per month. There is no proprietary telephone triage system in place, rather incoming calls are screened based on the information provided by the caller, which allows 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.

Emergency calls are logged over 24 hours and each call is allocated a unique call number. Once the details have been captured by the call taker, the call is transferred to the EMS dispatcher who will then forward the details to the EMS crews who will respond to the incident location. Emergency vehicles within the CoJEMS are dispatched based on the proximity of the closest fire station and vehicles that are allocated to the station. The first available EMS vehicle is then dispatched to the emergency call, which could be a fire engine (FE), ambulance or a primary response vehicle (PRV), responding to the call in order to provide any immediate emergency medical care that may be required. Should an ambulance not be dispatched immediately on receipt of an emergency call due to the fact that the ambulances are unavailable as they may be on calls, an ambulance will be dispatched to assist the FE or PRV crews, in order to transport the patient to hospital as soon as it becomes available. The study only focused on calls where the CoJEMS vehicles were dispatched from the central command centre. The study documented and analysed incidents, from the time of the first call received by the CoJEMS central command centre until the arrival of the first CoJEMS vehicle or vehicles at the incident address provided by the caller. Once the data was recorded from the CoJEMS central communications centre, the same data was received from the NWAS in the UK.

3.6.2 The North West Ambulance Service

The North West Ambulance Service Trust is one of 10 ambulance trusts in the UK, with the head office based in Bolton, England.

The NWAS was established in 2006 with the merger of four ambulance trusts, namely, Greater Manchester, Cheshire, Merseyside, Cumbria and Lancashire. The NWAS operated three emergency call centres where they receive over one million calls annually. Similar to the CoJEMS, incoming calls are received by the call taker who will determine the emergency, allocate a unique call number to the incident while capturing the details of the incident which will include the incident location. These details are then sent to the emergency dispatcher who will dispatch the closest appropriate EMS vehicle to the incident location (www.nwas.nhs.uk).

3.7 SAMPLING STRATEGY

Polit and Beck define a population as the entire aggregation of cases that meet the designated criteria, with the target population being the aggregate of cases about which the researcher would like to make generalisations (Polit & Beck 2007; Polit & T. 2010).

As mentioned previously, the aim of this study was to document and describe the time intervals taken to complete selected activities routinely associated with the activation and response of the CoJEMS and compare them with the time intervals achieved by the NWAS in the UK.

In this study therefore, the population identified was the response times for all emergency calls attended to by the CoJEMS and the NWAS. In order to obtain a sample size sufficient to support the outcomes of the study, consultation with a Durban University of Technology (DUT) statistician was necessary and it was calculated that a sample size of 779 calls was sufficiently powered to achieve the aims and objectives of the study (Annexure F). The sampled population included all calls received by the CoJEMS central command centre that were classified as an emergency requiring emergency medical assistance.

Incoming calls were screened, by the call takers, according to current operating procedures, and once it was determined the call was an emergency requiring medical assistance, the call was included in the study and thus followed by the research assistants until the first CoJEMS vehicle arrived at the incident address. The research assistants documented the actual time taken to complete each of the identified time intervals. Once complete with a call, the researchers would then return to the call takers and wait for the next incoming emergency call.

The identified calls were followed during different periods of the shifts identified as Monday to Saturday between midnight (00:00) and 09:00 and on Friday and Saturday evenings from 16:00 to midnight. This data was recorded over a period of a month and included both peak times as well as off-peak times; weekdays as well as weekends until a sample of 784 calls were captured. The identified time periods for the data collection of the CoJEMS calls were provided to the NWAS and similar data sets were requested for the same time periods from the NWAS. It is acknowledged that several limitations may exist and these are discussed in detail in the following chapters.

The study focused on the time intervals for all calls where EMS vehicles were dispatched from their respective central communications centres. The study analysed different time intervals, related to the activities that occur from the time that the first call is received by the central command centre, until the arrival of the respective EMS vehicles at the incident address provided by the caller.

The theoretical population, as defined by Aldous, *et al.*, is the entire population that the study would be referring to (Aldous, Rheeder & Esterhuizen 2013). With well over 16 000 calls received monthly, it was impossible to include in the study all the emergency calls received by the CoJEMS central communications centre. Furthermore, the researcher was limited with the resources available to assist in the collection of data, as the data collection had to be done manually. Within the constraints of the

study, the target population was then a sample that is representative of the entire population.

It was therefore important to clearly identify the specific time intervals required to address the aim of the study, as they relate to the different activities that take place within the CoJEMS central communications centre.

The different time intervals used for the research are listed in Table 3.1.

Time intervals	Description of activity:
Time interval 1	The time taken from when the call was received by the call taker at the CoJEMS central command centre, and the call was categorised as an emergency, the details of the incident are recorded and the incident was allocated a unique incident number and sends the call through to the CoJEMS dispatch staff.
Time interval 2	The time taken for the dispatch staff to acknowledge the call/ incident number.
Time interval 3	The time taken for the dispatch staff to identify the first available EMS vehicle and providing the crews with the necessary information about the incident. (Incident Location, Type of Incident, Priority of the Incident etc.).
Time interval 4	The time taken from the vehicle/crews having received the call, until the EMS unit arrives at the incident location provided by the call taker.

Table 3.1 – Time intervals used within the research study

3.8 RELIABILITY AND VALIDITY

The purpose behind any research is to produce evidence that can be used in guiding decisions regarding a particular practice, within a specific discipline. In order for this to happen, it is essential that the data reported on is reliable and valid as it seeks to provide clarity on the research aims sought. The research study findings cannot be implemented if the reliability and validity of the data have not been rigorously tested and supported. In a quantitative study, validity is defined as the extent to which a particular concept can be accurately measured (Heale & Twycross 2015). In determining whether an instrument is valid, it is necessary to again look at the aim of the study and determine whether the tool is going to produce the results that are required for the research study. The question is asked, “Does the tool capture the data that is supposed to be collected?” (Aldous, Rheeder & Esterhuizen 2013). Reliability is defined as how consistently the results will be measured and produced. The reliability of an instrument will be determined by whether the tool will produce similar results on different occasions under constant conditions (Polit & Beck 2007; Heale & Twycross 2015).

Having identified the need to document the response-time intervals for the CoJEMS to emergency calls, and based on the time intervals required for the research study, the researcher developed the data collection tool (Annexure E) that was used in the study. In order 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 taking a number of calls and capturing the required information onto the tool and then reflecting on whether the tool 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.

3.8.1 Captured at the CoJEMS command centre

All emergency calls received by the central command centre are voice recorded, with date and time indicators. Incoming calls are automatically routed to the first available call taker, and if all the call takers are busy, the call is routed to the shift supervisor. The call taker is required to gather required information regarding the call and this information is entered into a computer system used by the CoJEMS to record details of the incident, priority of the call, the type of vehicles dispatched to the incident, the time these vehicles are dispatched, the time of arrival on the incident, time of departure to hospital, arrival at hospital and the time the vehicle is available for the next call. Data is entered manually into the computer system and therefore the risk of human error is present and was considered during the capturing of the raw data. As mentioned previously, the call taking databases do not accurately communicate with the EMS dispatch database as the two systems function independently of one another. Furthermore, because the calls received were actual emergency calls, the researcher did not want to interfere in the normal working of the CoJEMS central command centre staff and potentially influence the call times, the researcher was able to use “research assistants”. In order for the researcher to obtain valid and reliable data it was necessary to use “research assistants” to manually record the information required for the research project. To ensure validity of the data, the research assistants each had electronic timing devices for recording of the actual times taken for each interval. To further ensure validity of the data, the research assistants were required to follow a single emergency call from start to the arrival of the first CoJEMS vehicle at the incident location.

These research assistants were required to record the above-mentioned time intervals, for the incidents meeting the requirements of the CoJEMS central communications centre for EMS dispatch. The research assistants were instructed to follow a single call, from the time of the incoming call until the CoJEMS vehicle arrived at the incident location, recording each individual time interval as required by the research. This information was manually recorded on the researchers’ central command centre data-collection tool (Annexure E). The time that the call was initially received was captured to determine the actual time of day the call was received. To ensure consistency this time was taken directly from the computer used by the call taker to capture the initial call details. On completion of the shift, the research assistants handed the completed data collection tool to the researcher. This raw

data captured by the research assistants was then entered into an Excel spreadsheet by the researcher, from which results could be compared and reported on. The call takers were not specifically briefed on the aims and objectives of this study in order to limit the potential for a Hawthorne effect.

3.8.2 Captured by the North West Ambulance Service

The NWAS use a recognised automated commercial system for logging all data relating to emergency calls, which is a system internationally recognised. The NWAS use this system for reporting on this information to their governmental health structures (NHI), as well as for their own research purposes. The researcher was able to provide the NWAS with a copy of the data collection tool (Annexure E) used for the collection of data from the CoJEMS. The NWAS then imported the raw data into the data collection tool and send this information via email to the researcher. The researcher was then able to use this raw data and capture this raw data on the same Excel spreadsheet used by the researcher for the interpretation of data received from the CoJEMS.

3.9 INCLUSION CRITERIA

Polit and Beck (2004) define inclusion criteria or eligibility criteria as the characteristics that are essential to the study. It was essential to trace the entire path of an emergency incident, from the time the initial call was received, until the first responding CoJEMS unit arrived at the incident location. All emergency calls captured during the data collection period and meeting the requirements of the study were included in the research study.

3.10 EXCLUSION CRITERIA

The following calls were excluded from the study:

- a) Incidents where the CoJEMS vehicles were cancelled en route.
- b) Emergency calls received directly by stations, or by the crews, and the calls were not logged directly with the central command centre.
- c) Emergency calls where there were incomplete details captured by the research assistants.

- d) Incidents excluded from the NWAS were incidents where all the details of the incidents did not capture correctly, and there were details missing.
- e) Data sets where the complete set of requirements for the research study could not be accurately determined.

3.11 DATA ANALYSIS

Data collected during the determined time is a true reflection of the total call volumes and types of calls received by the CoJEMS central command centre. The data was then analysed and interpreted, using the latest version of the IBM Statistical Package for Social Sciences (SPSS) software to establish the EMS activation time intervals and overall response times to emergencies. This data was then interpreted to provide the necessary information about the time taken for each response interval of The Patient Journey, from within the central command centre, as well as the unit responding to an emergency incident.

The researcher was then able to compare the response-time intervals described in this study to response-time intervals of a purposefully identified international role player (ambulance service) operating within a similar context to that of the CoJEMS. In the case of this study, the results were compared to similar data stemming from the NWAS, which forms part of the UK National Health Service (NHS) trust. The researcher had chosen the NWAS as it is an ambulance service that has a proportionally similar working environment as the CoJEMS, which includes the volume of calls received annually, that it covers a large metropolitan area and that it responds to a wide range of emergency incidents where similar data can be drawn from (NHS 2017). The data captured in the tool, was analysed using simple descriptive statistics, ie, response-time intervals are reported in terms of average, median and mode. The results are depicted in the form of graphs, tables and charts, with accompanying narratives where applicable.

3.12 ETHICAL CONSIDERATIONS

All ethical guidelines outlined by the Durban University of Technology, Faculty of Health Sciences policy were adhered to. The CoJEMS was able to supply the researcher with a letter granting permission to conduct the research study. This letter is included and was submitted to the ethics committee for approval with ethical clearance number REC150/17 (Annexure G).

The researcher, for the majority of the data collection, made use of data from the central command centre of the CoJEMS, as well as the data captured by the research assistants that assisted in the data

collection.

Approval was also obtained from the NWS Ambulance Trust before the data collection took place (Annexure D). The data sets received from the NWS had no identifying information except the incident or call number and the date and times as requested by the researcher.

During the collection of data only incident numbers were used to identify emergency calls from both the CoJEMS and the NWS.

Furthermore, data was captured on the researcher's personal computer, and will be stored in a password protected file on an external hard drive for a period of five years following completion of the study. Data will be made available, through the researcher, to the supervisor, co supervisor, and any other individual directly involved in the research project, should it be requested.

3.13 SUMMARY

By outlining the objectives of the study, this chapter provided the background and purpose of the study which was to document, describe and compare the response-time intervals of the CoJEMS in South Africa to those of the NWS in the UK.

Due to the nature of the data required, a prospective quantitative descriptive design was selected for the completion of the study. The research design was chosen due to the type of data that was to be collected and necessary to report on. The data was collected prospectively because, at the time of the study, the CoJEMS call taking and dispatch computer systems did not accurately communicate with each other, and therefore accurate retrospective data was not available. The data sets required during the research were time and numbers, therefore the data collection was quantitative.

This chapter further provided the rationale for the use of a quantitative study making use of a prospective descriptive design. The following chapter presents the findings and brief description of the data.

CHAPTER 4 - RESULTS

4.1 INTRODUCTION

As mentioned in Chapter 3, the aim of this study was to document, describe and compare response-time intervals of the CoJEMS in South Africa to the NWAS in the UK.

For the purposes of this study, it was calculated that a sample of 779 calls was sufficiently powered to achieve that aim and objective. Over the study period many more calls were captured. However, certain of these were found to be missing some of the data sets required. Calls with missing data sets were thus excluded from the study. Through application of the inclusion and exclusion criteria (cf Chapter 3), the researcher was able to achieve a final sample of 784 calls for the CoJEMS and 786 calls for NWAS, in which all of the required data sets were present. This chapter presents the results and findings stemming from the literature review and the analysis of the above-mentioned data sets.

As mentioned in Chapter 3, one of the core components of this study consisted of a literature review which served to identify the separate activities and associated time intervals making up the overall EMS response time. The literature review (cf Chapter 2) showed that the primary role of an EMS is to respond to an emergency incident when activated and upon arrival provide the appropriate medical care before transporting the patient to a receiving medical facility. The overall time from EMS activation until the patient arrives at the medical facility and the EMS vehicle is ready to be dispatched to the next call may be referred to as The Patient Journey (Meislin *et al.* 1999). As discussed in Chapter 2 of this study, Meislin further identified that there are several activities associated with The Patient Journey. Each of these activities takes time and these time intervals include the *prehospital interval* and a time from the arrival at the hospital until the EMS vehicle is available again (cf Chapter 2, Figure 2.1).

The literature review showed that the prehospital interval can be further divided into five separate time frames, these being:

- a) The time from when the emergency occurred until the call is received by the Emergency Medical Dispatch (EMD) (Meislin *et al.* 1999; Castren *et al.* 2008) and;
- b) The time taken for EMD to log the call, identify and dispatch an available EMS unit (ambulance) (Lim, Mamat & Braunl 2011; Wong & Blandford 2011) and;
- c) The time taken for the EMS unit to drive to the location of the incident, ie, the

response interval (Newton 2013; Stein, Wallis & Adetunji 2015a; Finlayson 2017) and;

- d) The time that the EMS personnel (ambulance crews) would spend on-scene treating the patient at the incident location and finally (Waseem, Naseer & Razzak 2011; Vincent-Lambert & Mottershaw 2017);
- e) The time taken to transport the patient to the receiving facility (Budge, Ingolfsson & Zerom 2008).

The literature review also showed that EMS crews and agencies have different definitions for response times. Thus, for the purposes of this study response times have been defined as “the time the first call is received by the central command centre, until the first responding vehicle arrives on scene” (Castren *et al.* 2008). This was seen to fit well with the aim and focus of the study which concentrated on EMD and EMS unit response-time intervals.

When looking at the literature on EMD and call centre activities, it was found that, by and large, regardless of the service, the majority of activities associated with reconvening and logging calls are “standard” or “generic” in nature. These activities include:

- (a) The call taker answering the incoming call and collecting the necessary information about the emergency incident. This information includes, but is not limited to, the location of the emergency incident, the type of emergency whether it is a medical or trauma, the number of patient’s that are injured or ill, and any other information that may be relevant and important. This allows the call taker to allocate a priority to the emergency incident.
- (b) Once the above information has been captured the call taker allocates an incident or call number to the call and passes on the details to EMS dispatcher who is then required to identify the closest available EMS vehicle and provide the EMS crews with the necessary information regarding the emergency.
- (c) Once the EMS crews have received the information regarding the emergency, the EMS vehicle is required to respond to the incident location and locate the patients in a safe, yet fast manner to initiate emergency medical care.

As discussed in Chapter 3, data in the form of time taken to conduct the above-mentioned activities were captured and placed in an Excel spreadsheet for analysis and interpretation. As the aim of the study was not simply to describe but also to compare response-time intervals for the CoJEMS with the

NWAS therefore in order to facilitate this comparison it was decided to present the data sets using Box and Whisker charts. Box and Whisker charts enable the researcher to clearly identify the distribution of the raw data important to the research study. The sections that follow presents the results of this analysis.

4.2 TIME TAKEN TO ANSWER AND CATEGORISE THE INCOMING EMERGENCY CALLS

Once it is realised that a person is ill or injured and a decision is made to call the EMS, there is an expectation from the public that the processes included in The Patient Journey (cf Chapter 2) will take place as quickly as possible. As mentioned previously, The Patient Journey begins when the first contact is made with the EMS and it is during the first contact with the EMS communications centre when valuable information must be gathered by the EMS call taker. The EMS call taker is required to categorise the incoming call by requesting information from the caller regarding the incident type, patient condition, number of patients, and very importantly the location of the incident. The time taken to gather this information must be kept to a minimum, while ensuring all the details are correctly captured to assist the responding EMS vehicles to arrive at the correct incident location in the shortest possible time.

The CoJEMS central command and communications centre operates with two distinctly separate sections, namely, call taking and dispatch. The call taking section focuses on answering the phone (call taking). The dispatching section remains responsible for receiving information from the call takers and the dispatching and communicating with EMS crews and vehicles. All incoming calls received by the CoJEMS central command centre are automatically routed and answered by the first available call taker. The call taker then captures the details and allocates an incident number to the call. The time intervals taken to complete these tasks were captured for the CoJEMS and compared to those of the NWAS. The results are shown in Chart 4.1.

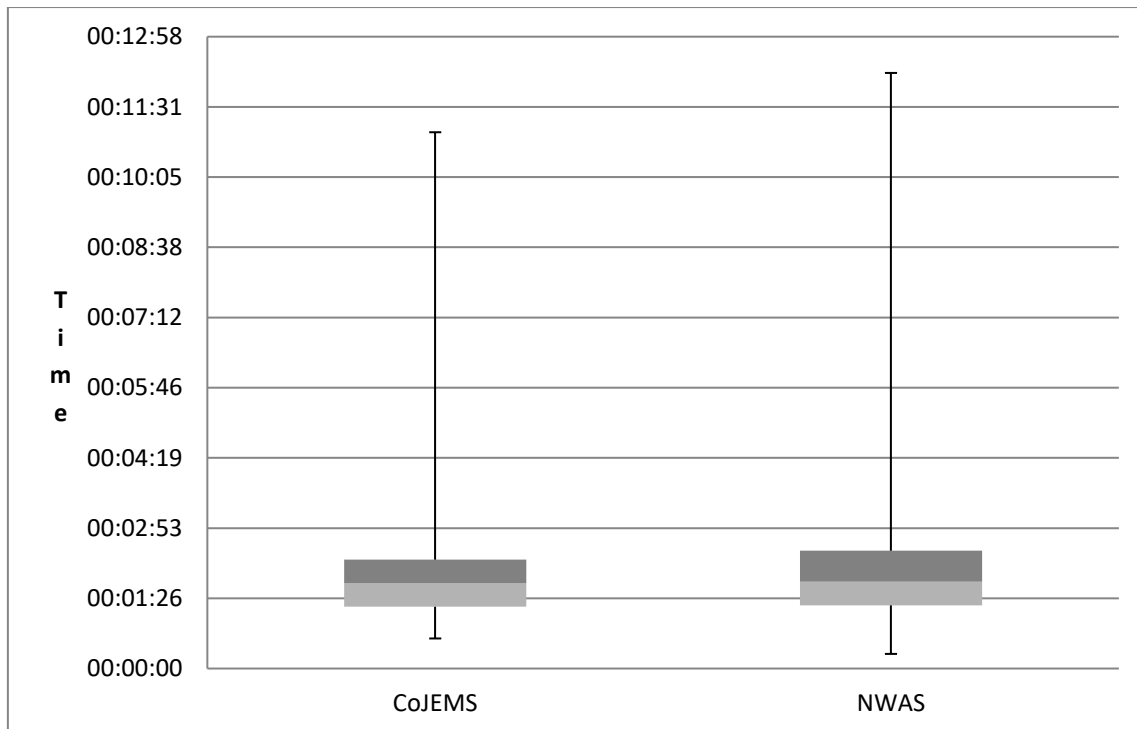


Chart 4.1 - Data Set A - Time taken to answer and categorise the emergency call

	CoJEMS	NWAAS
Minimum Time	0:00:37	0:00:18
Q1	0:01:16	0:01:18
Median Time	0:01:45	0:01:47
Q3	0:02:14	0:02:25
Maximum Time	0:11:00	0:12:13

From the above chart one can identify the shortest time to answer and capture the details of the emergency call for CoJEMS, which was 37 seconds (00:37), with the longest being 11 minutes, resulting in a median time of 1:45. The NWAAS had a minimum time of 18 seconds (00:18), with a maximum of over 12 minutes, resulting in a slightly longer median time of 1:47 to answer a call and capture the required details.

4.3 TIME TAKEN TO IDENTIFY AN AVAILABLE EMS VEHICLE

Once an emergency call has been received and the details of the emergency call has been captured by the call taker, the details are sent to the EMS dispatcher. The EMS dispatcher will acknowledge the new emergency incident, noting the type of emergency, the priority of the incident and incident location based on the details provided by the call taker. The EMS dispatcher is then required to identify the closest, most appropriate vehicles to be sent to the given location of the emergency. As

with other activities that occur within the EMD time interval, it is essential that the time taken to complete this activity is kept to a minimum as it has a direct impact on the overall response time. Although technology may be available to trace vehicle location, such as vehicle tracking devices, these may only indicate the vehicle distance in relation to the incident location and possibly the vehicle availability. The responsibility of knowing what type of vehicle it is, and what level of training the EMS crews hold that are working on the specific vehicle for the day, still requires a degree of human intervention. Furthermore, with a limited number of EMS vehicles in any service, the EMS dispatchers are often faced with the challenge of finding an EMS vehicle that is available to attend to the emergency incident, while taking into consideration the priority of the emergency to ensure the correct EMS vehicle and crews are dispatched. EMS dispatchers may also be called on to reroute EMS vehicles and crews from non-emergency calls to high priority calls based on the needs of the patient. This will then require the EMS dispatcher to find additional vehicles to attend to the non-emergency calls to ensure that all the emergency calls are attended to within the shortest possible time. Once the EMS vehicle has been identified, the crews working on the vehicle are contacted and the details of the emergency incident are provided to them.

The below chart (Chart 4.2) outlines the time interval associated with this data set.

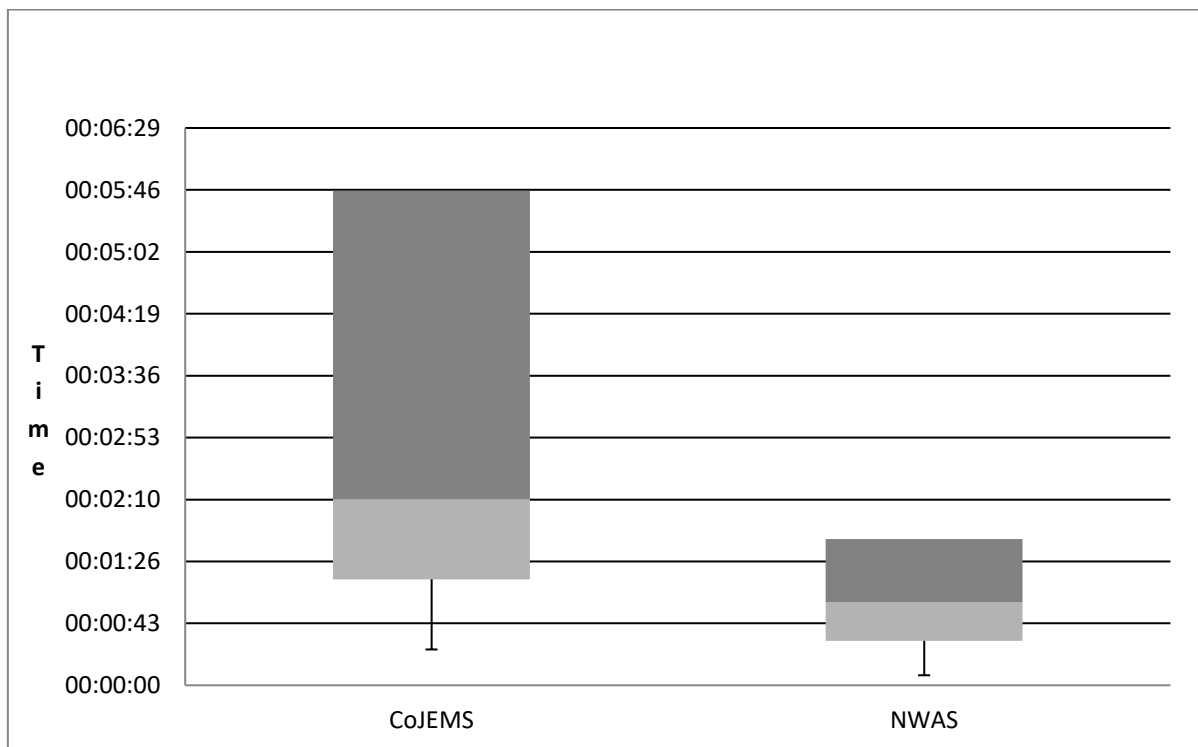


Chart 4.2 - Data Set B – Time taken to identify an available EMS vehicle

	CoJEMS	NWAS
Minimum Time	0:00:25	0:00:07
Q1	0:01:14	0:00:31
Median Time	0:02:10	0:00:58
Q3	0:05:45	0:01:42
Maximum Time	2:05:00	0:10:09

Although not depicted in Chart 4.2 it may be seen in the above table the maximum time taken to identify an available EMS vehicle is that of the CoJEMS, with a time of over 2 hours, whereas NWAS had a maximum time of only 10 minutes. The minimum time for both the CoJEMS and the NWAS was less than a minute and the NWAS achieved a median time of less than one minute, where the CoJEMS median time was slightly more than two minutes.

4.4 TIME TAKEN FROM EMS VEHICLE DISPATCH TO ARRIVAL AT THE INCIDENT LOCATION

Once the EMS dispatcher has provided the EMS crews with the information as received by the EMS central command centre, the EMS crews will then proceed to the incident location. Although the expectation from the public is that the EMS crews will arrive in the shortest possible time following an emergency, the priority of the emergency will play a role in how rapidly the EMS crews will drive to the incident location. Furthermore, the closest EMS vehicle may still be at the medical facility to which it had just delivered the previous patient and may therefore not be in close proximity to the incident, having to then navigate several factors safely to arrive at the incident location, which all have a direct impact on the overall response time. The time taken from receipt of the emergency call details by the EMS crews until they arrive at the incident location is shown in the below charts (Chart 4.3 (a) and (b)) and is often referred to as the “response time” by the EMS crews, as this is the only time for which the EMS crews can be held accountable. It must be said that this time interval cannot be confused with the clearly defined response time.

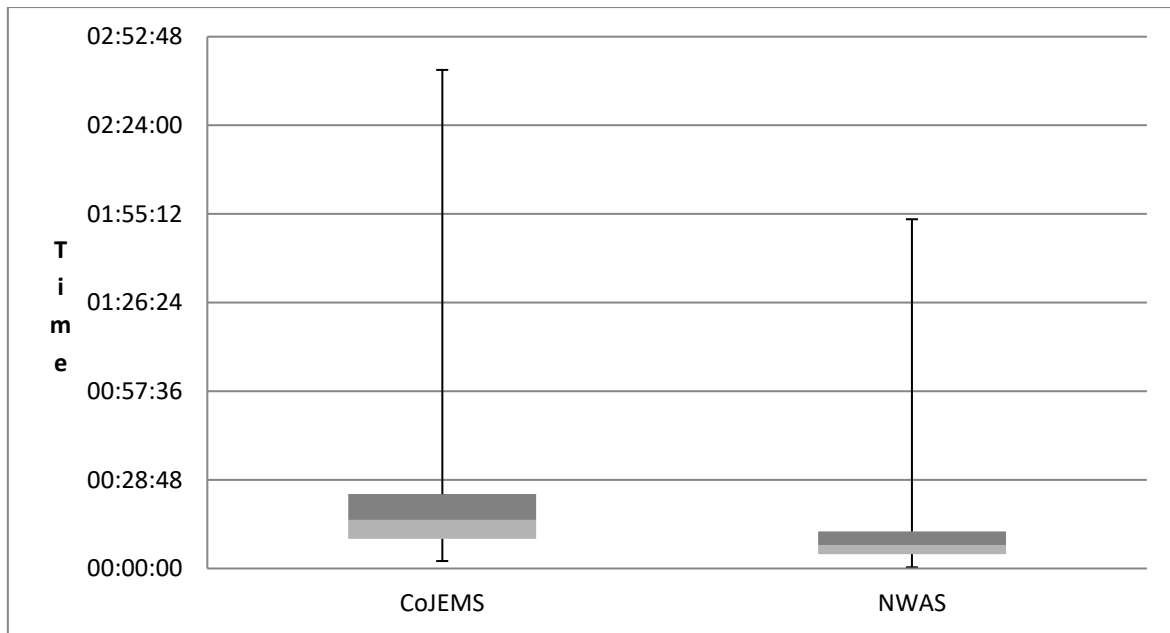


Chart 4.3 - Data Set C (a) – Time taken from dispatch to incident (with maximum times shown)

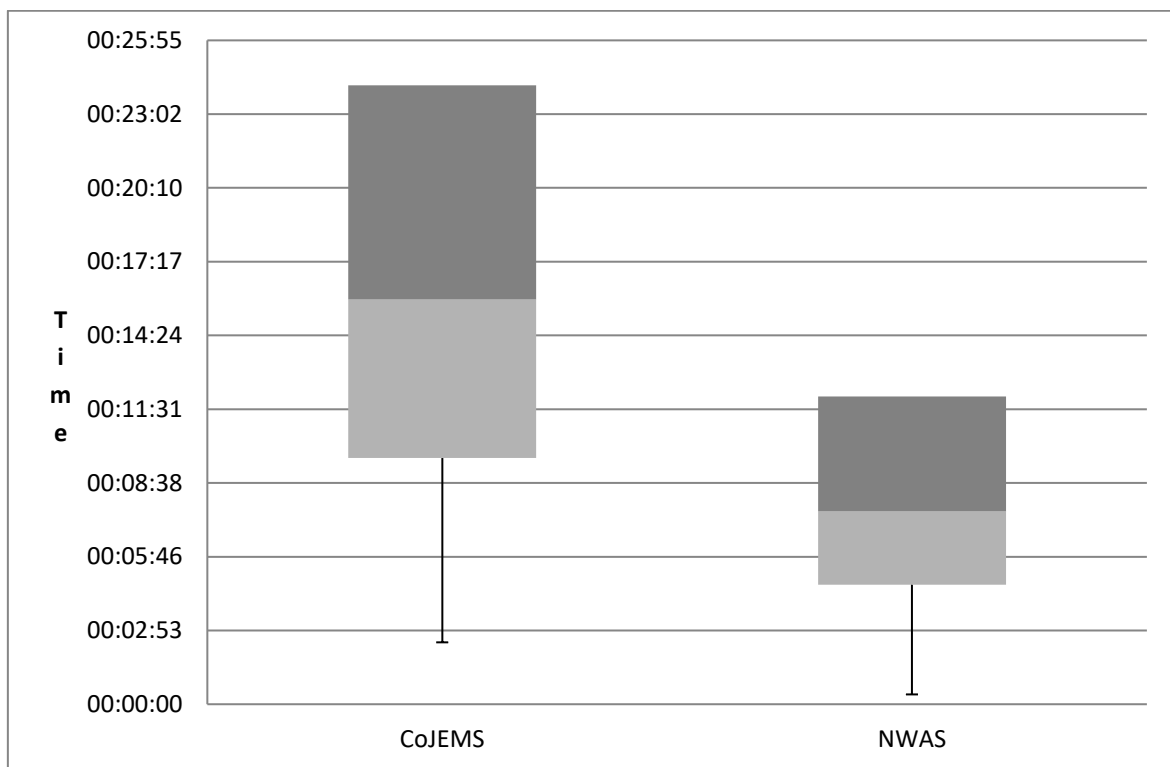


Chart 4.3 - Data Set C (b) – Time taken from dispatch to incident (without maximum times shown)

	CoJEMS	NWAS
Minimum Time	0:02:25	0:00:23
Q1	0:09:37	0:04:40
Median Time	0:15:48	0:07:32
Q3	0:24:10	0:12:01
Maximum Time	2:42:00	1:53:29

The NWAS achieved the fastest actual EMS response time of less than 1 minute, with CoJEMS achieving their fastest time of slightly more than 2 minutes. The CoJEMS achieved the slowest response time of over 2 hours at 2:42, with a median response time of 15 minutes. NWAS achieved a median response time of slightly less than 20 minutes with their slowest response time of less than 2 hours.

4.5 RESPONSE TIME COMPARISON

As described in Chapter 2, the aim of an EMS is to ensure that the EMS crews and vehicles arrive at the incident location in the shortest time following the activation of the EMS. This has also been defined as the “response time” (Castren *et al.* 2008) and includes all the activities that are routinely associated with the activation and response of an EMS. The below chart (Chart 4.4 (a) and (b)) shows the total time from when the emergency call is received until the first EMS unit arrives at the incident location. This total time will include the time taken by the call taker to answer the incoming emergency call and capture the emergency call details and allocate an incident number, sending the information on to the emergency dispatcher who will then identify the closest, appropriate, available EMS vehicle and providing the EMS crews on the vehicle with the necessary information regarding the emergency call and the vehicle actually responding to and arriving at the incident location.

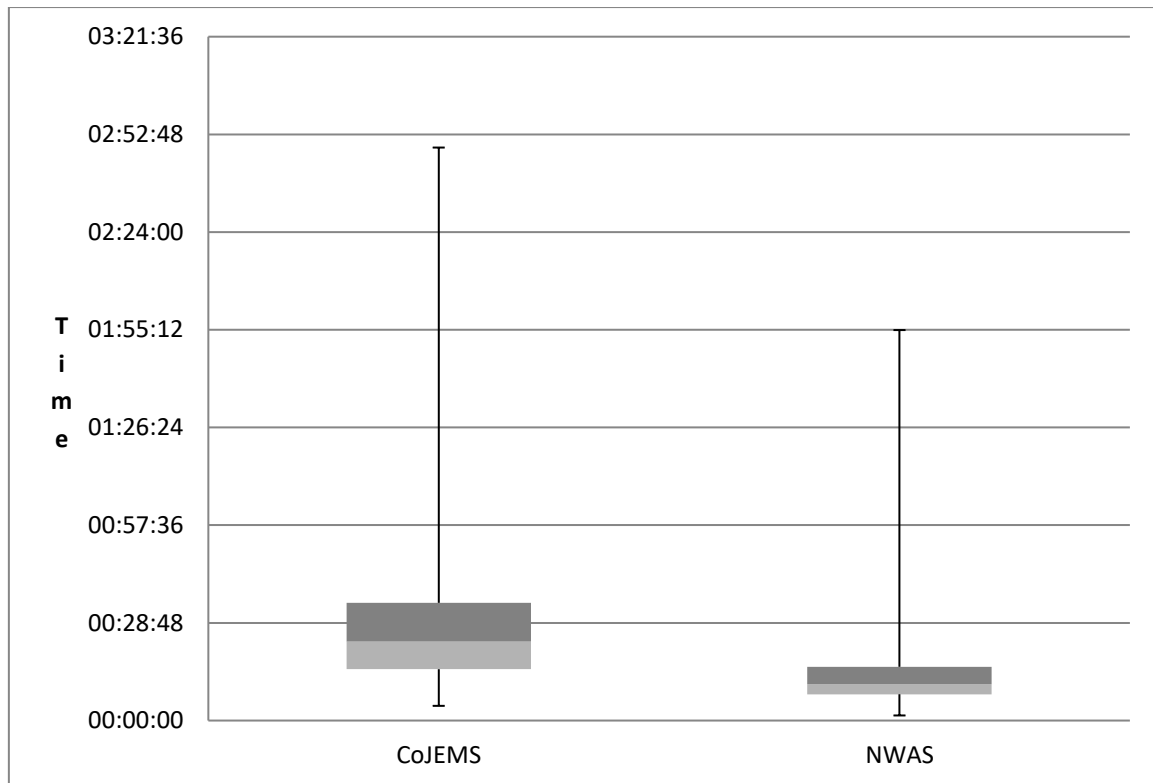


Chart 4.4 - Data Set D (a) – Response Time Comparisons (with maximum times shown)

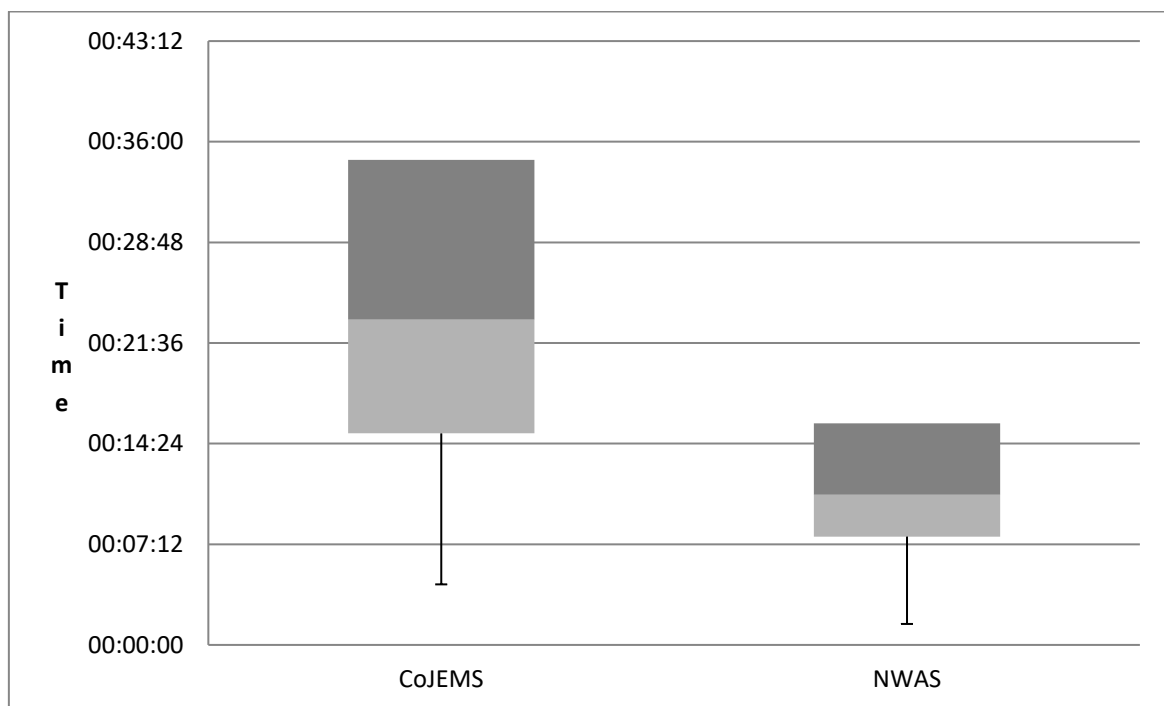


Chart 4.4 - Data Set D (b) – Response Time Comparisons (without maximum times shown)

	CoJEMS	NWAS
Minimum Time	0:04:20	0:01:30
Q1	0:15:08	0:07:45
Median Time	0:23:16	0:10:45
Q3	0:34:42	0:15:51
Maximum Time	2:48:55	1:55:07

The NWAS achieved the fastest time of less than 1 minute with the CoJEMS fastest time of less than 5 minutes. The slowest time achieved by the CoJEMS was almost 3 hours, whereas the NWAS slowest time was less than 2 hours. This resulted in an average of 23 minutes for the CoJEMS with the NWAS achieving an average time of only 10 minutes from the time that the call is received until the first EMS unit arrives at the incident location.

4.6 TOTAL EMERGENCY CALL TIME AND THE PATIENT JOURNEY WITHIN THE COJEMS

In defining The Patient Journey, Meislin (Meislin *et al.* 1999) identified several activities that occur from the time of an emergency taking place until the patient is safely delivered to a medical facility and the vehicle is available to attend to the following emergency. Although there is little that any EMS can do until the call for assistance has been received, being available to attend to an emergency is part of any EMS system. As with any resource, there are only a certain number of EMS vehicles and ensuring the availability of the limited number of EMS vehicles and crews on any given day is essential to reducing response times. Despite the best efforts in reducing the time taken to answer and capture the emergency call details, if the EMS vehicles and crews are unavailable to attend to the emergency calls, the EMS dispatcher is unable to send an EMS vehicle and crew to the location of the emergency. The emergency calls are then delayed until a vehicle becomes available and can then be dispatched to the emergency incident. As seen in the time intervals above, the major differences between the CoJEMS and the NWAS started appearing during the identification of available EMS vehicles to attend to the emergency incidents. In an attempt to unpack the reasons behind this, the researcher recorded additional time intervals specifically for the CoJEMS. The time intervals sought by the researcher may have a direct impact on the main aim of the research and this is further explored in the following chapter. The researcher identified two specific time intervals that may have a direct impact on the availability of the CoJEMS vehicles to attend to the following emergency. The two specific time intervals identified by the researcher were:

- (a) The time taken from when the initial call is received by the CoJEMS central communications centre until the EMS vehicle and crews are available to attend to the next emergency (Chart 4.5)

- (b) The time that the CoJEMS crews spend with the patient, which is recorded from the time the CoJEMS crews arrive on scene until the patient is safely handed over to the staff at the medical facility (Chart 4.6).

The above data were not available for the NWS and therefore the comparison of these time intervals between the CoJEMS and the NWS was not conducted as it did not form part of the initial research study.

There are many factors that influence the availability of EMS vehicles and crews, which include the on-scene time, distance between the incident and the receiving facilities, the time taken to hand over the patient at the receiving facility, and the time taken to clean and prepare the EMS vehicle for the next call.

Chart 4.5 details the total time taken for an emergency call within the CoJEMS, from the receipt of the initial emergency call by the CoJEMS central command centre until the patient has been delivered to the receiving facility and the EMS vehicle and crews are available for the next emergency call.

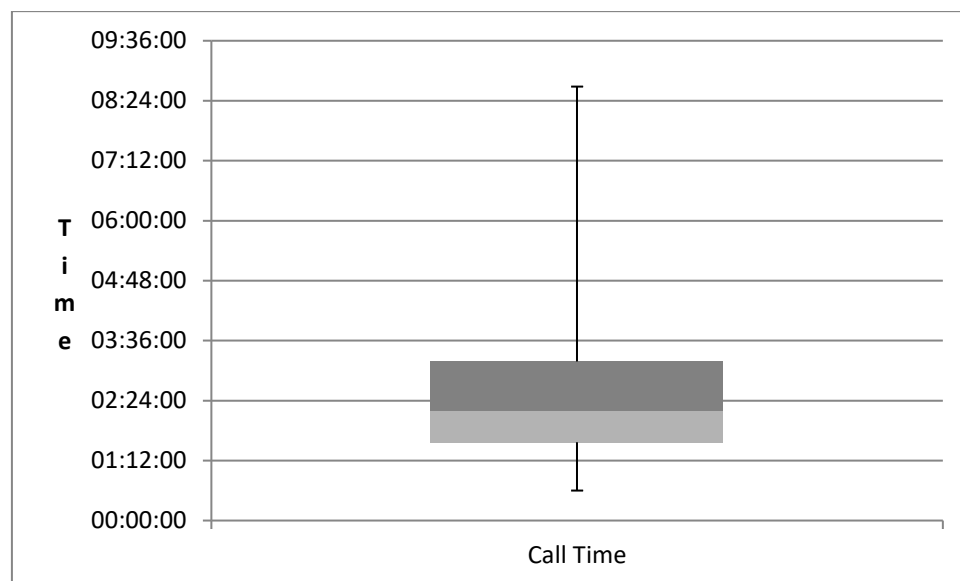


Chart 4.5 - Total call time

	CoJEMS
Minimum Time	0:36:00
Q1	1:34:00
Median Time	2:11:00
Q3	3:11:00
Maximum Time	8:41:00

As mentioned previously, the above chart shows data from the COJEMS for the time interval that starts when the call is received in the call centre until the patient has been delivered to the receiving facility and the ambulance is again available to service the next call. In this regard, we note that the fastest time for this interval was 36 minutes, with the longest time being over 8 hours, and an average of 2 hours and 11 minutes.

Chart 4.6 shows the average time that the CoJEMS EMS crews spend with a patient was over 43 minutes, with the longest time spent with a patient being over 4 hours. This time interval identifies the time from the EMS crew arrival at the incident location, the time taken to stabilise the patient on the scene, and the drive time with the patient to the receiving facility and includes the time taken to hand over the patient to the staff at the receiving facility.

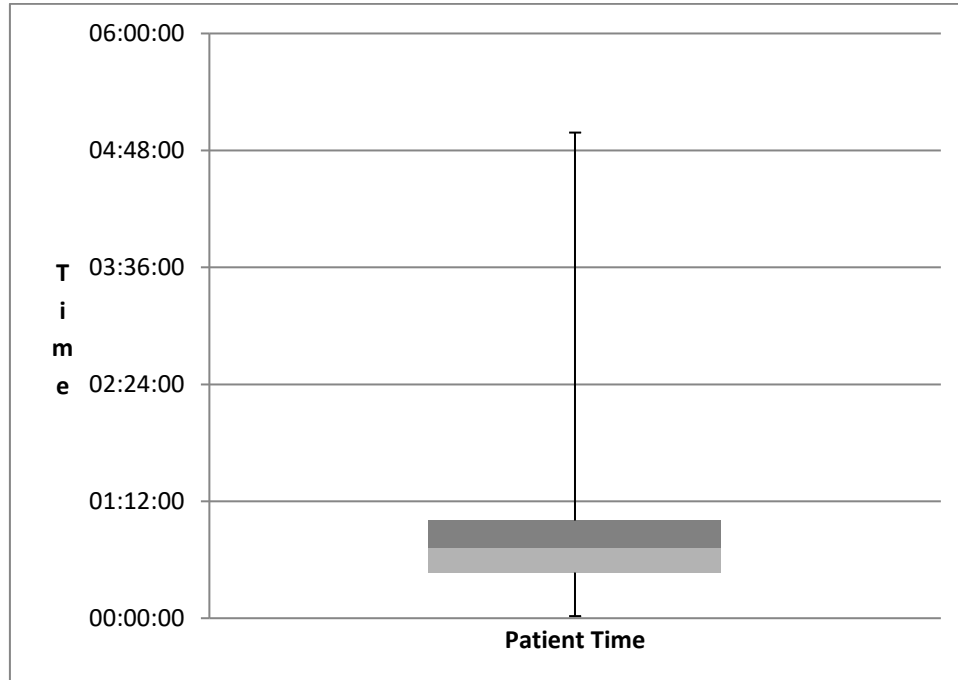


Chart 4.6 - Total time spent with the patient.

	CoJEMS
Minimum Time	0:01:18
Q1	0:28:07
Median Time	0:43:21
Q3	1:00:10
Maximum Time	4:58:59

The researcher then compared the total call time to the time that the EMS crews spend with the patient to determine if there was a significant relationship between the two time intervals that can be directly related to the overall response time.

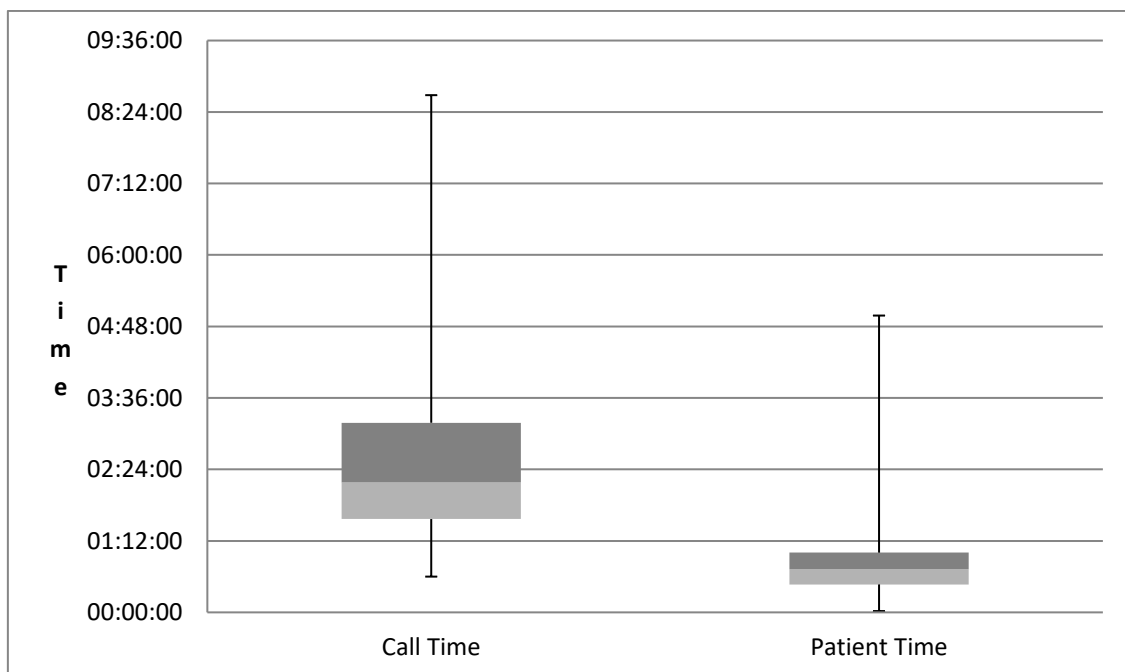


Chart 4.7 - Comparison of Total Call Time vs Patient Time.

	Call Time	Patient Time
Minimum Time	0:36:00	0:01:18
Q1	1:34:00	0:28:07
Median Time	2:11:00	0:43:21
Q3	3:11:00	1:00:10
Maximum Time	8:41:00	4:58:59

The comparison of total call time to the total time that the CoJEMS crews are spending with the patient reveals that around 30% of the total call time is spent by the CoJEMS crews with a patient. This implies that several other factors may be involved in the availability of the CoJEMS vehicles and

could be further investigated to potentially improve response times and service delivery to the community.

4.7 SUMMARY

This chapter presented the results of the data analysis and comparison, in relation to the outcomes of the study.

The aim of the study was to compare identified time intervals from the CoJEMS to the NWAS. As described in this chapter, the results of the time intervals for each of the identified time intervals were recorded and tabulated.

The results were then transferred into a Box and Whisker chart to provide the reader with a clear view of the comparison between the CoJEMS and the NWAS with a brief narrative for these activities.

The chapter then concluded with an overview of the time that the CoJEMS crews were spending with the patient as it relates to the overall call time, which will ultimately have a direct impact on the availability of the EMS vehicles and ultimately influence overall response times.

Chapter 5 presents a discussion of these research findings.

CHAPTER 5 - DISCUSSION

5.1 INTRODUCTION

The aim of this study was to document, describe and compare response-time intervals routinely associated with the activation and response of the CoJEMS and the NWAS in the UK. This was accomplished by the use of a prospective quantitative descriptive design.

In identifying the different activities as they relate to the aim and purpose of the study, a literature review was presented in Chapter 2. The researcher was then able to consider the existing knowledge and available research within the context of the study and a data collection tool was designed, that was used by both the CoJEMS and the NWAS. The raw data was collected as described in Chapter 3 of this study, and the results were presented in Chapter 4.

This chapter discusses the research results as presented in Chapter 4.

5.2 DEFINING RESPONSE-TIME INTERVALS

The emergency medical services (EMS) primary role is to respond to an emergency incident when notified of such and upon arrival at the incident provide the appropriate medical care, within the local protocols, and then transport the patient to a suitable medical facility. This is referred to as The Patient Journey (Meislin *et al.* 1999). Meislin further identified the prehospital time within The Patient Journey and this is further divided into a time when the actual emergency occurred until the call is received by the EMS, an Emergency Medical Dispatch (EMD) response interval, an EMS unit (vehicle) response interval and then the time that the EMS personnel would treat the patient at the incident location and transport the patient to the receiving facility. In relation to the already identified patient journey, the focus of this study was on the activities that take place during the EMD response-time intervals and the EMS unit response-time intervals.

Due to the very nature of the EMS, one of the most widely accepted criteria historically used for measuring an effective and efficient EMS in South Africa was that of response times, particularly to cases where the patient's condition is thought to be life threatening (MacFarlane & Benn 2003). Several research studies conducted in South Africa have focused on the EMS unit response time interval and the factors that may influence the response time. These studies have focused on ways to improve response times by increasing the number of EMS vehicles (Stein, Wallis & Adetunji 2015b), while others have focused on the dynamic placement of EMS vehicles during different times of the

day or week (Stein, Wallis & Adetunji 2015a). External factors do have an impact on the overall response times; however, due to the very nature of the external factors, these cannot accurately be determined for every EMS service and as these had already been explored by other authors they were not the focus of this research study.

When looking at the EMD response intervals there are several activities that take place during this interval. Within the context of The Patient Journey, the activities that take place during the EMD and EMS response times formed the basis of this study. Although the activities were identified during the literature review, the researcher found that there was no literature available to determine the impact of each of the individual activities that take place during the EMD and EMS response interval on the overall response times. The activities that take place within the call centre and central command centre are often overlooked as they may appear to be “standard” or “generic” activities and yet they are part of most, if not all, EMS services. Furthermore, these activities do have an impact on the overall response times and ultimately The Patient Journey (Meislin *et al.* 1999). These activities include:

- (a) The time taken to answer the incoming call and collect the necessary information about the emergency incident including the location and type of emergency.
- (b) The time taken to identify the closest available EMS vehicle and provide the EMS crews with the necessary information regarding the emergency.
- (c) The time taken for the vehicle to respond to the incident location and locate patients.

Defined as the “EMS response time,” this study sought to determine the individual time intervals making up this time interval for the CoJEMS in South Africa and compare this to similar data sets for the NWAS in the UK.

5.3 TIME TAKEN TO ANSWER AND CATEGORISE THE INCOMING EMERGENCY CALLS

The first point of contact that a member of the public has with an EMS, following an emergency taking place, is with a central communications centre. This is primarily done by a member of the public who either witnessed an emergency taking place or are themselves experiencing a medical emergency. The person will then contact the EMS central communications centre, largely through the use of a telephone and calling the emergency numbers. The CoJEMS can be accessed by the public through the national EMS telephone number, 10177 (112 by cellular telephone) or the direct contact

number, 011 375 5911/9. By dialling any of these telephone numbers a member of public will access the CoJEMS. At the time of the study, the CoJEMS were receiving over 200 000 calls annually (Joburg 2017). In contrast, the NWS have a single emergency telephone number (999) which will directly route the call to the central communications and call centre which, at the time of the study, were receiving around 1-million calls annually (NHS 2017).

Due to the nature of the central communications centre or call centre, the incoming calls for both the CoJEMS and the NWS are answered automatically and directed to the first available call taker. This study revealed that the CoJEMS and NWS achieved a very similar mean time of 1:45 and 1:47 respectively (Chart 4.1). It is further noted that the inter-quartile range for both the CoJEMS and the NWS for this activity is narrow. The inter-quartile range is defined as the “measure of variability” within a specific data set. In the context of this time interval, this is an indication that the time taken for this activity is consistently achieved.

This demonstrates that the number of available call takers in relation to the number of incoming calls received by the CoJEMS and NWS was similar. Several factors play a role in this, including the number of call takers who are on shift at any given moment and the amount of information captured by the call takers. The initial information required to correctly identify the incoming call as an emergency is known to be fairly standard and include:

- (a) What is the actual emergency?
- (b) What are the contact details of the contact person at the location of the emergency?
- (c) What is the location of the emergency?
- (d) How many patients are involved?
- (e) Any identifying landmarks that may assist the EMS crews in locating the incident?

Once the above information has been correctly captured, the call taker may ask for further information that can be of assistance to getting a better understanding of what is happening at the location of the emergency. Although these questions are short and very focused, when one considers that the cultures residing within any country are constantly changing, resulting in multiple languages within a community, these become barriers to effective communication and may add to an extended time to obtain the vital information required to correctly dispatch an EMS vehicle to the emergency.

This information is processed by the call taker and, based on the information that is captured,

allocates a priority to the emergency incident. The “Recommended guidelines for uniform reporting of data from out-of-hospital cardiac arrest: The Utstein Style” (Cummins *et al.* 1991) was adopted by the National Fire Prevention Agency (NFPA) (Upson & Notarianni 2010), the American Heart Association (AHA) as well as the European Resuscitation Council. These guidelines allowed for a total response time of 8 minutes and 59 seconds, while it is recommended that EMS vehicles are dispatched and mobile within 60 seconds of the communications centre receiving the initial emergency call. The total EMD response time interval should therefore be less than 60 seconds when the call is answered by the call taker, the necessary emergency incident details are captured, and the information is relayed to the EMS crews that will be responding to the location of the emergency incident. Although the results showed that neither the CoJEMS nor the NWS were able to achieve the 60 second benchmark, it is important to note that the NWS can dispatch an EMS vehicle while obtaining information from the initial caller.

5.4 TIME TAKEN TO IDENTIFY AN AVAILABLE EMS VEHICLE

Once all the information has been captured, the closest most appropriate vehicles need to be identified and the details of the call are provided to the crews. The CoJEMS were considerably slower in this activity, with the average time of 2 minutes and 10 seconds, more than double that of the NWS (Chart 4.2). A significant finding of this study was the longest time for the NWS to complete this activity was 10 minutes; however, the CoJEMS had a time of over 2 hours. The decision that the EMS dispatchers are required to make are often complex and constantly changing as new information is received. Furthermore, the decisions that the EMS dispatchers make when dispatching EMS crews will have an impact on the availability of ambulances later on (Wong & Blandford 2011; Finlayson 2017). This may be one of multiple factors that have resulted in the delays identified for the CoJEMS during the research study.

A further contributing factor is found in structures in which the EMS call takers and the EMS dispatchers are separate. The fact that the CoJEMS call takers and EMS dispatchers work separately from one another delays the time for this activity as it is only once the call taker has completed the task can they send the call details through to the EMS dispatcher. The EMS dispatcher is then only able to acknowledge the new emergency call, identify the area of the call, as well as the closest fire station and EMS vehicle that will be able to attend to the emergency.

The NWS central communications centre call takers work closely with the EMS dispatchers and as data is captured regarding the location of the emergency and the priority of the emergency is confirmed, an EMS vehicle can immediately be located and the EMS crews can be provided with the

details of the emergency incident. The remaining details can then be captured by the NWS call taker while a vehicle is being dispatched and proceeding to the incident location. This close working relationship and integration of the call taking and dispatching computer systems allows for an overall reduction in this time interval.

Although a close working relationship between the call takers and dispatcher is important, there are additional factors that play an important role in the identification of available EMS vehicles. As mentioned in this study, the CoJEMS have 30 fire stations positioned through the CoJ at which the EMS vehicles are stationed. The CoJEMS currently operate around 70 ambulances and 6 primary response vehicles daily. If one included the additional vehicles that the CoJEMS have available through the fire service, it would increase the number of EMS vehicles available to attend to emergency incidents to over 100 EMS vehicles daily. Although this allows for additional resources to be available should it become necessary, the ultimate goal is still ensuring the patient arrives at a suitable medical facility. Although assistance can be provided by the crews working on a fire engine, the primary aim of an EMS is to “improve the outcomes of a patient” (Al-Shaqsi 2010b) and the definitive care of a patient can only be started once the patient has arrived at a medical facility or hospital.

The NWS operate over 1000 EMS vehicles daily (NHS 2017) which translates into a greater availability of EMS vehicles to attend to the emergency incidents.

An additional fact that may influence this time interval is that the CoJEMS EMS crews are contacted with the use of portable two-way radio communications and in extreme circumstance, by way of cellular communication. The large areas that the CoJEMS vehicles need to cover result in the loss of cellular or radio communications networks in certain areas, making it difficult, or sometimes impossible, for dispatchers to get in touch with EMS crews. The emergency calls are then left unattended until the dispatchers can contact the EMS crews to provide them with the necessary information.

The CoJEMS vehicles are not fitted with any tracking devices which make it exceptionally difficult for the dispatchers to know when vehicles have completed previous emergency calls and the current location of the EMS crews and vehicles. This may result in the fact that the dispatchers are not able to contact the EMS crews while they are handing over their patient in the emergency department, cleaning their vehicles, or returning to their fire-station base. The EMS dispatchers are then unable to contact the EMS crews and the calls are then left unattended, resulting in the large delays in the activities that occur during this time interval.

The factors above lead to the inconsistency found within the CoJEMS as noted in Chart 4.2 with a larger interquartile range (IQR). This is in contrast to the similar dataset for the NWAS in which the IQR is much smaller, indicating more consistency in achieving the mean time to EMS dispatch.

As mentioned previously, the total EMD response time interval should therefore be less than 60 seconds when the call is answered by the call taker, the necessary emergency incident details are captured, and the information is relayed to the EMS crews that will be responding to the emergency incident location. The close working relationship that the NWAS call takers and EMS dispatchers have allows for an overall reduction in the combination of the first two time intervals.

When the above activities are combined it is evident that the CoJEMS achieve a call time to dispatch of just under 4 minutes (1:45 and 2:10), when the CoJEMS dispatcher must wait until the call taker has completed the capturing of the emergency details until the call is received and the EMS dispatcher is able to source an appropriate vehicle to attend to the call. The NWAS, with a far more integrated call taking and EMS dispatch service, can dispatch an EMS vehicle within 1 minute of receiving the initial incoming call and therefore within the recommended guidelines (Meislin *et al.* 1999; Castren *et al.* 2008; Upson & Notarianni 2010).

5.5 TIME TAKEN FROM EMS VEHICLE DISPATCH TO ARRIVAL AT THE INCIDENT LOCATION

Once the EMS personnel have received the call details, the vehicle and crews are then required to respond to the incident locations as quickly and safely as possible, in order to render emergency care to patients. Analysis of the data sets revealed that the CoJEMS vehicles achieved an average response time of 15 minutes which is again double that of the 7:32 achieved by the NWAS. It is therefore noted that the NWAS were able to meet the internationally accepted 8-minute response time (Castren *et al.* 2008).

The importance of achieving a response time of less than 8 minutes is clearly shown for the management of cardiac and stroke victims (Castren *et al.* 2008; Weiss *et al.* 2013), as well as cases of trauma patients in which life-saving interventions—which include airway management and haemorrhage control initiated shortly after the injury—have been proven to save lives (Newgard 2010; Kue *et al.* 2015). In a country where violent crime, road traffic accidents and cardiovascular disease are prevalent, determining the reasons for an increase in EMS vehicle response times is vital as it will provide a better understanding and may lead to the implementation of effective strategies to reduce EMS vehicle response times.

Several factors may have an impact on this time interval. As previously pointed out, the CoJEMS have 30 fire stations from where the EMS vehicles operate and, at the time of the study, were operating an average of 70 ambulance and 6 primary response vehicles daily. These fire stations are strategically placed throughout CoJ. However, the distances between the fire stations and the major hospitals to which the EMS crews must deliver their patients is between 10km and 20km in the city centre, while the outlying areas need to cover distances over 50km to get to medical facilities. EMS crews are required to return to their respective fire stations on completion of a call, while it may not be necessary at a given time. In comparison, the NWS have 1000 ambulances and the evidence is seen in the fact that the NWS achieve a response time of less than half that of the CoJEMS.

Although not unique to the CoJ, the lack of a public transport system that is able to accommodate the majority of the residents of the CoJ has a direct impact on the number of personal vehicles making use of the roads within the CoJ. This places a huge number of vehicles on the roads which the EMS crews must take into consideration when responding to emergency incidents. Studies have been conducted in South Africa that looked at the dynamic placement of ambulances (Stein, Wallis & Adetunji 2015a) and increasing the number of EMS vehicles (Stein, Wallis & Adetunji 2015b) to improve response times. In a country that is facing many economic challenges, placing additional vehicles has additional costs without a real improvement in service delivery. The dynamic placement of EMS vehicles may well be a beneficial for the CoJEMS to improve response times, and this is worth exploring further.

Furthermore, with the lack of active EMS vehicle tracking, the EMS dispatchers may provide the crews with the necessary information regarding the emergency and incident location; it may be that the EMS crews are still at the medical facilities cleaning their vehicles, completing paperwork or any other reason not to immediately drive to the incident location. The delays in any of these activities has a direct impact on the EMS vehicle response times.

5.6 OVERALL RESPONSE TIMES

In line with the accepted definition of the response time, in this study this was the time taken from the emergency call being received by the communications centre until the arrival of the first EMS vehicle at the incident location (Castren *et al.* 2008). In a comparison of these times, it was clear that the NWS achieved much faster response times when compared to the CoJEMS. It was also noted that the CoJEMS mean EMS response time is also considerably slower than the South African national norm of a 15-minute EMS response time.

Although the CoJEMS receive almost five times fewer calls annually than the NWAS, the number of available EMS vehicles that the NWAS can use is almost ten times that of the CoJEMS. Furthermore, the NWAS having more EMS vehicles and the fact that the integrated call taking and EMS dispatching allows for immediate dispatch of the EMS vehicles following receipt of the emergency call also contributes towards a faster EMS activation and response time.

The CoJEMS have considerably less EMS vehicles than NWAS, with large distances identified between the receiving facilities and the respective EMS base station, which is at a CoJ fire station. Without a vehicle tracking system, the CoJEMS dispatchers dispatch the EMS vehicles based on the proximity of the call to the fire station at which the EMS vehicles will be stationed, which may not be the closest EMS vehicle to the incident. This often results in the EMS vehicles still at the medical facilities at which the EMS crews are still handing the patient over to when they receive the next emergency call. The EMS crews are then required to clean their vehicles, and then still respond large distances to return to the area they are stationed at before the EMS crews can start looking for the address of the incident location.

5.7 THE PATIENT JOURNEY

Meislin, *et al.* (1999) identified the overall patient journey as that of the pre-hospital interval, as well as a time following arrival at the receiving medical facility where the hospital staff receive the patient during a patient hand over, until the vehicle becomes available again for the next call or is operational again. As part of The Patient Journey, the aim of an EMS is ultimately the safe arrival of a patient to a medical facility where definitive treatment can be started, in the shortest possible time. The South African National EMS regulation (Health 2015) defines an EMS as “a person, organization or body that is dedicated, staffed and equipped to offer emergency medical care, inter-health facility medical treatment or transport of the ill or injured”. This not only has a direct impact on the mortality and morbidity of a patient, but will also impact those available resources within an EMS.

Several factors may influence this time. These may include the time spent on scene stabilising the patient before transportation (Vincent-Lambert & Mottershaw 2017), the distance to a medical facility that can manage the patient’s condition (Budge, Ingolfsson & Zerom 2008), 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.

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 documentation, the vehicle to be cleaned according to the local protocols and guidelines, and equipment replaced and restocked.

Several factors play a direct role in the availability of the vehicle and these include the type of patient who was treated and transported. While many of the patients attended to by EMS personnel require little invasive intervention, there are patients who are critically ill or injured who require major intervention during transportation to the medical facility, who leave the vehicle in a condition where body fluids (such as blood and vomitus) must be thoroughly cleaned and disinfected before the vehicle becomes fully operational to attend to the next incident. Furthermore, large amounts of equipment may have been used that must now be replaced, all of which add to the time following the delivery of the patient and affect the availability of the EMS crews and vehicle.

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.

As mentioned in chapter one of the research study, the researcher identified the need through personal experiences while attending to emergency incidents that contributed or led to the need for the research to be completed. It was during the researcher's time actively working in the CoJEMS that the researcher experienced lengthy delays in handing patients over to medical staff at receiving facilities. Some of the experiences encountered by the researcher included:

- a) Several medical facilities would refuse to accept the patient unless a hospital file had been opened by the ambulance crews. This required one of the ambulance crews to stand in the queue at the reception of the receiving facilities emergency department (ED), provide the clerk with the patient information, and wait for a hospital file to be opened and printed. The file was then taken with the patient to the medical personnel in the ED who would then receive the patient hand over, and accept the patient onto the bed of the receiving facility. Only then would the ambulance crews be released to complete documentation and clean their ambulance.
- b) With the limited number of receiving hospital in Johannesburg, the hospital EDs are often full of patients who have either been brought in by other EMS providers or taken in privately. This results in delays while the receiving facility staff are trying to find a bed on which to

place the patient.

- c) Some receiving facilities have a process of screening and triaging of the patients brought in by the EMS crews. This triage process is often done when a medical staff member becomes available.
- d) Where the EMS crews attended to a critical patient where a large amount of equipment was used to stabilise and treat a patient, the EMS crews would then be required to return to their respective fire-station bases where the EMS crews can replace the equipment used and become available to be deployed. Since the CoJEMS only have 30 fire stations over an area of 1644km² (Figure 2.4), the distances between a medical facility and the fire station where the EMS vehicle can be restocked can be up to 40km, depending on where the EMS vehicle and crews are based.
- e) With limited state hospitals, there are times when the receiving facilities are full to capacity and are then placed on “ambulance divert”, which would then require the EMS crews to find another available medical facility that is open to accept the patient. This again adds to the overall time spent with the patient as the next available medical facility may be quite a distance away.

Several factors that impact on overall EMS response times may occur at any point along The Patient Journey. During the research it was noted that the average overall call time for the CoJEMS, from the time that the first emergency call is received by the EMS command centre until the patient is handed over at the receiving facility and the EMS vehicle and crews are ready for the next emergency call is a mean time of just over 2 hours (Chart 4.5) and a mean time that the EMS crews are spending with the patient is just over 40 minutes (Chart 4.6). It is further evident that the IQR of both these time intervals is narrow, showing that the CoJEMS consistently achieve these mean times. Although there were times when the CoJEMS vehicles were unavailable for more than 8 hours, these were the exception and possibly as a result of prolonged extrication following a road traffic accident or a medical facility that was unable to receive the patient and the EMS crews were required to divert to another facility resulting in a patient time of close to 5 hours.

When one considers that the mean CoJEMS response time is 23 minutes and a patient time of 40 minutes, the CoJEMS 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 service such as the CoJEMS where there are only 70

ambulance operational, which is already well below the World Health Organisation (WHO) recommendation of 1 ambulance per 100 000 people (WHO 2017). The impact is evident in the time intervals for the identified activities of this research study when the EMS dispatchers are unable to get in contact with the EMS crews and vehicles, resulting in emergency calls being delayed with a potential impact on patient mortality and morbidity.

Call Time (36:00; 2:11:00; 8:41:00) vs Patient Time (1:18; 43:21; 4:58:59)

5.8 SUMMARY

This chapter presented some of the central findings of the research and contains a detailed discussion of the results presented in Chapter 4, as well as an in-depth discussion of these results as they relate to the study objectives identified in Chapter 1.

In summary, the researcher included 784 emergency calls for the CoJEMS, and 786 emergency calls for the NWAS, which was a statistically fair representation of the overall emergency calls received.

The data collected was analysed and it was found that the CoJEMS are unable to meet the internationally accepted response times as defined by Castren (Castren *et al.* 2008) as well as the South African national norm for EMS response time of 15 minutes. The CoJEMS compared favourably with the NWAS in receiving the incoming emergency call and capturing the details regarding the emergency call. The time differences became evident during the identification of the available EMS vehicle and increased during the EMS vehicle response time for the CoJEMS and NWAS and this resulted in an overall response time for the CoJEMS that is considerably slower than the NWAS, and well below the local and internationally accepted response time.

The researcher noted several potential factors within each of the identified time intervals that may impact negatively on the overall response times of the CoJEMS. These included the lack of an integrated EMS call taking and EMS dispatcher, shortage of available EMS vehicles, potential distances the EMS vehicles are required to travel and an increased overall call time.

The following chapter presents a summary of the research study, the limitations of this study, and recommendations and potential for further related research.

CHAPTER 6 - SUMMARY, RECOMMENDATIONS, LIMITATIONS AND CONCLUSION

6.1 INTRODUCTION

This final chapter provides a summary of the research including selected recommendations for future practice. The chapter will also present some of the limitations to the study, as well as suggestions for further research opportunities.

6.2 SUMMARY OF THE DISSERTATION

In Chapter 1, the researcher introduced and provided a background to the study which was to document, describe and compare response-time intervals for the City of Johannesburg Emergency Management Services (CoJEMS) in South Africa and the North West Ambulances Services (NWAS) in the UK. Chapter 1 also introduced the research problem that gave rise to the focus and aim and potential value of the study for the Emergency Medical Services (EMS).

Chapter 2 presented the current literature related to the aim of the study. Through the literature review the researcher was able to identify response time as an important measure of an effective EMS that is still used as the primary measure of an EMS. The researcher identified that a reduction in EMS response time has been proven to reduce morbidity and mortality in both trauma and medical emergencies (Newgard 2010; Blanchard *et al.* 2012; Weiss *et al.* 2013). Through the literature review, it was further identified that there are several activities that take place from the time of the emergency taking place until the patient arrives at a medical facility for definitive care, making up The Patient Journey (Castren *et al.* 2008). Although previous literature had identified the Emergency Medical Dispatch (EMD) time interval and the EMS response time interval, the literature failed to identify the effect that the specific activities within these time intervals have on the overall EMS response time and patient journey.

Chapter 3 discussed the research setting and design of the research study. The chapter further presented the arguments for the use of a quantitative descriptive study using prospective data, as well as ethical considerations of the study.

Chapter 4 presented the results of the study in the form of Box and Whisker charts that allowed for

ease of interpretation.

Chapter 5 provided a discussion of the results presented in Chapter 4 within the context of the study and pre-existing literature.

This final chapter (Chapter 6) provides a summary of the research study, along with limitations to the study and recommendations for further research.

The main findings of the research included:

- (a) The CoJEMS and the NWAS were able to answer the incoming emergency calls and record the relevant details regarding the emergency in-line with international recommendations (Castren *et al.* 2008; Upson & Notarianni 2010).
- (b) The CoJEMS took considerably longer to find an available EMS vehicle to be dispatched to the emergency incident location. This could be due to there not being a clear link between the CoJEMS call takers and EMS dispatchers, as well as the fact that the CoJEMS have fewer EMS vehicles when compared to the NWAS.
- (c) Response times for the CoJEMS fell outside of both the internationally accepted response times of 8 minutes (Upson & Notarianni 2010). CoJEMS were also unable to consistently meet the accepted South African EMS response time of 15 minutes (Newton 2013; Finlayson 2017).
- (d) In contrast to the CoJEMS, the NWAS was noted to operate within the accepted norms for overall response times.
- (e) The CoJEMS EMS vehicles and crews spent only 50% of the total call time with the patient, which requires further investigation as this is valuable time that EMS vehicles are unavailable to attend to the next emergency call, leaving EMS dispatchers with calls that are incapable of dispatch.

6.3 RECOMMENDATIONS

Following the analysis and interpretation of the results of this study, the following recommendations can be made:

- (a) The CoJEMS to improve the relationship between the call takers and EMS dispatchers within

the central communications centre. This must include the training and education of the personnel/staff working within the central communications centre as well as an upgrade of the IT infrastructure. The evidence visible in the interpretation of the data, where a close relationship was evident in the NWAS, allowed for immediate dispatch of the EMS vehicles and crews, while further information was being received from the initial caller. This prevented delays in waiting for the capturing of the call details to be completed before the EMS vehicles are identified and dispatched to the incident location.

- (b) Installation of a reliable vehicle tracking system in order for the CoJEMS EMS dispatchers to correctly and rapidly identify the location of all EMS vehicles within the fleet. This will not only allow the EMS dispatchers to quickly identify all the EMS vehicles within the CoJEMS, but it will also allow for the collection of valuable data regarding distances travelled by the EMS vehicles, with the possibility of investigating alternative placement of the EMS vehicles, or dynamic placement of EMS vehicles as has been implemented in EMS systems.
- (c) Education and training of the EMS call takers and dispatchers to be able to recognise medical emergencies through description provided by the incoming caller. The CoJEMS, and possibly South African EMS, must investigate the development of a dedicated emergency services call-taking and dispatching qualification.
- (d) Installation of a Medical Priority Dispatch System (MPDS) that is currently available in South Africa (Newton 2013; Finlayson 2017) will also provide the EMS call takers and dispatcher with much needed guidance in prioritising incoming emergency calls.
- (e) Discussions with the major hospitals to facilitate the handing over of the patient's at their emergency departments. Although not the focus of this study, the limited availability of EMS vehicles was apparent through the study, and a major contributing factor could be the time the EMS crews are spending with activities that are not directly related to their core function, such as the opening of patient files for the administrative staff at the hospitals.

6.4 POTENTIAL CONTRIBUTION OF THIS STUDY

This study revealed that there are several activities that take place during the activation, dispatch and arrival of an EMS during an emergency. Each of the identified activities has an impact on the time taken to respond to emergency calls. The effect that the availability of the limited resources has on each of these activities was highlighted during the study. The possible contributions that this study revealed are:

- (a) Before this study the South African EMS were unable to benchmark the EMS response times to any international role player. Although benchmarking within EMS in South Africa had been researched previously, the efficiency was based on the local norms and standards. This study provides evidence to benchmark the efficiency of a South African EMS (CoJEMS) when compared to an international EMS (NWS).
- (b) The very nature of the EMS in South Africa is rapidly evolving and must adapt to the change that is taking place. The changing of the social-economic climate worldwide will require an EMS to ensure available resources are used effectively, while providing an efficient EMS to the public. Results of previous studies conducted in South Africa revealed that an increase in EMS vehicles will not always result in a reduction in EMS response times (Stein, Wallis & Adetunji 2015b). Together with an increase in the available resources, the CoJEMS must develop a closer relationship with private EMS operating in the CoJ.
- (c) Furthermore, the changes in the global burden of diseases will require an EMS to adapt to these changes based on these demands. Further research must be undertaken to investigate how these impact on the EMS and the demands that will be placed on the EMS.
- (d) The evolution in the training and education of the pre-hospital emergency care providers has historically been focused on treatment of the patient. The only qualifications that an emergency call taker or dispatcher is required to have is a four-week certificate course known as the Basic Ambulance Assistant (BAA), with no call taking or EMS dispatching qualifications. Although “in-service” training is provided, this may limit the ability of call takers and EMS dispatchers to make complex and dynamic decisions based on the priority of the emergency and the available resources. The need therefore exists to develop a formal training and education programme for the South African EMS environment that will include all aspects of the emergency services.

6.5 STUDY LIMITATIONS

As with any research study, this study presented limitations that may have an impact on the validity and reliability of the findings. The researcher acknowledges the following limitations:

- a) Although the sample data was obtained to obtain a specific number of emergency calls, there was no differentiation between night shifts and day shifts, school holidays, weekends or week days. This study focused on emergency calls responded to during a particular time period with no specific differentiation between nights and days, weekends or week days or the school holiday periods. The researcher acknowledges that the results may change for different time

periods and further research may be necessary to determine if there are any significant differences in response times during peak and off-peak periods.

- b) All emergency calls received and dispatched by the central communications centres for both the CoJEMS and the NWAS were included in the study, providing aggregate data for all emergency call types and priorities. It is acknowledged that EMS differentiates and prioritises incoming emergency calls differently based on the nature of the emergency. EMS response times may be different based on the priority of the incoming emergency call and further studies could look into these differences.
- c) It is acknowledged that the study made use of a small sample. Despite the small sample size in terms of calls logged, the sample size was sufficiently powered to achieve the aim of the study.
- d) In the case of the NWAS, data was collected from a database that had all the data requirements necessary for the research study. It was assumed that the data was accurately extracted and placed onto the data collection tool however as this was self-reported it is possible that certain data sets may have been inaccurately captured. The CoJEMS do not have an accurate database to draw the complete set of data from and due to the difference between the call taking and EMS dispatching departments within the CoJEMS, as highlighted in the study, prospective data was collected manually by research assistants. Making use of more research assistants may have captured a larger volume of calls during the determined time period which may add significant value to the study.

6.6 PROPOSALS FOR FURTHER STUDY

As mentioned in this chapter, the research revealed the need for the development of a recognised emergency services call taking and dispatching qualification. Research needs to be conducted into the feasibility of the design of a formal qualification focused on all aspects of emergency services, including the fire services, and EMS, as well as the police services.

Furthermore, the need exists within the CoJEMS to investigate the long turnaround times for the CoJEMS vehicles at the receiving medical facilities. Further research into the reasons for the EMS crews long turn-around time at the receiving facilities and ways in which these can be eliminated to reduce the time that the EMS vehicles are unavailable may result in an improved overall EMS response time and an improved service delivery.

6.7 CONCLUSION

In this study, the researcher used quantitative data collected for the CoJEMS and the N WAS to answer the research questions asked in Chapter 1. Through the literature review it was evident that the need to determine how the individual activities that take place during the EMS response impact on the overall response times. The research revealed that there were certain similarities between the CoJEMS and the N WAS. The research also revealed several challenges that do exist within the South African EMS that make it impossible to meet the national norm for EMS response times, which are considerably slower than the internationally accepted EMS response times. As response times are used to measure the efficiency of the CoJEMS, the findings of this study may provide valuable evidence to the management of the CoJEMS to develop policies and guidelines to improve the service provided to the citizens of the CoJ by reducing the EMS response times. There may also be a need to determine whether the current national EMS response times norms are achievable and what adaptations must be made if these response times can be achieved.

Although EMS response times are still being used to determine the effectiveness of an EMS, the aim of any EMS must be to improve patient outcomes through a reduction in morbidity and mortality and it is therefore necessary to identify any factors that will impact positively on patient outcomes.

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**ANNEXURE A – Letter to the City of Johannesburg Emergency
Management Services**

Attention: Mr L. Makola
Executive Head
Emergency Management Services

26th April 2016

Re: Permission to conduct research with City of Johannesburg EMS

I am currently enrolled at the Durban University of Technology (DUT) to complete the Master of Technology in Emergency Medical Care. Completion of the degree requires a full research project.

The research I would like to conduct is entitled “***An analysis of response-time intervals for a public sector emergency service in Johannesburg, South Africa: A comparative study.***”

The proposed research will be conducted using a Prospective, Quantitative Descriptive Survey Design. Data collection will be done through the command centre, and this data will then be correlated with the different vehicles based at the individual stations, from which information will be extrapolated and the results of which will be analyzed.

The results of this research may assist CoJEMS to determine whether the current response time intervals are in line with local and international standards, from which data can be drawn to identify ways to improve the response time intervals, and patient times, with the potential of improvement in patient outcomes. Furthermore, results of the study can be analysed to identify areas that may impact negatively on response times. Enabling measures can be put in place to reduce the delays in patients arriving at medical facilities

In order for my research proposal to be accepted by the Department of Emergency Medical Care and Rescue, I need pre-approval or full approval to conduct this research.

I have attached the concept document I presented to Durban University for research approval, as well as a draft Proposal due for submission and approval to the Department of Research at DUT.

My approved proposal will be made available to you once I have DUT approval.

I would appreciate your permission in this regard.

Kind regards

Wynand Van Der Net

ANNEXURE B – Approval by the City of Johannesburg Emergency Management Services



a world class African city



City of Johannesburg
Emergency Management Services

Public Safety Headquarters PO Box 14961 Tel: +27(0) 11 768 9100
196 Main Road Johannesburg Fax: +27(0) 11 768 2189
Maitland South Africa 2000

To: Mr. W. Van Der Net
Principal Investigator
Durban University of Technology

From: Mr. A. Mqwa
Acting Executive Head
EMS

11 September 2018

**RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH: AN ANALYSIS OF
RESPONSE TIME IN INTERVALS FOR A PUBLIC SECTOR EMERGENCY SERVICE IN
JOHANNESBURG, SOUTH AFRICA: A COMPARATIVE STUDY**

Dear Mr. W. Van Der Net

After considering all documents submitted to City of Johannesburg: Emergency Management Services, I hereby confirm that, **Mr. W. Van der Net MAY / MAY NOT** conduct her research study in the City Of Johannesburg: Emergency Management Services.

Yours Sincerely

**A. MQWA
ACTING EXECUTIVE HEAD
PUBLIC SAFETY
EMS**

ONCE PERMISSION IS GRANTED-

THE FOLLOWING CONDITIONS SHOULD BE ADHERED TO:

- Findings / results to be made available to CoJEMS Executive Management.
- Recommendations to be suggested based on the outcome of the study.
- Implications to be suggested.

I acknowledge and will abide to the conditions listed above.

**MR. W VAN DER NET
PRINCIPAL INVESTIGATOR
UNIVERSITY OF JOHANNESBURG**

ANNEXURE C – Letter to the North West Ambulance Service



North West Ambulance Service



NHS Trust

Research and Development Proposal Pro-forma

This form must be completed for all research studies within or by the Trust. The proposal needs to be approved by the Clinical Governance & Safety Sub- committee. Please contact the Clinical Governance Co-ordinator at Trust Headquarters should you require any assistance in completing the form or any other queries.

Name of proposer / principal investigator	Wynand Van Der Net
Job Title	Divisional Chief: Training Academy
Directorate	City of Johannesburg Emergency Management Services (CoJEMS)
Date of proposal submission	September 2016

Title of Research Study
An analysis of response time intervals for a public sector emergency service in Johannesburg, South Africa: A comparative study.

Background (Why do you want to undertake the research, what has prompted this study?)
The City of Johannesburg Emergency Management Services (CoJEMS) is a municipal EMS service that provides the emergency medical services its citizens as a service provider to the Gauteng provincial government. Response times in Gauteng have been used as a measure of effectiveness for a number of years, with the current response time target of less than 15 minutes for priority 1 calls being the accepted standard. Response times are also not well defined as to when they begin and end. Response time can be broken into a number of set intervals, certain services consider the response time to include from the time the call is answered in the call centre to the

arrival of the first responding unit. Others only include the time from when the responding unit is despatched until their arrival on scene. It is argued that from the perspective of the ill or injured patient response time should include the time from when their call is answered by the call centre until help arrives. It is therefore important to firstly determine the current response-time intervals of CoJEMS and then compare these to international data.

Aim of the Study (What are you trying to achieve, your expectations?)

The purpose of the study is to document, analyse and describe, the time intervals taken to complete each of the generic activities routinely associated with EMS activation and response to emergency incidents within the City of Johannesburg Emergency Management Services (CoJEMS).

It is the intention of the researcher to compare the response-time intervals described in this study to response-time intervals for a purposefully identified international role player/ ambulance service operating within a similar context to the CoJEMS.

The results of this research may assist CoJEMS in determining whether the current EMS activation times and subsequent response times are in line with local and international standards, and to consider measures to improve these times, and reduce patient journey times.

Objectives (what aspects of care or practice are to be examined?)

The main objective of the research is to determine response-time intervals and the researcher aims to investigate the following three main objectives:

1. To determine the following:
 - *Time intervals from when calls are received until they are categorised as emergency incidents, in line with the dispatch criteria, by the central command centre*
 - *Times taken to capture the details, and allocate incident numbers*
 - *Times taken for call takers to forward calls to the dispatchers*
 - *Times taken for the dispatcher to identify the first available vehicle to dispatch to the incident.*

- *Time intervals from when the vehicle is dispatched, to the time that the vehicle arrives at the incident location.*
2. To critically compare the above data sets to similar data sets from a participating international role player/ ambulance service.
 3. To recommend strategies that may improve local response times.

Study Plan

How do you propose to collect the data?

The sampled population will include all calls received by the CoJ EMS central command centre, in accordance with the CoJ EMS priority dispatching criteria (Annexure A). Incoming calls will be screened, and once it is determined the call meets the CoJEMS priority dispatching criteria, the call will be followed until the first arriving CoJ EMS unit arrives at the incident address.

The researcher will make use of research assistants to collect data at the central command centre, and the researcher will be present during the predetermined data collection periods. Information that will be required will include the date of the incident, the incident number, priority of the incident, the time the incident is captured by the central command centre, the time the first vehicle is dispatched to the incident, the type of first vehicle dispatched to the incident, the time of the CoJEMS ambulance dispatched to the scene, and the arrival time of the different CoJEMS vehicle/s at the incident.

Data collected during the identified times is a fair representation of the annual call volumes and different call types responded to by the CoJEMS and will involve the collection of data from the computer system where calls are logged.

Sample size (indicate how this was calculated and whether any advice was sought in calculating it?)

After consultation with the Durban University of Technology appointed statistician a sample size of 779 calls has been determined as a sufficiently powered to observe a power of 80% and to detect a small to medium effect.

Method of analysis

Data will be analysed using the latest version of the IBM SPSS software, and the statistical results will be reported on. The data captured in the tool, will be analysed

using simple descriptive statistics, ie response-time intervals will be reported in terms of average, median and mode. The results will be depicted in the form of graphs, tables and charts with accompanying narratives where applicable.

Who is going to collect the data?

Data collection will be managed by the supervisor, making use of research assistants. In order not to impact on the work of the central command centre staff, the researcher will make use of “research assistants” to record the information required for the research project. The time that the call is initially received will be captured to determine the actual time of day the call is received, and to ensure validity of the data, the research assistants will be provided with the same electronic timing device for recording of the actual times taken for each interval.

Timescale (to collect the data, to analyse the data?)

Once the research proposal has been accepted, and approved, the researcher will commence with the data collection. The research has determined that the data collection can be concluded within a month following the approval.

Details of costs/resource implications (if applicable)

The researcher will cover the costs associated with the research and these include the statistician, editor, as well as the printing and binding of the final product. These costs are approved by the Durban University of Technology where the researcher is a registered student. There are no additional costs to any participants.

Please confirm that you have attached the following documents:

(Delete as appropriate)

Background research undertaken (i.e. Literature review)	Y
Information about patient involvement in the study (in the study design)	Y

Arrangements for obtaining informed consent & identifying participants	Y
Questionnaires or surveys to be used	N/A
Risk assessment	Y
Strategy for dissemination	N

Ethical status:

Please confirm the stage that the NRES application of the study is at:

Please confirm that you are familiar with:

(Delete as appropriate)

The Data Protection Act and other legal provisions/guidance	N
The Internal Adverse Incident Process	N
The requirements of the Trust's Research Governance Framework	N

Proposed study start date	October 2016
Proposed study finish date	December 2016
Expected date of final report	June 2017

Notes

- *The proposal form is to inform the approval process. The proposal will be considered against the Trust's R&D Framework before being submitted for final approval at the Clinical Governance & Safety sub-committee.*
- *You will be notified in writing of the approval decision.*
- *Research outcomes will be reported to the Board through the Clinical Governance sub-committee and may be used in the Trust Annual Report.*
- *All findings and intellectual property rights will belong to the Trust under the terms of the employment contract.*
- *The Trust reserves the right to at no cost reproduce and use any findings for its own non-commercial purposes.*

ANNEXURE D – Approval by the North West Ambulance Service



North West Ambulance Service **NHS**
NHS Trust

Headquarters
Ladybridge Hall
399 Chorley New Road Heaton,
Bolton BL1 5DD
Tel: 01204 498400 Fax: 01204 498423
www.nwas.nhs.uk

Headquarters: Ladybridge Hall, 399 Chorley New Road, Bolton. BL1 5DD **Chair:** Ms W Dignan **Chief Executive:** Mr D Cartwright

Wynand Van Der Net

20th September 2016

Dear Wynand

Re: An analysis of response time intervals for a public sector emergency service in Johannesburg, South Africa: A comparative study.

Thank you for approaching Nwas NHS Trust with regard to your study, and for completing the Trust R&D Proposal pro-forma.

I am pleased to advise you following phase 2 review by the Clinical Leadership Group a decision has been made to formally approve and adopt your study into the Nwas current R&D portfolio **as it meets the requirements to be considered as service evaluation**

Please ensure that you have made yourself familiar with the Nwas R&D Framework requirements; the framework can be located on Nwas intranet or I can forward a copy on to you should you require.

Your project has been assigned the following unique number and this should be indicated on all correspondence with regard to your study: **Nwas 2016_2017 116**

The next step is for you to provide update reports, so that the Clinical Leadership Board and other sub-committees can be informed of your projects progress.

I take this opportunity to wish you well with your study, and do not hesitate to contact me should you require any further assistance with the Nwas R&D Framework process.

Kind Regards,

pp *M. Kane*

Clinical Quality Manager

Mary Peters

Senior Clinical Quality Manager



North West Ambulance Service

NHS Trust

Headquarters
 Ladybridge Hall
 399 Chorley New Road
 Heaton, Bolton
 BL1 5DD
 Tel: 01204 498400
 Fax: 01204 498423
www.nwas.nhs.uk

Wynand Van Der Net

20th September 2016

Dear Wynand

Re: An analysis of response time intervals for a public sector emergency service in Johannesburg, South Africa: A comparative study.

Thank you for approaching NWAS NHS Trust with regard to your study, and for completing the Trust R&D Proposal pro-forma.

I am pleased to advise you following phase 2 review by the Clinical Leadership Group a decision has been made to formally approve and adopt your study into the NWAS current R&D portfolio as it meets the requirements to be considered as service evaluation

Please ensure that you have made yourself familiar with the NWAS R&D Framework requirements; the framework can be located on NWAS intranet or I can forward a copy on to you should you require.

Your project has been assigned the following unique number and this should be indicated on all correspondence with regard to your study: **NWAS 2016_2017 116**

The next step is for you to provide update reports, so that the Clinical Leadership Board and other sub-committees can be informed of your projects progress.

I take this opportunity to wish you well with your study, and do not hesitate to contact me should you require any further assistance with the NWAS R&D Framework process.

Kind Regards,

pp *M. Kane*

Clinical Quality Manager

Mary Peters

Senior Clinical Quality Manager

Headquarters: Ladybridge Hall, 399 Chorley New Road, Bolton. BL1 5DD

Chair: Ms W Dignan

Chief Executive: Mr D Cartwright



Champion



Delivering the right care, at the right time, in the right place

ANNEXURE E – The Data Collection Tool

[illegible]

ANNEXURE F – Statistical Analysis of Minimum Number of Calls Required

Webmail :: RE: Re: Masters Proposal

http://www.webmail.co.za/rc/?_task=mail&_safe=0&_uid=37370&_r

Subject RE: Re: Masters Proposal

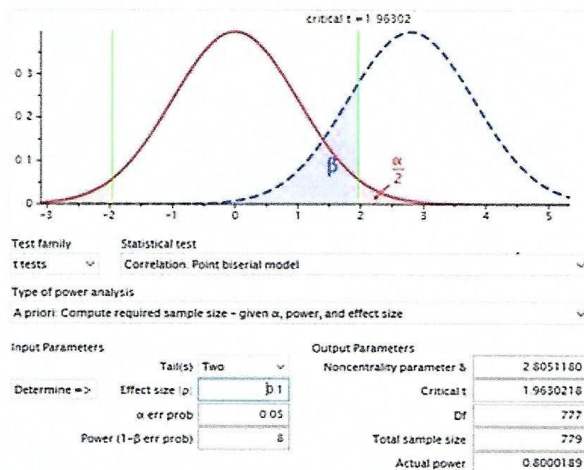
From Deepak Singh <singhd@dut.ac.za>

To Wynand van <vdnet@webmail.co.za>

Date 2016-07-26 17:23

Hi Wynand

Please see below.



What this says is that to observe a power of 80% and to be able to detect a small to medium effect, a sample of 779 is required.

Best wishes

Deepak

From: Wynand van [mailto:vdnet@webmail.co.za]

Sent: Tuesday, 26 July 2016 1:00 PM

To: Deepak Singh <singhd@dut.ac.za>

Subject: RE: Re: Masters Proposal

Hi Deepak

Wow, thanks for the quick response.

ANNEXURE G – Ethical Clearance from Durban University of Technology (DUT)



20 November 2017

Mr W Van Der Net
37 Lebombo
Montpark Drive
Montgomery Park

Dear Mr Van Der Net

ACKNOWLEDGEMENT OF RECEIPT OF APPLICATION FOR ETHICAL APPROVAL

Title: A comparative study of emergency service response intervals in Johannesburg, South Africa and the North West Ambulance Service, United Kingdom.

Reference Number: REC 150/17

The Institutional Research Ethics Committee acknowledges receipt of your research proposal received on 10 November 2017 which is to be reviewed via the expedited process.

A reference number has been assigned to your proposal. You are required to quote this number for all queries relating to the study.

PLEASE NOTE THAT THIS IS NOT AN ETHICS APPROVAL LETTER

Yours Sincerely

Professor J K Adam
Chairperson: IREC

