AN EVALUATION OF THE APPROPRIATENESS OF EMERGENCY MEDICAL SERVICE (EMS) RESPONSES IN THE ETHEKWINI HEALTH DISTRICT OF KWAZULU-NATAL

A dissertation submitted in fulfilment of the requirements for the degree of Master of Technology: Emergency Medical Care in the Faculty of Health Sciences at the Durban University of Technology

Paul Richard Newton

January 2014

Department of Emergency Medical Care & Rescue

Durban University of Technology

SUPERVISOR: Mr Raveen Naidoo

CO-SUPERVISOR: Prof. Petra Brysiewicz

Declaration of Originality

This is to certify that the work herein is entirely my own and not of any other person, unless explicitly acknowledged (including citation of published and unpublished sources).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.

Signed: ______[redacted]______ Date: 24th January, 2014

Declaration of Ethical Clearance

I hereby certify that the research undertaken in this dissertation has the approval of the Institutional Research Ethics Committee of the Durban University of Technology, Durban.

Institutional Research Ethics Clearance Number: FHSEC 009/11

Signed: [redacted] Date: 24th January, 2014

Researcher: Mr P.R. Newton

Signed: [redacted] Date: 24th January, 2014

Supervisor: Mr R. Naidoo (MSc: Cardiology)

Signed: [redacted] Date: 24th January, 2014

Co-supervisor: Prof. P. Brysiewicz (PhD: Health Science)

Abstract

Introduction: The Emergency Medical Service (EMS) is required to respond to cases of life threatening illness or injury which may later be found to be non-emergent thus creating a mismatch between the dispatch of limited EMS resources and actual patient need. This study proposed that such a mismatch presently exists among South African urban EMS systems resulting in unacceptably high levels of inappropriate emergency responses. The purpose of this study therefore, was to evaluate the appropriateness of EMS responses in comparison to patient needs in a South African urban EMS system.

Methods: All emergency cases dispatched over a 72 hour period at the Emergency Medical Communication Centre (EMCC) of the eThekwini Emergency Medical and Rescue Service (EMRS), a public sector urban EMS system, were prospectively enrolled in a quantitative study employing a descriptive, comparative design. Computer generated Vehicle Control Forms (VCF) containing dispatch data were matched and compared with Patient Report Forms (PRF) containing epidemiological and clinical data to describe the nature and extent of inappropriate responses based on patient need. Data were subjected to simple descriptive analysis and comparisons were analysed with correlations and chi-square. The Pearson's r and Spearman's rho were used to establish significance between more than two variables.

Results:

A total of 1689 cases were enrolled in the study of which 1385 met the inclusion criteria; 304 cases were excluded due to incomplete or duplicated data. The demand for EMS resources fluctuated widely throughout the day with levels peaking at midday and declining sharply after midnight. The median response time across all priorities was 56 minutes (IQR 59min) with just under half (46.4%) of all cases having a response time of more than an hour and almost one in ten (9.5%) exceeding 2½ hours. Significant variations existed between dispatch and on-scene priority settings and category descriptors most notable of which was seen in the highest priority ‘red code’ category which constituted more than 56% of all cases dispatched yet accounted for less than 2% on-scene (p <0.001). Conversely, over 80% of ‘red code’ responses actually required a lower priority response. Similarly, significant discrepancies were seen in the allocation of resources compared to the interventional needs of patients where it was shown that more than 58% of all cases required no interventions and just under 36% required only basic life support (BLS) level interventions (p <0.001). Of those patients triaged as ‘red code’ on-scene, less than 12% were initially allocated an appropriate Advanced Life Support (ALS) level of response and, of particular concern, only 7% of patients found to be dead or ‘blue code’ on-scene were initially dedicated a ‘red code’ response.

Conclusion: South African urban EMS systems are presently unable to meet the needs of patients in terms of demand and matching resources to patient needs with evidently high levels of inconsistent and inappropriate responses resulting in sub-optimal use of limited resources.

Dedication

Albert Schweitzer said "Sometimes our light goes out but is blown into flame by another human being. Each of us owes deepest thanks to those who have rekindled this light." It is to those human beings who rekindled my light that this dissertation is dedicated.

To my loving mother Maureen who has unwaveringly supported me throughout my life in all things I have done, you made me who I am today.

To my devoted partner Ciaràn who never once doubted that I could do this, without your encouragement I may have given up.

To my dear friend, colleague and supervisor Raveen without whom I may never have started on this journey and who expertly led me to its end.

Acknowledgements

I would like to express the deepest appreciation to my primary research supervisor Mr. Raveen Naidoo, who continually and convincingly conveyed a spirit of adventure and a sense of excitement in regard to research and scholarship. Without his expert guidance and persistent help this dissertation would not have been possible.

I would also like to thank Professor Petra Brysiewicz, my co-supervisor, whose work demonstrated to me a deep concern for excellence in health science research, her expert guidance along with a deep understanding of the research process helped me to make this dissertation something more than I would have thought possible at the outset.

In addition, a thank you to my friends and colleagues at the Department of Emergency Medical Care and Rescue and the Faculty of Health Sciences of the Durban University of Technology who provided me with limitless opportunities and a support network that could not have been equalled elsewhere.

Finally, a special thank you to the KwaZulu-Natal Department of Health and the eThekwini Emergency Medical and Rescue Service for allowing me to conduct the research and for extending me their warmhearted hospitality.

Table of Contents

Declaration of Originality ... ii

Declaration of Ethical Clearance ... iii

Abstract ... iv

Dedication ... vi

Acknowledgements ... vii

Table of Contents ... viii

List of Figures ... xiv

List of Tables ... xvii

List of Appendices ... xix

List of Abbreviations ... xx

1 CHAPTER ONE: INTRODUCTION ... 1

1.1 Chapter Overview ... 1

1.2 The Researcher’s Interest in the Study ... 1

1.3 The Research Problem ... 2

1.4 Statement of Purpose and Study Objectives ... 4

1.5 Research Questions ... 4

1.6 Thesis Statement ... 5

1.7 Conceptual Framework ... 5

1.8 Study Rationale ... 7

1.9 Significance of the Study 8
1.10 Study Delimitations 9
1.11 Underlying Assumptions 11
1.12 Definition of Terms 11
1.13 Dissertation Structure 13
2 CHAPTER TWO: LITERATURE REVIEW 15
2.1 Chapter Overview 15
2.2 Search strategy 15
2.3 Introduction to EMS systems 17
2.4 Inappropriate use of EMS systems 19
2.5 Reform of EMS systems 21
2.6 Dispatch Decisions 23
2.6.1 Multi-tiered Dispatch 25
2.6.2 Priority Dispatch 27
2.6.3 Alternatives to Dispatch 34
2.7 On-Scene Decisions 37
2.7.1 Triage and Diagnosis 39
2.7.2 Patient Routing 41
2.7.3 Alternatives to Transportation 43
2.8 Dispatch versus On-Scene Prioritisation 45

2.9 Response Time Targets 47
2.10 Systems Status Management 51
2.10.1 Geographic Information Systems 51
2.10.2 Demand Pattern Analysis 53
2.10.3 Dynamic Location/Relocation 55
2.11 Summary 57
3 CHAPTER THREE: RESEARCH METHODOLOGY 60
3.1 Chapter Overview 60
3.2 Study Design 60
3.3 Validity of the Research Design 64
3.4 Research Setting and Site 66
3.4.1 KwaZulu-Natal 66
3.4.2 EThekwini Health District 67
3.4.3 Emergency Medical and Rescue Service (EMRS) 69
3.5 Population and Sample 80
3.6 Data Collection 81
3.7 Data Verification 82
3.8 Data Analysis 82
3.9 Ethical Considerations 83
3.10 Summary 86

4 CHAPTER FOUR: RESULTS ... 88

4.1 Chapter Overview ... 88

4.2 Patient Demographics ... 88

4.3 Resource Demand ... 88

4.4 Dispatch and Response Chronology ... 89

4.5 Analysis of Dispatch Priority and Resource Allocation ... 93

4.5.1 Dispatch Priorities ... 93

4.5.2 Incident Type Categories on Dispatch ... 94

4.5.3 Incident Descriptions on Dispatch ... 95

4.5.4 Qualification Level of Emergency Medical Dispatchers ... 99

4.5.5 Resource Allocation ... 100

4.6 Evaluation of On-Scene Patient Clinical Need ... 101

4.6.1 Triage Code Findings On-Scene ... 101

4.6.2 Incident Type Categories On-Scene ... 102

4.6.3 Incident Descriptions On-Scene ... 103

4.6.4 Qualification Levels of On-Scene Emergency Care Providers 106

4.6.5 On-Scene Interventions ... 106

4.7 Comparison of Dispatch and Patient Clinical Need ... 108

4.7.1 Dispatch Priority code versus On-scene Triage Code ... 108

4.7.2 Dispatch versus On-Scene Incident Types ... 111

4.7.3 Dispatch versus On-scene Incident Type Descriptions 112

4.7.4 Dispatched Resources versus On-Scene Interventions 115

4.8 Summary 119

5 CHAPTER FIVE: DISCUSSION 120

5.1 Chapter Overview 120

5.2 Response Times 120

5.2.1 Review of the Results 120

5.2.2 Increased Demand 123

5.2.3 The EMD Response Interval 125

5.2.4 The EMS Unit Response Interval 127

5.2.5 The Response Time Continuum 129

5.3 Patient Priorities, Incident Categories and Incident Descriptions .. 130

5.3.1 Review of the Results 130

5.3.2 Medical Priority Dispatch Systems (MPDS) 132

5.3.3 Incident Reporting Standards 133

5.4 Qualification Levels 134

5.4.1 Review of the Results 135

5.4.2 Emergency Medical Dispatch 137

5.4.3 Operational Division 138

5.5 Clinical Need and Resource Allocation 139

5.5.1 Review of the Results 140

5.5.2 Alternatives to Dispatch 142

5.5.3 Alternatives to Transport 144

5.6 Summary 147

6 CHAPTER SIX: CONCLUSION 148

6.1 Chapter Overview 148

6.2 Summary 148

6.3 Recommendations for Implementation 149

6.3.1 Systems Status Management 149

6.3.2 Medical Priority Dispatch System 150

6.3.3 Response Time Standards 150

6.3.4 Alternative Response Modes 150

6.3.5 Public Awareness 151

6.3.6 Reporting Standards 151

6.4 Recommendations for Research 151

6.4.1 National Research Agenda 151

6.4.2 National Integrated Information System 152

6.5 Limitations of the Study 153

7 APPENDICES 154

8 REFERENCES 170

List of Figures

Figure 1.1: The patient journey (Krafft *et al.* 2003)..................................... 10

Figure 3.1: Quantitative research decision tree (Keele 2010) 62

Figure 3.2: Organisational structure of the KwaZulu-Natal EMRS 70

Figure 3.3: Map of eThekwini with EMRS base locations (Geographic Information Systems Unit 2010)... 76

Figure 4.1: Fluctuations in the demand for EMS resources throughout the day 89

Figure 4.2: Median EMD response intervals across the different dispatch priorities 90

Figure 4.3: Median EMS unit response intervals across the different dispatch priorities 90

Figure 4.4: Median response times across the different dispatch priorities.. 91

Figure 4.5: Incremental response times across all dispatch priorities 92

Figure 4.6: Dispatch priorities across the different response time increments 92

Figure 4.7: Percentage distribution of dispatch prioritisation........................ 93

Figure 4.8: Frequency of incident description upon dispatch within the accident category... 95

Figure 4.9: Frequency of incident description upon dispatch within the assault category 96

Figure 4.10: Frequency of incident description upon dispatch within the maternity category 96

Figure 4.11: Frequency of incident descriptions upon dispatch within the medical category 98

Figure 4.12: Frequency of incident descriptions upon dispatch within the motor vehicle accident category.. 98

Figure 4.13: Frequency of incident descriptions upon dispatch within the obstetric category.. 99

Figure 4.14: Qualification levels of response on dispatch 100

Figure 4.15: Triage code of patients on-scene.. 101

Figure 4.16: Frequency of incident description within the accident category upon arrival at scene.. 103

Figure 4.17: Frequency of incident description within the assault category upon arrival at scene.. 103

Figure 4.18: Frequency of incident description within the maternity category upon arrival at scene.. 104

Figure 4.19: Frequency of incident description within the medical category upon arrival at scene.. 104

Figure 4.20: Frequency of incident description within the motor vehicle accident category upon arrival at scene.. 105

Figure 4.21: Frequency of incident description within the obstetric category upon arrival at scene.. 105

Figure 4.22: Comparison of dispatch priority against on-scene triage code108

Figure 4.23: On-scene triage code within the red code/priority one dispatch 109

Figure 4.24: On-scene triage code within the yellow code/priority two dispatch 110

Figure 4.25: On-scene triage code within the green code/priority three dispatch 110

Figure 4.26: Incident description differences between dispatch and on-scene within the accident category 113

Figure 4.27: Incident description differences between dispatch and on-scene within the assault category 113

Figure 4.28: Incident description differences between dispatch and on-scene within the maternity category 114

Figure 4.29: Incident description differences between dispatch and on-scene within the medical category 114

Figure 4.30: Incident description differences between dispatch and on-scene within the obstetric category 115

Figure 4.31: Qualification levels of emergency care provider against patients triaged as red code on scene 116

Figure 4.32: Qualification levels of emergency care provider against patients triaged as yellow code on scene 117

Figure 4.33: Qualification levels of emergency care provider against patients triaged as green code on scene 117

Figure 4.34: Qualification levels of emergency care provider against patients triaged as blue code on scene 118

List of Tables

Table 2.1: Example of chief complaint determinant codes in MPDS (Priority Dispatch Corporation 2005) 31

Table 2.2: Example of priority determinant codes in MPDS (Priority Dispatch Corporation 2005) 32

Table 3.1: Decision table regarding type of research method to be employed 61

Table 3.2: eThekwini health district structure (KwaZulu-Natal Department of Health 2001) 68

Table 3.3: eThekwini district EMCC staff complement 72

Table 3.4: eThekwini operational vehicle status 78

Table 3.5: Summary of the application of the principles of the Nuremburg Code in relation to the study (The Nuremberg Code 1949) 84

Table 3.6: The rights of research participants enshrined in the fundamental ethical principles and how they apply to the study (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research 1979) 85

Table 4.1: EMD response interval percentiles 89

Table 4.2: EMS unit response interval percentiles 90

Table 4.3: Response time percentiles 91

Table 4.4: Incremental response times across the different dispatch priorities 93

Table 4.5: Frequency of dispatch incident categories 94

Table 4.6: Dispatch priority allocation within the incident categories 95

Table 4.7: Grouping of major medical category descriptions 97

Table 4.8: Grouping of minor medical category descriptions 97

Table 4.9: Allocation of dispatch priority across EMD qualification levels 99

Table 4.10: EMD response intervals between qualification levels.............. 100

Table 4.11: Frequencies of on-scene incident categories.......................... 102

Table 4.12: On-scene triage code within the incident categories............... 102

Table 4.13: On-scene triage code across Emergency Care Provider qualification 106

Table 4.14: Frequencies of on-scene interventions 107

Table 4.15: Reasons for non-transport of patients.................................... 107

Table 4.16: Comparison of priority/triage allocations between dispatch and on-scene 109

Table 4.17: Triage code on dispatch against triage code on scene through the different response time increments 111

Table 4.18: Comparison of incident type categories on dispatch and on-scene 112

Table 4.19: Qualification level of emergency care provider against triage code on-scene 116

Table 4.20: Qualification level of emergency care provider against on-scene intervention 118

Table 4.21: On-scene Triage code allocation against the nature of intervention 119

List of Appendices

Appendix 7.1: Vehicle Control Form (VCF) of the eThekwini EMCC 155

Appendix 7.2: Patient Report Form (PRF) of the eThekwini EMRS 157

Appendix 7.3: Consolidated IBM statistics data input 158

Appendix 7.4: Quotation for statistical analysis... 159

Appendix 7.5: Durban University of Technology Institutional Research Ethics Committee certificate of ethical clearance 160

Appendix 7.6: Letter of permission to conduct research in the eThekwini district EMRS 161

Appendix 7.7: Letter of permission to conduct research in the KwaZulu-Natal Department of Health... 163

Appendix 7.8: Letter of approval to conduct research with the KwaZulu-Natal Department of Health... 164

Appendix 7.9: Ratification of research by the Higher Degree Committee of the Durban University of Technology 165

Appendix 7.10: Safety monitoring and annual recertification letter of approval from the Durban University of Technology Institutional Research Ethics Committee.. 167

Appendix 7.11: Description of dispatch within the incident type category .. 168

List of Abbreviations

ALS:	Advanced Life Support
AMPDS:	Advanced Medical Priority Dispatch System
BLS:	Basic Life Support
ECP:	Emergency Care Provider
EMCC:	Emergency Medical Communications Centre
EMD:	Emergency Medical Dispatcher
EMRS:	Emergency Medical & Rescue Service
EMS:	Emergency Medical Service
GIS:	Geographic Information System
ILS:	Intermediate Life Support
MODP:	Multiple Option Decision Point
MPDS:	Medical Priority Dispatch System

1 CHAPTER ONE: INTRODUCTION

1.1 Chapter Overview

The discipline of pre-hospital Emergency Medical Care and Rescue is relatively new in the Global context and very little has been learned through structured research relating to its operational efficiency and general effectiveness (Kobusingye, Hyder, Bishai, Hicks, Mock and Joshipura 2005). This research looks at the operational efficiency and effectiveness of an Emergency Medical Service (EMS) system from a South African perspective.

This chapter will introduce the researcher and the research problem; state the purpose and objectives of the research; formulate the research questions; establish the researchers standpoint in the form of a thesis statement; identify a conceptual framework in which to address the problem; highlight the rationale for the study; discuss the significance of the research; delineate the research by describing its limitations and underlying assumptions; define the study's terminology; and finally outline the structure and content of the chapters that follow.

1.2 The Researcher's Interest in the Study

The researcher has extensive experience in the EMS field having been involved in a career spanning almost thirty years, in both an urban and rural environment, encompassing all aspects relating to a modern day EMS system, including but not limited to:

- Clinical practice
- Technical rescue
- Education and training
- Operational management
- Disaster management

- Aero-medical operations

During this time, the pre-hospital emergency care environment and the EMS landscape in general have experienced profound changes many of which may be considered detrimental to further development. Of particular concern is the alarming increase in the levels of what the researcher perceives to be the inappropriate use of EMS resources.

The researcher also recognises that in recent years there has been an increasing expectation for the Emergency Care Provider (ECP) to base his or her practice on emerging evidence from research which is clinically appropriate, cost effective, and which results in positive patient outcomes.

It is with these factors in mind that the researcher wishes to pursue this study with the belief that the findings of the study will help to inform further positive development within this field.

1.3 The Research Problem

The ECP is frequently faced with the realisation that a potentially dangerous emergency response to a patient with a supposed life threatening illness or injury is not indicated (Frank and deVilliers 1995; Marks, Daniel, Afolabi, Spiers and Nguyen-Van-Tam 2002; Gratton, Ellison, Hunt and Ma 2003a; Patterson, Baxley, Probst, Hussey and Moore 2006). When arriving at the scene of the incident it is found that either the nature of the call is non-emergent or there is no clearly defined need for EMS resources.

The nature of an emergency response poses significant risks to the responding ECP who is required to be at the side of the patient in the shortest possible time, utilising appropriate emergency response procedures (Emergency Medical Rescue Services: Province of KwaZulu-Natal nd). Emergency response procedures usually involve the use of advanced driving skills along with visual and audible emergency warning devices, or lights and sirens. A responding vehicle may often startle and confound pedestrians and other road users when they are suddenly confronted with the realisation that they need to get out of the way of the responding vehicle immediately and the potential for disaster, such as a road traffic collision, may be significant if one considers the range of unexpected or irrational reactions that may occur as a consequence (Anderson 2008).

Once an emergency response has been initiated by a member of the public to a call that is considered to be a life threatening emergency the responding unit is generally unavailable to respond to any other emergency calls (Emergency Medical Rescue Services: Province of KwaZulu-Natal nd). There exist only a finite number of emergency units in any EMS system and during busy periods it is not unusual for all units to be undertaking an emergency response or to otherwise be involved in the care or transportation of an ill or injured patient. When this happens there are no longer any units left to respond to any other requests for help which may involve life threatening emergencies (Carrol 2006). This has obvious implications for patients in immediate and dire need of life saving interventions.

Typically an ECP crew will respond to requests for help that are deemed to be immediately life threatening based on information provided by the caller (Emergency Medical Rescue Services: Province of KwaZulu-Natal nd). However, it is frequently found that once the responding unit arrives on scene the patient needs are different to those that were initially communicated (Palazzo, Warner, Harron and Sadana 1998). When these mismatches occur the response may be deemed to be inappropriate. The reasons for such disparities are thought to be complex and varied and may include factors such as public ignorance or misunderstanding, poor or unavailable public transport systems, inaccessible primary health care facilities, deliberate misrepresentation of need or malicious hoax calls (Slovis, Carruth, Seitz, Thomas and Elsea 1985; Curka, Pepe, Ginger, Sherrard, Ivy and Zacharia 1993; Palazzo *et al.* 1998).

Historically, international studies suggest that between 30% and 52% of all EMS responses in urban centres are later found to be inappropriate (Gibson 1977; Morris and Cross 1980; Rademaker, Powell and Read 1987; Frank and deVilliers 1995; Palazzo *et al.* 1998; Marks *et al.* 2002; Gratton, Ellison, Hunt and Ma 2003b; Patterson *et al.* 2006). South Africa, a developing nation of limited resources and unique challenges, is likely to be experiencing similar trends among its urban EMS systems at present. Indeed, a single recent study by MacFarlane, van Loggerenberg and Kloeck (2005) highlights the plight of South African EMS systems in which it describes the inappropriate use of EMS vehicles to overload the system creating a situation where resources required for more serious, life threatening cases are no longer available.

1.4 Statement of Purpose and Study Objectives

The purpose of the study is to evaluate the appropriateness of EMS responses in comparison to patient needs in a South African urban EMS system.

The study has as its objectives:

- To analyse the EMS dispatch in terms of the level of prioritisation and the resources allocated to the response;
- To evaluate the needs of the patient once the EMS responding unit arrives on scene; and
- To compare the appropriateness of the EMS dispatch with the actual needs of the patient.

1.5 Research Questions

The primary research question asks: Is there a significant level of mismatch between the EMS resources dispatched compared to actual patient need among South African urban EMS systems?

To formulate an answer to the primary research question, the study sought to answer the following secondary research questions:

- Is the demand for EMS resources met in terms of acceptable response time norms and standards?
- Do priority levels, incident categories and incident descriptions assigned on dispatch routinely match those assigned by responding units on scene?
- Are priority levels, incident categories and incident descriptions consistently and accurately applied through all qualification levels of EMS personnel?
- Do the different levels of response assigned on dispatch adequately and routinely meet the clinical needs of patients in terms of resource allocation?

1.6 Thesis Statement

The research proposes that there presently exists a significant mismatch between the dispatch of resources and actual patient need among South African urban EMS systems which results in high levels of inappropriate emergency responses. Where this occurs, the patient and the EMS system may be better served by developing alternatives to the traditional EMS response and the means by which patients are transported or referred for further management.

1.7 Conceptual Framework

The purpose of a conceptual framework is to provide an explanation of what is to be studied in terms of the key factors, variables or concepts and the presumed relationships between them (Miles and Huberman 1994). It provides structure and content for the study based on the personal experiences of the researcher in relation to what is known in the literature. The development of this study's conceptual framework is provided below.

Neely, Drake, Moorhead, Schmidt, Skeen and Wilson (1997) propose a Multiple Option Decision Point (MODP) model of EMS systems that aims to address the issue of inappropriate responses. The model describes two contact points at which multiple options can be considered for the creation of unique clinical pathways to guide patient movement from point to point.

The first point of contact is when a call for help is placed with the Emergency Medical Communications Centre (EMCC). At this point the Emergency Medical Dispatcher (EMD) must evaluate the needs of the patient and decide upon an appropriate response. Fundamentally, the EMD must decide whether the patient requires an emergent response or may be better served by alternative or non-emergent resources. Additionally the EMD must decide on the appropriate level of care that the patient may require by dispatching a standard Basic Life Support (BLS) – or in some cases Intermediate Life Support (ILS) – ambulance or a more specialised Advanced Life Support (ALS) ambulance or response unit. The EMD must also consider the need for any other specialised units, such as rescue or aeromedical services.

The second point of contact is when the dispatched resources arrive at the scene. Here, the attending ECP can make an accurate clinical assessment and the needs of the patient can be re-evaluated. Decisions can then be made regarding the provision of appropriate levels of care, modes of transportation and whether or not the patient can be treated and discharged at the scene or referred for follow up.

By employing the Neely MODP model (Neely *et al.* 1997) as the basis of its conceptual framework, a broad organisational and interpretive context can be developed where empirical data can be collected at both of the points of contact discussed in the preceding paragraphs. The analysis of the data will then allow an accurate evaluation of the appropriateness of EMS responses in comparison to patient needs and the results of the analysis will lead to the identification of any shortcomings in existing EMS dispatch and patient routing policies and procedures. The study can then make recommendations towards the optimal utilisation of EMS resources.

For the purpose of reporting, the Utstein Style will be employed. The Utstein Style is a set of recommended guidelines for uniform reporting of emergency medical dispatch when conducting research in emergency medicine (Castren, Karisten, Lippert, Christensen, Bovim, Kvam, Robertson-Steel, Overton, Kraft, Engerstrom and Garcia-Castril-Riego 2008). The Utstein Style was first proposed for emergency medical services in 1991. The name derives from a 1990 conference of the European Society of Cardiology, the European Academy of Anaesthesiology, the European Society for Intensive Care Medicine, and related national societies, held at the Utstein Abbey on the island of Mosterøy, in Norway (Cummins, Chamberlain, Abramson, Allen, Baskett, Becker, Bossaert, Delooz, Dick and Eisenberg 1991).

1.8 Study Rationale

It is apparent that research among EMS systems in general is lacking throughout the world and in South Africa in particular. It is also apparent that South African EMS systems have unique challenges which can be addressed to a greater extent through strong, evidence-based, scientific enquiry (MacFarlane *et al.* 2005).

A review of the evidence on EMS systems in general reveals many gaps in the global knowledge (Brazier, Murphy, Lynch and Bury 1999). Kobusingye *et al.* (2005) describe research and development for emergency services as a neglected topic where research into EMS systems is part of the 10/90 gap in global health research. This, according to the Global Forum for Health Research (2002), refers to substantial gaps in global knowledge where less than 10% of global research investment is spent on problems affecting 90% of the world's population. Osterwalder (2004) points out that the effectiveness and efficiency of expensive EMS systems throughout the industrialised world are supported by a paucity of scientific evidence and that research into EMS systems is urgently needed.

It will become clear upon reading the literature review presented in chapter two of this study that of those studies that have been published relating specifically to EMS dispatch systems and processes, contextual weaknesses are apparent in that they are not generalizable to present day South African EMS systems. Lack of generalizability is most often related to the populations studied, the location of the studies, the timing of the studies, and the means of the dispatch systems or processes assessed.

Presently, South Africa faces a number of unique challenges associated with the provision of quality EMS systems throughout the country. Indeed, a recent study by MacFarlane *et al.* (2005) highlights the disparities that presently exist in terms of the inequitable distribution of poorly resourced EMS systems. The study emphasises the need for improved public education, better public transport systems and an increase in basic patient transport vehicles to improve a situation in which the inappropriate use of EMS vehicles results in the system becoming overwhelmed due to the inappropriate use of resources which may be required for more serious cases. Another more recent study conducted in the Eastern Cape suggests that only 3.3% of emergency responses are reached within an hour and a staggering 16.7% of all requests for an ambulance are never dispatched (Meents and Boyles 2010). Anecdotal evidence and the author’s experience further suggest that this is likely to be the case in many other parts of the country.

1.9 Significance of the Study

EMS systems are a critical component of any national health system (Kobusingye *et al.* 2005). The goal of an effective EMS system should be to deliver quality, cost effective and appropriate emergency care at the point of injury or illness, to those patients who need it, within the shortest possible time (MacFarlane *et al.* 2005). This is then followed by rapid transit to centres capable of providing definitive care. To achieve this, the optimal use of resources is crucial, particularly in matching resources to patient need (Kobusingye *et al.* 2005; MacFarlane *et al.* 2005).

This study will revisit the existing systems management strategies in a typical public service South African EMS provider, the eThekwini health district Emergency Medical and Rescue Service (EMRS), with a view to identifying the apparent mismatch between patient need and resource utilization. The results of the study may then inform EMS policy decision makers throughout South Africa on how best to improve the utilisation of their limited resources which may indirectly result in *inter alia:*

- Substantial cost savings by more appropriately utilising vehicles, equipment and personnel;
- More equitable distribution of resources with improved public accessibility;
- Improved response times with a corresponding decrease in the rate and frequency of vehicle collisions;
- Improved public road safety due to a decrease in the need to use emergency response procedures; and
- Strengthening of staff morale with the potential to improve incentives resultant from cost savings.

All of which may ultimately significantly improve the rates of morbidity and mortality among those patients who genuinely require emergency care.

1.10 Study Delimitations

The Emergency Medical Dispatch expert group at the Utstein Consensus Symposium 2005 (Castren *et al.* 2008) describe the key stages in the patient pathway process from the time the incident occurs to the delivery of definitive care. This process, known as the ‘patient journey’ (Figure 1.1) was first identified by the European Emergency Data (EED) project (Krafft, Castrillo-Riesgo, Edwards, Fischer, Overton, Robertson-Steel and Konig 2003).

For the purpose of the research the study has been limited to the EMD response interval and the EMS unit response interval, as defined by the EED project. This is the interval from the receipt of the call at the EMCC until arrival of the responding unit at the patient's side, including the decisions made by the attending unit for further patient routing or alternative management strategies.

Furthermore, the study is limited to emergency responses undertaken in urban areas only. The eThekwini Health District is primarily made up of urban and peri-urban locales and patient demographics differ to those found in a rural EMS system. The study therefore, does not include any rural responses attended to by the eThekwini Health District's EMRS outside of their normal areas of operation.

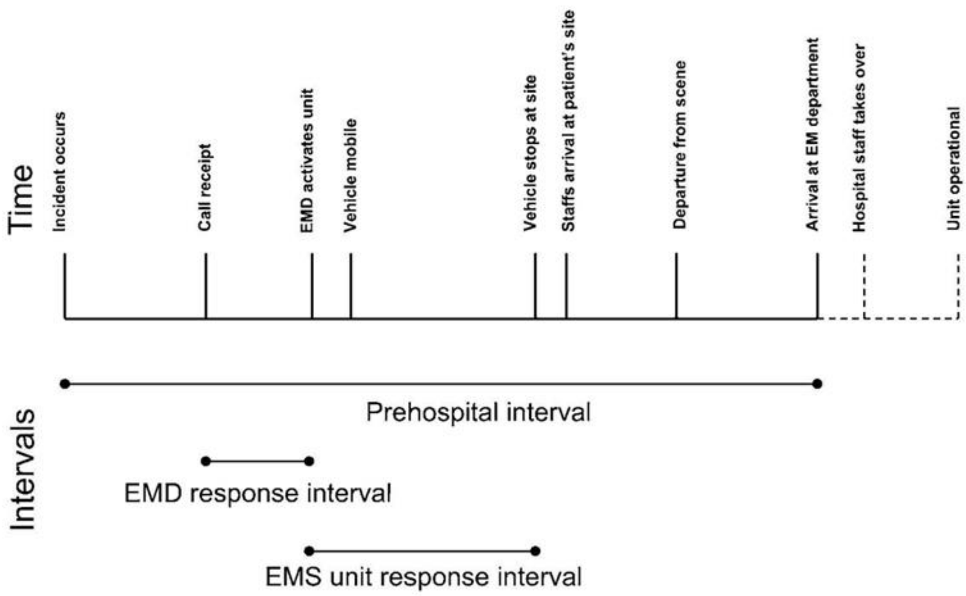


Figure 1.1: The patient journey (Krafft *et al.* 2003)

1.11 Underlying Assumptions

The research assumes that the data used for the purpose of the study fairly reflects the norms in skills and training among the different levels of EMS personnel and that these personnel function within their respective scopes of practice. It further assumes that the eThekwini Health District's EMS system operates within the legislative guidelines of the National and Provincial Health structures and complies with the provisions of the relevant statutory regulating bodies relating to the provision of EMS within the Republic of South Africa.

1.12 Definition of Terms

Advanced Life Support (ALS): Definitive emergency medical care that may include defibrillation, advanced airway management, and use of drugs and medications (Stedman 2005).

Appropriate EMS response: An appropriate EMS response is characterised by the optimal dispatch of resources in meeting the time sensitive clinical needs of a patient suffering from a life threatening illness or injury in a pre-hospital environment; ensuring their onward referral and/or transportation to a medical centre capable of providing further definitive care (MacFarlane *et al.* 2005).

Basic Life Support (BLS): Emergency cardiopulmonary resuscitation; control of bleeding; treatment of shock, acidosis, and poisoning; stabilization of injuries and wounds; and basic first aid (Stedman 2005).

Emergency Medical Communications Centre (EMCC): A communications system which must provide the means by which EMS resources can be accessed, mobilised, managed, and coordinated during both normal and adverse situations by employing sufficient communication pathways and operational capabilities to facilitate effective EMS operations (The State of Florida 2008).

Emergency Medical Dispatcher (EMD): An individual with training in medical care and telecommunications who is allowed to use predetermined medical protocols to both dispatch correct resources to an emergency scene and to give instructions to victims and bystanders before arrival of first responders" (Stedman 2005).

Emergency Medical Service (EMS): A system of delivery of EMS, usually established and maintained on a local or district level, referred to for pre-hospital emergency response. Also includes phases of dispatch, emergency care, rescue, and transportation to a hospital (Stedman 2005).

Emergency Care Provider (ECP): Persons who respond to a medical emergency in an official capacity as part of an organised response team (Cummins *et al.* 1991).

Inappropriate EMS response: An inappropriate EMS response may be reflected in several ways (Berry, Blocker, Bryant, Goodloe, Leland, Sacra, Synovitz, Williamson and Woodard 2009):

- Committing an underutilization of resources for critical patients resulting in unmet need;
- Committing an overutilization of resources for persons with needs not ideally addressed by higher levels of EMS care,
- Committing an overutilization of resources for persons with needs not ideally addressed by EMS at all; and
- Committing resources to a response utilising 'emergency response procedures' to non-time sensitive acute illness or injury.

Intermediate Life Support (ILS): Emergency medical care which wholly encompasses basic life support, as defined earlier in this section, with additional essential advanced techniques and administration of a limited number of medications (Butman, Martin and Vomacka 1995).

Paramedic: A medical professional who provides medical care at an advanced life support level in the pre-hospital environment, usually in an emergency, at the point of illness or injury. This includes an initial assessment, a diagnosis and a treatment plan to manage the patient's particular health crisis. Treatment can also be continued en-route to a hospital if more definitive care for the patient is required (Butman *et al.* 1995).

Triage: Derived from the Old French word *trier*, is a process for sorting injured people into groups based on their need for or likely benefit from immediate medical treatment. Triage is used in hospital emergency rooms, on battlefields, and at disaster sites when limited medical resources must be allocated (The American Heritage Dictionary of the English Language, 2009).

1.13 Dissertation Structure

A brief overview of what the chapters that follow will contain and justification for the chosen dissertation structure follows:

Chapter Two presents an in depth literature review which aims to contextualise the study and provide the reader with a theoretical grounding, a survey of published works relating to the study, and an analysis of those works.

Chapter Three presents the methods used in the research and will include the research design, the study setting, the techniques used to collect and examine the data, and an overview of the ethical considerations in conducting the study.

Chapter Four will present the results of the research and will consist of statistical output along with discussion and illustrations in the form of tables, graphs and charts.

Chapter Five forms the main body of discussion serving to present unbiased argument, either for or against the thesis, by examining the evidence and analysing the results of the research.

Chapter Six will close the dissertation by presenting a summary of the findings along with conclusions deduced from the evidence followed by recommendations for implementation and further research.

Following the closing chapter, section seven will contain any supporting material or appendices referred to in the dissertation and section eight will provide a list of references used.

The structure of the dissertation follows a generally accepted standard format consisting of logical divisions and order. The symmetry of the structure aims to guide the reader from point to point in a naturally progressive manner, attempting to ensure simplicity, ease of reading and clear understanding.

2 CHAPTER TWO: LITERATURE REVIEW

2.1 Chapter Overview

The intention of a literature review is to closely examine the existing evidence and to provide a context for the problem being researched. The literature review is typically undertaken early in the research process and allows the researcher to formulate research questions; develop a thesis statement; suggest appropriate research designs and methods; identify a conceptual or theoretical framework; and endorse the argument supporting the need for the study. Additionally the literature review helps the researcher to interpret the study findings which may inspire new ideas and form foundations for further study (Polit and Beck 2010).

This chapter will summarise the state of the existing evidence providing the reader with background knowledge relating to the research problem and highlighting the significance and need for the study.

The chapter will firstly define the strategies used in the information search and how the appropriate information was identified and screened. This will be followed by the literature review which has been broken down into sections which provide for greater contextualisation of the research problem; this is then followed by discussion relating to the decisions that are made and how they are made during the dispatch process and whilst on-scene; the apparent mismatch between the dispatch of Emergency Medical Service (EMS) resources and actual patient need; International norms and standards relating to EMS response times; and the strategies being used by EMS systems in their attempts to more effectively meet these norms and standards. Finally, a brief summary of the chapter will be delivered.

2.2 Search strategy

A bibliographic database search was initially undertaken online with the Elsevier Science Direct website at http://www.sciencedirect.com/ where journal articles which are subscribed to by the Durban University of Technology library services were accessed.

The keywords and Boolean operators; ("emergency medical service" OR “ambulance”) AND (“dispatch" OR "triage") were used and limited to appear in the title, abstract and keyword of subscribed articles appearing in the subject sub-set of “medicine and dentistry” and “Nursing and health professions”. Two searches were conducted with different date ranges: the first limiting articles to before 1991, for an historical perspective, and; the second limiting articles from 2000 to 2011, for current evidence. A total of thirty articles were returned in the first search and 179 in the second.

A further search was conducted online with the Google Scholar search engine at http://scholar.google.co.za/schhp?hl=en&tab=ws where articles with full text availability were accessed.

The keywords and Boolean operators; ("emergency medical service" OR "ambulance") AND ("dispatch" OR "triage") were used and limited to appear in the title only. The date range applied was 2006 to 2011. A total of 26 articles were returned.

Of the articles returned the abstracts were read for relevance, where articles did not provide abstracts the introduction section was read. Articles that were found to be relevant were downloaded to the researcher’s hard drive and copies were printed. Each of the articles was then read fully to determine further relevance and if found to be inappropriate or irrelevant to the research topic were rejected.

The reference lists of key articles were perused to retrieve any other relevant articles. Where an article consisted of a secondary source, research reports describing earlier original studies, then the article’s citations and reference list was consulted for information leading to the primary source, or original study. Conversely, earlier pivotal studies were used to search forward in citation indexes to locate more recent studies.

Articles identified from the bibliographic searches were then either acquired through Google Scholar, where full text versions were available, or utilising the Durban University of Technology Library's 'Metalib' resources. Articles that could not be accessed online or to which the University did not subscribe were requested through the library's subject librarian.

Further searches were conducted during the course of the study, as and when the need for further information was identified, and the Google Scholar search engine at http://scholar.google.co.za/schhp?hl=en&tab=ws was used for this purpose along with the Durban University of Technology library's new 'Summon" search engine. The keywords and phrases used to source specific information were:

- ("response time*") AND ("Emergency Medical Service*" OR "ambulance")
- ("Geographic Information System*") AND ("Emergency Medical Service*" OR ambulance)
- ("Demand Pattern Analysis") AND ("Emergency Medical Service*" OR "ambulance")
- ("System* Status Management") AND ("Emergency Medical Service*" OR "ambulance")

Additional articles were graciously provided by the researcher's friends, peers, students and colleagues either on request or voluntarily.

It should be noted that only articles written in the English language were used for the compilation of the literature review, although where articles in other languages were thought to be appropriate every effort was made to obtain a translated version.

2.3 Introduction to EMS systems

An EMS system may be best defined by the Mosby's Medical Dictionary as a network of services coordinated to provide aid and medical assistance from primary response to definitive care, involving Emergency Care Providers (ECP) trained in the rescue, stabilization, transportation, and advanced treatment of traumatic or medical emergencies. Linked by a communication system that operates on both a local and a regional level, EMS is a tiered system of care, which is usually initiated by citizen action in the form of a telephone call to an emergency number. Subsequent stages include the emergency medical dispatch, first medical responder, emergency ambulance, medium and heavy rescue equipment, and paramedic units, if necessary. (Mosby 2009).

There are many variations in the provision of EMS throughout the world, from the highly sophisticated present day EMS systems enjoyed by first world industrialised nations to the most basic or even non-existent systems of poor third world developing nations. The general aim of any EMS system is to provide urgent medical care to those persons in need, with the goal of satisfactorily diagnosing and treating the presenting conditions and arranging for their removal to the next point of definitive care within the shortest possible time. Typical EMS systems are also responsible for the transfer of patients from one medical facility to another; usually to facilitate the provision of specialised care. Conversely they may also be required to transfer patients from specialised facilities to a local district level hospital or nursing home when they no longer require specialised care (Langhelle, Lossius, Silfvast, Björnsson, Lippert, Ersson and Søreide 2004; Pozner, Zane, Nelson and Levine 2004; Black and Davies 2005; MacFarlane *et al.* 2005; Ellis and Sorene 2008; Hung, Cheung, Rainer and Graham 2009).

The term EMS has evolved over time to reflect a change from a simple system of ambulances, providing only basic transportation to those that request it, to a system in which actual medical care and stabilisation is given by an Emergency Care Provider (ECP) on scene and during transport to a centre of definitive care (Pozner *et al.* 2004; MacFarlane *et al.* 2005).

2.4 Inappropriate use of EMS systems

The misuse of modern EMS systems over time appears to have reached endemic proportions. International studies found that as much as 30% to 52% of calls requesting an EMS response were non-emergency cases (Gibson 1977; Morris and Cross 1980; Rademaker *et al.* 1987). Snooks, Wrigley, George, Thomas, Smith and Glasper (1998), reviewed ten studies conducted in six different countries between 1977 and 1996 and found similar trends where 11.3% to 51.7% of responses were inappropriate. A single South African study conducted in the Overberg region of the Western Cape over the period 1987 to 1990 supports these figures. This study found that up to 68% of the cases transported by the Caledon EMS were non-emergency cases (Frank and deVilliers 1995).

More recent studies suggest that the trend remains unchanged. In a census survey of 623, 000 emergency (999) calls made to the London ambulance service between 1996 and 1997, responding paramedics considered that only 60% of the cases responded to were deemed to have required an emergency response, with the remainder deemed to have been better served by other services such as primary healthcare or social services (Victor, Peacock, Chazot, Walsh and Holmes 1999). Palazzo *et al.* (1998) concluded in their study - involving three levels of patient assessment by the attending paramedic, the casualty officer and a senior consultant - that up to 46.3% of emergency ambulance calls responded to by the London ambulance service may have been inappropriate. The most recent study, having been conducted at the Glasgow Royal Infirmary during 2007, indicates that even with the introduction of new complex patient management strategies by the United Kingdom National Health Service (NHS), 19.5% of patients arriving by ambulance lacked a clear indication for emergency transport. In their study they admit that arriving at this figure was a subjective process and that the design of the study may have underestimated the true proportion of inappropriate ambulance transports (Vardy, Mansbridge and Ireland 2009).

The Vardy (2009) study also fails to take into account the number of patients that may have been redirected to alternative resources or who were not transported. A bulletin issued by London Department of Health in 1999 reports this figure to be 17% of the total number of ambulance calls attended to by the London Ambulance Service (London Department of Health 1999) and a study undertaken by Victor *et al.* (1999) over the same period supports these findings, concluding that 20% of all emergency ambulance responses by the London Ambulance Service resulted in the non-transportation of patients.

In other industrialised nations throughout the world similar results have been reported among EMS systems. In the United States, Gratton *et al.* (2003b) found that up to 30% of patients transported to an Emergency Department did not necessitate ambulance transport and Hipskind, Gren and Barr (1997) found that as much as 30% of all cases responded to resulted in the patient refusing transport, with many patients being asymptomatic. Similarly, in Taiwan, Chen, Bullard and Liaw (1996) found that up to 32% of all emergency ambulance responses resulted in the non-transportation of patients.

Even among children the prevalence of inappropriate EMS transports have reportedly been as high as 61% (Camasso-Richardson, Wilde and Petrack 1997). However, a more recent study undertaken throughout three counties in South Carolina in the United States reported a more modest figure of 16.4% (Patterson *et al.* 2006). Related studies have reported inappropriate Emergency Department visits among the paediatric population to range between 15% and 82% (Haddy, Schmaler and Epting 1987; Tsai and Kallsen 1987; Johnston and King 1988; McCaig and Burt 2004). Irrespective of the actual figure the paediatric population make up a substantial proportion of any EMS system's client base, reportedly between 6% and 10% of all EMS transports (Tsai and Kallsen 1987; Johnston and King 1988) and cannot therefore be ignored.

The reasons for the inappropriate use of EMS systems are thought be complex and varied and may include public ignorance of the role of EMS, poor access to primary health care facilities, limited alternative means of transport, deliberate misrepresentation of need and malicious hoax calls (Slovis *et al.* 1985). Other socioeconomic factors are likely to include age, gender, household income (Svenson 2000) *(Kawakami, Ohshige, Kubota and Tochikubo 2007)* and alcohol intoxication or drug abuse (Vardy *et al.* 2009). The type of health insurance that the patient possesses and the level of the patient's physical function have also been suggested to be indicators of ambulance use (Rucker, Edwards, Burstin, O'Niel and Brennan 1997).

Widespread misuse of EMS systems inevitably results in a higher demand for limited resources leading to the frequent unavailability of units to respond to life threatening cases (Slovis *et al.* 1985). This in turn may lead to increased public dissatisfaction with the resultant poor quality of service provision (Palumbo, Kubincanek, Emerman, Jouriles, Cydulka and Shade 1996), increased strain on equipment due to continuous over usage (Palumbo *et al.* 1996), increased risks to ECP's and other road users by the unnecessary use of emergency response procedures (Clawson 1981), with increased levels of dissatisfaction due to frequent wasted trips (Robinson 1981).

2.5 Reform of EMS systems

In 1997 Dr Keith W. Neely proposed a fundamental reform of EMS systems to counter the apparent mismatch between resource allocation and patient need where it was suggested that a Multiple Option Decision Point (MODP) model be adopted (Neely *et al.* 1997).

Dr Neely identified existing EMS systems as having three single decision points along the EMS response continuum where decisions relating to resource allocation could be made:

- At dispatch, when EMS resources are inevitably dispatched on request;
- On scene, where all patients that do not refuse care are treated and transported; and
- During transport, where all patients are delivered to an Emergency Department

The MODP model offers that at each of these decision points, multiple options can be created to inform patient movements from point to point. For instance, decisions can be made at dispatch regarding the nature of the request and whether there is a need for an emergent or non-emergent response; at the scene by the attending ECP who may initially treat the patient and refer them for follow up using alternative means of transportation; or during transportation where the patient can be conveyed to the most appropriate care facility (Neely *et al.* 1997).

Predictably, a number of challenges were identified by Dr Neely in implementing changes to existing EMS models in the United States such as statutory limitations, changes in scopes of practice and more importantly developing, evaluating and validating effective decision making criteria at each point of the MODP model (Neely *et al.* 1997).

Many EMS systems in the United States were simultaneously considering alternatives to the traditional emergency medical response but the evidence at the time was considered to be weak relating to the usefulness of EMS triage criteria in defining the need for an EMS response (Mann, Schmidt and Cone 2004)

In January of 2003 the Neely conference was held in association with the National Association of EMS Physicians' annual meeting in Panama City, Florida, USA. The aim of the conference was to develop a set of criteria that could be used in further research relating to the evaluation of dispatch and field triage systems; specifically, criteria for determining the need for an EMS response and the safety of directing patients to more appropriate support structures or services by alternative means. (Schmidt, Cone and Mann 2004).

The Neely conference concluded that the need for defining standard triage criteria and outcome measures for evaluating triage protocols which support alternative forms of transport and care was agreed upon by the EMS experts present. It also concluded that further research was required to determine how these research criteria would be combined and applied to demonstrate the benefit of pre-hospital triage based on medical necessity among patient populations. Nevertheless, unanimous agreement was reached that it was indeed possible to define these criteria (Mann *et al.* 2004).

Expert consensus was that the MODP model was an appropriate system to use in attempting to apply criteria to characterise medical necessity when responding EMS resources and that decisions could be made at each point of the model. However, it was conceded that more accurate and safe decisions relating to patient needs could only be conducted once a responding unit reached the scene, as compared to decisions made at the point of dispatch (Mann *et al.* 2004). Since the Neely conference little more has transpired relating to the use of standardised criteria (Carrol 2006; Patterson and Moore 2006)

The complexities involved in the application of standardised criteria and the decision making process in determining medical necessity and patient need can be examined at each of the three points of the MODP model. For the purpose of this study however, only the points involved in the Emergency Medical Dispatcher (EMD) and EMS unit response interval of the patient journey discussed in the previous chapter (Figure 1.1) will be considered.

2.6 Dispatch Decisions

When a medical emergency occurs or a person is seriously injured the first point of contact is through the Emergency Medical Communications Centre

(EMCC) of that particular districts EMS system, usually by means of the local telephone service. The function of the EMCC initially is to try to ascertain the severity of the illness or injury and direct an appropriate response of EMS resources. This is the first point of the Neely MODP model mentioned in the previous section.

Historically, EMS systems were designed to provide an emergency response to all requests for assistance where it was assumed that the request for an ambulance was required for a patient with serious illness or injury. Ambulances were therefore dispatched on a 'first come, first serve' basis where the EMD was simply required to establish the nature of the illness or injury, the location of the patient and the telephone number of the caller, should further directions be required by the responding ECP's. Indeed, this practice has persisted into the 21st century in some industrialised regions (Thakore, McGugan and Morrison 2002). The problem with this approach is that the demand for an EMS response frequently outweighed the availability of the EMS systems finite resources. Inevitably, where demand outweighed resources significant delays in the response of ambulances were frequently experienced (Slovis *et al.* 1985) and in some systems this led to poorly trained and ill equipped EMD's making subjective, uninformed decisions in attempting to prioritise calls to better utilise these finite resources.

Many EMS systems, in attempts to address the imbalance between demand and available resources, utilised priority dispatch systems in attempts to prioritise calls on an actual needs basis as opposed to simply dispatching units on a 'first come, first serve' basis.

The first effort to formulate a formal, protocol based priority dispatch system was documented by Clawson (1981). This system was developed in Salt Lake City, Utah in the United States and involved the re-training of EMD's on the utilisation of ready-reference file cards which ultimately allowed them to ask a set of standardised questions on which to formulate a dispatch priority. The results of the study indicated that there was an improvement in the efficient utilisation of available EMS resources with a reduction in the number of emergency responses. Additionally, the EMD's that received training did so willingly and reported that the course was beneficial in terms of their job responsibilities.

Following on from Clawson's study a number of other EMS systems developed similar dispatch systems which involved the addition of a multi-tiered response, where different levels of trained personnel and specialised resources could be allocated to specific dispatch priorities (Slovis *et al.* 1985; Curka *et al.* 1993) and, more recently, proposals to offer alternatives to a traditional EMS response, such as alternatives to ambulance transport or referral to an appropriate allied service provider, where an emergency response is considered inappropriate (Schmidt, Neely, Adams, Newgard, Wittwer, Muhr and Norton 2003).

Since these beginnings EMS systems have continued to develop dispatch protocols with differing levels of sophistication by utilising variations of multi-tiered and priority dispatch strategies while investigating, and in some cases implementing, alternatives to a traditional EMS response.

2.6.1 Multi-tiered Dispatch

The investment required in terms of medical and societal resources, such as personnel, vehicles, training and equipment, to establish an effective EMS system is undeniably substantial. It is prudent therefore, that EMS systems maximise the effectiveness of their resource deployment strategies.

Present day EMS systems generally employ one of two strategies associated with the deployment of their resources. The first is where every emergency ambulance has advanced life support (ALS) capacity and is routinely dispatched to all requests for an emergency response (Black and Davies 2005); the second is where ALS resources are limited and are dispatched separately to requests for an emergency ambulance response (MacFarlane *et al.* 2005).

EMS systems that routinely dispatch ALS capacity to all requests for an ambulance are generally limited to wealthy industrialised nations with advanced and sophisticated national health structures, such as the United Kingdom's NHS (Black and Davies 2005). Such EMS systems, although possibly delivering a higher standard of patient care and quality service, are uncommon and may not be cost effective for the majority of the world's nations.

Conversely, multi-tiered EMS systems are more widespread among the world's nations and are generally considered to be more cost effective and financially sustainable (Stout, Pepe and Mosesso 2000). These systems are generally made up of standard BLS units and limited specialised ALS units which may sometimes include a variety of support units, such as medical rescue vehicles or aero-medical rotor wing transport.

In multi-tiered EMS systems the actual demand for ALS resources has been reported to be between 3% and 30% of calls (Scalice 1978; Stout *et al.* 2000). More accurately, a recent study sampling 5433 EMS responses in a modern EMS system in Taipei found that only 9% of cases met the criteria for ALS intervention (Lu, Chen, Ko, Lin, Shih, Yen, Ma, Chen, Chen and Lin 2006).

Although the argument supporting the use of a multi-tiered dispatch strategy among EMS systems may be convincing, each system has its own distinct advantages or disadvantages and it appears as though decisions on which system to employ in a given location may primarily be based on financial considerations (Stout *et al.* 2000).

Presently, multi-tiered response systems form the basis of the majority of EMS systems worldwide (Stout *et al.* 2000; Langhelle *et al.* 2004; Pozner *et al.* 2004; Black and Davies 2005; Kobusingye *et al.* 2005; MacFarlane *et al.* 2005; Hung *et al.* 2009), however a paucity of evidence exists in the current literature as to its effectiveness. Where literature does exist, the studies are usually comparative in nature, describing differences between tiered response systems and systems where all responding units have ALS capacity (Stout *et al.* 2000).

2.6.2 Priority Dispatch

Priority dispatch involves sorting calls into order of apparent need. It involves protocols which assign different levels of response based on the callers answers to a set of standardised questions (Slovis *et al.* 1985), for instance responses may be graded as immediately life threatening, urgent or non-urgent. In multi-tiered systems this can be further refined by allocating specific resources to apparent need (Curka *et al.* 1993), for instance where an immediately life threatening case is identified with a suspected vehicular entrapment then specialised ALS and rescue units may be dispatched.

Priority dispatch systems have taken many forms since their inception. In earlier systems rudimentary ‘decision tree’ algorithms were developed to guide the EMD in the decision making process. Such a system was developed and implemented in the early 1980’s in the Atlanta and Fulton County EMS systems in Georgia, USA where Slovis *et al.* (1985) conducted a retrospective analysis comparing the documentation of the most critical category of patients from two months before the implementation of the dispatch system to three months following. The purpose of the study was to determine whether the priority dispatch system significantly reduced response times and whether there was any significant difference in the level of EMS responses received by the pre and post intervention system groups.

The Atlanta and Fulton county EMS priority dispatch, utilising a flip-card system, comprised of only 36 algorithms which categories were chosen on the basis of commonly received primary medical complaints or because the category was critical, such as in the case of a disaster. The decision pathway followed a number of key questions asked of the caller which would lead to the allocation of a priority dispatch code. These dispatch codes were ranked as: Code 1, the lowest priority emergency; Code 2, a non-life threatening emergency; and Code 3, an immediately life threatening emergency. The system was designed in such a way that the most critical questions were asked of the caller first, thus limiting the number of questions asked where a true emergency existed; conversely, more detailed questioning could continue if a call was deemed to be a non-emergency. The dispatch system was designed to err in favour of the patient and to guard against situations in which a higher priority patient could be mistakenly assessed as a lower priority. Where any doubt existed a higher priority was allocated.

Based on the allocation of the dispatch code the level and urgency of the response could be outlined where the EMD would then follow written dispatch directives with definitions of priorities. These could include suggestions to utilise alternative transport in the lowest priority categories to the immediate dispatch of the closest ALS resources to a true emergency.

The results of the Atlanta and Fulton study (Slovis *et al.* 1985) showed that the mean response time to Code 3 patients, those categorised as most urgent, was reduced by 3.8 minutes and significantly improved the use of ALS resources. Code 2 responses were reduced by 1.9 minutes; however Code 1 patient responses saw an increase of 6 minutes, a delay which can be considered acceptable under the circumstances. The study also recognised the potential of mis-triaging a critically ill patient to a lower category and when the data were closely scrutinised only 0.3% of calls were dispatched as least severe, Code 1, but were subsequently found to be most urgent, Code 3. In these five cases the priority dispatch system was not found to be at fault but rather the information provided to the EMD was inaccurate. Mis-triage of Code 3 patients to the Code 2 category occurred in 2.4% of cases, however utilising the priority dispatch system still resulted in improved response times, and mis-triage of Code 2 patients to the Code 1 category occurred in 4.6% of the cases. The study considered this to be an acceptable error rate and no significant adverse events were noted relating to patient care.

Slovis *et al.* (1985) clearly demonstrated that by utilising priority dispatch systems using decision based methodology and planned response modes to screen and rank incoming requests for EMS, the response to critically ill and injured patients can be improved.

Similar results have since been shown in a number of related studies. In 1990 Curka *et al.* (1993) undertook a study in Houston, Texas where a retrospective review of 35,075 consecutive EMS incident reports generated over a three month period revealed that a computerised dispatch triage algorithm can facilitate improvements in both EMS operations and pre-hospital patient care by safely and reliably identifying EMS incidents requiring only BLS. The results showed that the system spared the dispatch of ALS resources in 40.2% of cases which increased their availability and use for more serious calls. Of this figure it was found that less than 0.04% of the 14,100 cases where ALS resources were not dispatched may have benefited from ALS intervention.

Cone, Galante and MacMillan (2008) found that first-responder call volumes could be safely reduced by implementing an emergency medical dispatch system. The research was conducted as a prospective before and after study in a small city in Connecticut during 2006. The study concluded that by selectively dispatching units by using formal EMD protocols, the number of [engine] responses could be halved, with an under-triage rate of approximately 0.5%. Moreover, there were no adverse events relating to patient outcomes identified in those cases that were under-triaged.

In the United Kingdom Thakore *et al.* (2002) conducted a study to ascertain the effectiveness of applying triage criteria that might realistically be used in priority dispatch among British EMS systems. The study was conducted in the accident and emergency department of a large teaching hospital where the criteria were assessed against all patients delivered by an emergency ambulance over a 21 day period. A total of 471 patients were recruited of which only 45% were considered to have required an urgent response. The study concluded that the introduction of a priority-based dispatch system could reduce response times to those who are seriously ill or injured along with improved road safety

Present day EMS systems throughout industrialised nations have generally adopted priority dispatch as a means to accurately highlight and prioritise patients into order of clinical need. Additionally, pre-arrival or post-dispatch instructions can be offered to the caller where, for example, there is a need to perform an immediate life-saving intervention. This is generally achieved through the use of complex, algorithmic computer programmes which use a protocol based, scripted, interrogation process; the aim of which is to provide symptom based information on which to arrive at call priority and resource allocation decisions. The Medical Priority Dispatch System (MPDS) and the Advanced Medical Priority Dispatch System (AMPDS) are two such systems which have been developed through evidence based research (Clawson 1981; Slovis *et al.* 1985; Curka *et al.* 1993; Clawson, Cady, Martin and Sinclair 1998; O'Cathain, Turner and Nicholl 2002; Thakore *et al.* 2002; Heward, Damiani and Hartley-Sharpe 2004; Flynn, Archer and Morgans 2006; Clawson, Olola, Heward and Patterson 2007a; Clawson, Olola, Heward, Scott and Patterson 2007b; Sporer, Youngblood and Rodriguez 2007; Clawson, Olola, Heward, Patterson and Scott 2008a; Clawson, Olola, Heward, Patterson and Scott 2008b; Clawson, Olola, Scott, Heward and Patterson 2008; Cone *et al.* 2008; Sporer, Johnson, Yeh and Youngblood 2008; Sporer, Craig, Johnson and Yeh 2010).

Briefly, these systems allow the EMD to establish a chief complaint and set a determinant level to establish the most appropriate response in terms of priority and resource allocation. The determinant levels typically range from A, the most minor level, through to E, the most immediately life threatening level. Some systems also use the determinant level Ω, which may indicate alternative routing of the case at dispatch. Added to the determinant levels are two sub-category codes which make up three pieces of information in a number-letter-number format. The first component indicates the broad incident type category or chief complaint (Table 5.1), the second component is the priority allocation described above (Table 5.2), and the third component provides a more specific description of the patients' condition. For instance, in the MPDS system suspected cardiac arrest where the patient is not breathing is given the code 9-E-1.

Table 2.1: Example of chief complaint determinant codes in MPDS (Priority Dispatch Corporation 2005)

Card	Category	Card	Category
1	Abdominal Pain/Problems	20	Heat/Cold Exposure
2	Allergic Reactions/Animal Stings/Envenomation	21	Haemorrhage/Lacerations
3	Animal Bites/Attacks	22	Inaccessible Incident/Entrapments
4	Assault/Sexual Assault	23	Overdose/Poisoning (Ingestion)
5	Back Pain (Non-Traumatic/Non-Recent)	24	Pregnancy/Childbirth/Miscarriage
6	Breathing Problems	25	Psychiatric/Suicide Attempt
7	Burns/Explosions	26	Sick Person
8	Carbon Monoxide/Inhalation/HazMat	27	Stab/Gunshot/Penetrating Trauma
9	Cardiac or Respiratory Arrest/Death	28	Stroke (C.V.A.)
10	Chest Pain	29	Traffic/Transportation Accidents
11	Choking	30	Traumatic Injuries
12	Convulsions/Seizures	31	Unconscious (Near)
13	Diabetic Problems	32	Unknown Problem (Man Down)
14	Drowning/Diving/SCUBA Accident	33	Inter-Facility Transfer/Palliative Care
15	Electrocution/Lightning	34	Automatic Crash Notification (A.C.N.)
16	Eye Problems/Injuries	35	HCP (Health-Care Practitioner) Referral
17	Falls	36	Flu-Like Symptoms (Possible H1N1)
18	Headache	37	Inter-Facility Transfer specific to medically trained call

The system also provides for case input and output information, call termination scripts, and additional verbatim instructions such as for public automatic external defibrillator (AED) support; cardiopulmonary resuscitation

(CPR); childbirth assistance; airway, breathing and circulation (ABC) maintenance; and advice on procedures such as the Heimlich manoeuvre.

Table 2.2: Example of priority determinant codes in MPDS (Priority Dispatch Corporation 2005)

Type	Severity	Resources	Response
Alpha (A)	Non-Life Threatening	Basic Life Support	Non-Emergency
Bravo (B)	Possibly Life Threatening	Basic Life Support	Emergency
Charlie (C)	Life Threatening	Advanced Life Support	Emergency
Delta (D)	Serious Life Threat	Advanced Life Support	Emergency
Echo (E)	Life Status Questionable	Closest Available (Multiple Resources Sent)	Emergency
Omega (Ω)	Public Assist Only	Basic Life Support	Non-Emergency

The MPDS has been in use by a number of EMS systems throughout the world and studies indicate that its implementation has been effective in varying degrees. In Australia, the Centre for Ambulance and Paramedic studies at Monash University conducted research into the sensitivity and specificity of the MPDS in detecting cardiac arrest calls in Melbourne (Flynn *et al.* 2006). Their results showed that only 76.7% of cardiac arrest calls were correctly identified with a specificity of over 99%. In California, USA, Sporer *et al.* (2007) undertook a study to determine the sensitivity, specificity, and positive and negative predictive values of selected MPDS dispatch codes to predict the need for ALS medication or procedures. They found that their system had a high sensitivity overall but a low specificity.

The AMPDS has been in use by the London Ambulance Service since June 1999. This is the largest ambulance service in the world and receives in excess of 90,000 emergency calls per month. To establish the systems effectiveness Heward *et al.* (2004) undertook a study to establish what impact the implementation of an AMPDS system had on identifying patients in cardiac arrest and whether or not EMD compliance with the protocol influenced identification. The study was conducted in two stages: The first stage, a before and after study, concluded that since the implementation of AMPDS there had been an increase of more than 200% in accurately detecting patients suffering from cardiac arrest. The second stage of the study identified that as compliance with AMPDS protocol increased, so did the accuracy of the detection of cardiac arrest cases.

The issues raised by Heward *et al.* (2004) relating to compliance highlight the very important need for effective training and quality assurance among EMD's. As far back as 1975 questions have been asked regarding the levels of training required for effective EMD's (Griggs, Barringer, Klauk and Slome 1977) and Clawson (1981) identified training as a means to strengthening the weak link in the implementation of EMS priority dispatch systems. Studies suggest that compliance with protocol in the implementation of priority dispatch systems is ensured through rigorous training and feedback (Clawson *et al.* 1998) and where EMD's are allowed to make their own decisions based on subjectivity, anecdote or experience, inaccuracies and inconsistencies become more evident (Clawson *et al.* 2007b).

From a patient perspective O'Cathain *et al.* (2002) conducted a study to determine the acceptability of an emergency medical dispatch system to people who request an emergency ambulance. The study was undertaken in the Greater Manchester Ambulance Service of the United Kingdom. A systematic random sample of calls was taken before and after the implementation of an emergency medical dispatch system. The results showed that there was an increase in the overall satisfaction with the service provided. Of particular note in this study was a marked increase in the proportion of callers who reported having received first aid advice and general information.

The evidence suggests that where priority dispatch systems are used, and compliance and quality assurance controls are in place, the system is more effective than the EMD at correctly triaging the call. They further suggest that by utilising priority dispatch systems, maximal benefit in the efficient utilisation of EMS resources can be better achieved along with the additional benefit of improved service delivery with increased patient satisfaction levels.

However, there still remains very little literature in terms of primary research to support them.

In a systematic review of the evidence supporting the use of priority dispatch, Wilson, Cooke, Morrel, Bridge and Allen (2002) found that of 326 papers identified for inclusion in the study only 20 contained original data, of these only two high quality papers supported the concept of priority dispatch resulting in improved patient outcomes and a further two supported priority dispatch's role in improving resource utilisation. The study concluded that there is very little evidence to support the effect of priority dispatch on patient outcomes.

It is clear that research into EMS priority dispatch systems should continue and should primarily focus on specific components of the process in attempting to improve it. Indeed the National Association of Emergency Medical Service Physicians (2008) in their position statement suggest that aspects such as interrogation questions, dispatch prioritisation descriptors, post-dispatch instructions, pre-arrival instructions, and safety element advisories and/or their relationships be emphasised in research designed to improve priority dispatch systems.

2.6.3 Alternatives to Dispatch

Currently, most EMS systems throughout the world offer ambulance transport to patients that request it whether it is warranted or not (Jaslow, Barbera, Johnson and Moore 1998; Knapp, Kerns, Riley and Powers 2009b). Conversely, there may be unmet need where patients fail to utilise EMS transport when they should have (Chen *et al.* 1996). The need to more efficiently match patient need to limited, expensive EMS resources has driven many EMS systems to consider safe alternatives to traditional response methods. These may include referral to non-emergency access numbers (National Health Service 2013) or alternative appropriate services or facilities (Snooks, Williams, Crouch, Foster, Hartley-Sharpe and Dale

2002; Dale, Higgins, Williams, Foster, Snooks, Crouch, Hartley-Sharpe, Glucksman, Hooper and George 2003; Schmidt *et al.* 2003). However, despite current studies supporting the use of well-constructed priority dispatch guidelines in safely allocating a less time sensitive and resource intensive EMS response, there is little evidence to suggest that callers to the EMCC can be safely triaged to alternative resources.

In 1997, Neely, Norton and Schmidt (2000c) set about to determine whether existing priority dispatch protocols could identify callers with important clinical field findings to ascertain if EMD's could distinguish between callers that needed an emergent response and those that could be safely directed to alternative resources. Although the study had a number of limitations it concluded that the existing protocols did not appear useful if the goal is to identify at dispatch those without an important clinical field finding. The study further concluded that there should be more extensive information gathering through careful caller interrogation for future protocol study or implementation along with high level quality assurance measures to monitor EMD compliance.

Similarly, during the same year Neely, Eldurkar and Drake (2000a) sought to determine whether current EMS dispatch protocols could identify patients with important sentinel conditions based on layperson descriptions of medical conditions. The study concluded that existing protocols were not able to adequately detect callers with the study developed sentinel criteria and that the development of alternative protocols is necessary.

In order to determine whether it was possible to develop a protocol to match callers to traditional EMS resources or non-traditional alternative resources, Schmidt *et al.* (2003) undertook a prospective study of callers to urban EMCC's located in Clark County, Washington, between November 1998 and May 1999. Outcome data were gathered from EMS and Emergency Department patient care records where callers had been assigned the lowest priority level according to the existing dispatch criteria. Of the 656 study subjects a total of 7% were found to have had important findings, according to the study criteria, on arrival at the emergency department. When further analyses were conducted it was found that there were no important findings in any of the studies subjects under the age of 12. The study concluded that it was possible to produce a decision rule where children under the age of 12 could be safely directed to alternative resources, this constituted 10% of the study population.

During the same period in the United Kingdom Dale *et al.* (2003) undertook a pragmatic, controlled trial conducted across two ambulance service sites, the West Midlands and London, an area comprising a population of approximately 10 million people. The study sample was made up of 1246 category C or non-serious calls collected between April 1998 and May 1999. Random four hourly time intervals were selected and allocated to an intervention group, made up of 635 calls, and a control group, made up of 611 calls, using computer generated random numbers. The intervention group were subjected to further assessment and triage by a nurse or paramedic where, with the aid of computerised decision making support, the need for an ambulance response was determined. Those calls that were triaged as not requiring an ambulance response totalled 330 or 52% of the intervention group, of whom 47% were deemed to require care within 24 hours, 26% needed a routine appointment with a general medical practitioner and 27% sufficed with self-care advice. Subsequent re-analysis of the data which involved an in-depth review of patient records by an independent expert clinical panel to ascertain the safety and efficacy of the intervention revealed that telephone assessment, triage and advice of non-urgent ambulance service callers may be a safe alternative to the dispatch of an emergency ambulance. (Dale, Williams, Foster, Higgins, Snooks, Crouch, Hartley-Sharpe, Glucksman and George 2004).

Although it appears that there is a real need to redirect non-urgent callers to alternative resources, the issue remains a complex and controversial one.

There have been few rigorous trials reported and the evidence about the safety and efficacy of alternative responses is conflicting and weak. Further study has been recommended in all instances (Neely *et al.* 2000a; Neely *et al.* 2000c; Snooks *et al.* 2002; Dale *et al.* 2003; Schmidt *et al.* 2003; Dale *et al.* 2004).

2.7 On-Scene Decisions

Current EMS guidelines generally advocate the transport of all patients from the scene of illness or injury to the nearest appropriate hospital following an emergency response. Many of these patients are later found to have neither required transport to the hospital nor to have had a medical necessity for an EMS response (Gibson 1977; Morris and Cross 1980; O' Leary, Bury, McCabe, Kelly, McGoldrick and Ward 1987; Rademaker *et al.* 1987; Gardner 1990; Pennycook, Makower and Morrison 1991; Brown and Sindelar 1993; McCleay, Hamilton and Bowie 1995; Billittier, Moscati and Janicke 1996; Palazzo *et al.* 1998; Marks *et al.* 2002; Gratton *et al.* 2003b; Patterson *et al.* 2006).The inappropriate use of EMS resources in this manner results in the system becoming overburdened and ineffective, consuming already limited resources and ultimately making patients that require an emergent response wait longer for potentially life-saving interventions. Many of these interventions are time critical and any delays may likely result in increased rates of pre-hospital morbidity and mortality.

Despite the apparent on-going misuse of EMS resources few EMS systems have investigated a means to safely refuse ambulance transport to those individuals who do not require it or to offer alternatives to those patients identified with minor injury or illness.

In 1996 Jaslow *et al.* (1998), in a survey of the EMS systems of the largest 200 cities in the United States, identified that only 13% engaged in any form of EMS initiated refusal of transport and only 7 jurisdictions offered any form of alternative transport.

In 2004, following on Jaslow's study, Knapp, Kerns, Riley and Powers (2009a), surveyed the same 200 cities to determine if there was an increase in the number of EMS systems that had developed guidelines for EMS initiated refusal of transport and whether alternative means of transport were being offered. The study surprisingly found that there was a marked reduction in the number of systems engaged in any form of EMS initiated refusal of transport to 7% and none of the systems offered an alternative to ambulance transport.

In the United Kingdom during the same period similar challenges were being experienced. Inappropriate EMS responses to calls made to the 999 emergency telephone number most often resulted in the transportation of patients to an accident and emergency department whether it was warranted or not. This was thought to lead to the inefficient use of resources with associated unnecessary risks to patients, ECP's and the general public. The NHS Plan (Department of Health 2000) and the consultation document 'Reforming Emergency Care' (Department of Health 2001) emphasised the importance of offering alternatives to the dispatch of emergency ambulances and recommendations were made that local health authorities and ambulance services should be free to make whatever response is right for the patient's clinical need, by ambulance or otherwise. (NHS Executive Steering Group 1996).

Although some EMS systems in the United Kingdom have since investigated alternatives to a standard emergency ambulance response (Snooks *et al.* 2002; Snooks, Foster and Nicholl 2004a; Snooks, Kearsley, Dale, Halter, Redhead and Cheung 2004b; Snooks, Dale, Hartley-Sharpe and Halter 2004c), none of the systems currently engage in EMS initiated refusal of transport and there remains no alternative to ambulance transport once an emergency ambulance is dispatched .

It appears that, although there is strong evidence pointing to the need to develop alternatives to a traditional emergency response in both the United

States and the United Kingdom, little has occurred in terms of significant change. Indeed, the evidence suggests that most EMS systems continue to pursue a course where no alternative is offered to a standard emergency response (Knapp *et al.* 2009b).

Neely's MODP model (Neely *et al.* 1997) advocates that EMS systems should be considering using unique pathways for the routing of patients at a number of decision points in the patient journey continuum (Figure 1.1). The first decision point, discussed earlier in this chapter, is at the time of dispatch; the second decision point is once the responding EMS unit arrives on scene. Decisions that may need to be considered here relate to the triage and diagnosis of the patient to determine the appropriate level of care; whether or not the patient needs to be transported for further management and if so to which facility; and whether an alternative means of transport or care will be more appropriate.

2.7.1 Triage and Diagnosis

The reasons for the failure to pursue and implement alternatives to the transportation of all patients to a hospital, irrespective of need, among EMS systems may be contributed to concerns relating to medical liability (Goldberg, Zautke, Koenigsberg, Lee, Nagorka and Kling 1990). The ability of ECP's to accurately diagnose and triage patients to ascertain the most appropriate further management strategy has been at the forefront of enquiry in this regard. The question remains 'Can ECP's safely and accurately diagnose and triage patients to the most appropriate care?' Some studies have been undertaken in the United States and the United Kingdom involving paramedics but the literature remains scant and inconclusive.

In 1998, Pointer, Levitt, Young, Promes, Messana and Ader (2001) undertook a study of an urban EMS system to determine whether paramedics using guidelines could accurately triage patients in the field. A total of 1,180 patients were triaged by paramedics over a period of six months. For the purpose of the study the patients were triaged into four categories: the highest category (1) required the patient to be transported directly to the hospital with ALS intervention; the second highest category (2) required direct transport to the hospital by any means; the third category (3) required the patient to consult a physician within 24 hours; and the final category (4) required no further evaluation. The medical records of those patients were then evaluated post hoc by a review panel to establish the accuracy of the paramedics' diagnoses and triage categorisations. The review panel category assignment was based on actual patient outcome. The results showed that there was an under triage rate of 9.6% and more importantly 8.4% of the patients were incorrectly categorised as not needing to go to hospital.

Dunne, Compton, Welch, Zalenski and Bock (2003) undertook a similar study in a large urban EMS system. Their primary objective was to estimate the proportion of patients that were transported by ambulance who did not need immediate care; their secondary objectives were to evaluate the ability of paramedics to determine which patients required immediate transport and to assess patient characteristics on-scene to aid in the development of an EMS transport protocol. In terms of the paramedics' determination of the need for transport the study showed that when unaided by triage protocols or specific training, they could not adequately identify those patients in need of emergency medical treatment.

A more specific study, designed to determine whether paramedics can accurately predict which patients require hospital admission and if so whether to a general ward or an Intensive Care Unit (ICU), was conducted at the Denver Health Medical Centre in 2001 (Levine, Colwell, Pons, Gravitz, Haukoos and McVaney 2006). Of 936 patients included in the study paramedics predicted that 730 patients would be discharged and 202 would be admitted to hospital of which 78 would go to ICU. Of the 730 predicted discharges, 75 were admitted to hospital, 10 of which were admitted to the

ICU. Of the 202 patients that paramedics predicted would be admitted, 82 were discharged and only 47 were admitted to the ICU. The study concluded that paramedics generally had limited ability to predict whether transported patients needed admission to the hospital and, more specifically, whether they required admission to the ward or an ICU.

Contrary to the findings of the studies conducted in the United States, studies undertaken in the United Kingdom suggest some level of success. In an evaluation of the effectiveness of triage and direct transportation to minor injury units in the London and Surrey ambulance services Snooks *et al.* (2004a) found that paramedics were able to determine which patients were suitable for transport to minor injury units and which patients required transportation to a traditional accident and emergency department. The study reported shorter waiting times and high patient satisfaction.

Generally, studies to determine the ability of paramedics and other levels of ECP's to safely and accurately triage patients have been inconclusive and somewhat divergent. Differences in study design, assessment criterion and outcome measures along with differences in EMS systems design, scopes of practice and levels of education and training may be contributing factors.

2.7.2 Patient Routing

Presently, in EMS systems throughout the world, all patients, unless they refuse further care, are transported to a hospital casualty unit, emergency department, accident and emergency unit or similar following a request for an ambulance, irrespective of the level of care that may be required (Jaslow *et al.* 1998; Knapp *et al.* 2009b). This often results in ambulances bypassing primary health care facilities, which may be a more appropriate destination when transporting patients with minor illness or injury (Kamper, Mahoney, Nelson and Petterson 2001; Snooks *et al.* 2004a). These facilities are generally staffed by qualified nurses who have direct access to medical expertise and established referral links to district or regional general hospitals. By diverting ambulances carrying patients with minor illness or injury to these primary health care facilities savings may be seen in terms of shorter travelling distances, reduced job turnaround times, reduced waiting periods and a reduction in the overall time that the patient spends seeking care (Snooks *et al.* 2004a). These savings have the potential to bring benefits to both the EMS systems operational efficiency and the patients' level of service satisfaction (O'Cathain *et al.* 2002).

A cohort study with matched historical controls was undertaken in Seattle by Schaefer, Rea, Plorde, Peiguss, Goldberg and Murray (2002). During the intervention period ECP's were permitted to transport non-urgent patients to a destination other than an emergency department. Patients were interviewed following the intervention and cases taken to an alternate destination were reviewed by the study physician. Of 1016 patients meeting study eligibility criteria, only 453 were transported directly to an emergency department whereas 563 patients were either taken to a primary health care facility or not transported at all. No adverse events were identified following transportation to an alternative destination and only five patients subsequently required transportation to an emergency department. This represented a significant drop in the number of patients taken to an emergency department, compared to historical controls, and a rise in the numbers taken to a clinic or left to home care. The study concluded by indicating that an EMS programme of alternative destinations of care was safe and satisfactory to patients however, non-urgent use of emergency department facilities is complex.

Shortly following the Schaefer study, despite a smaller sample size and a small number of study limitations, Snooks *et al.* (2004a) found that the development of a programme involving the evaluation, triage and transportation of patients with minor injuries to primary care centres in the London and Surrey ambulance services catchment areas proved beneficial to both the ambulance services and the patients transported. The study noted that no adverse events were reported throughout the duration of the study and that further research in this area should be encouraged.

Although there are few studies, the existing evidence shows strong support for further research and development in this area.

2.7.3 Alternatives to Transportation

It has been suggested that the identification of patients not requiring transport to hospital may assist in curbing the abuse and misuse of EMS systems (Knapp *et al.* 2009a). If patients could be identified as suffering from minor illness or injury it may be possible to offer alternatives to emergency ambulance transportation (Kamper *et al.* 2001; Snooks *et al.* 2004c). These alternatives, based on patient presentation, may include a straightforward refusal to transport, treatment on-scene and referral to a further care facility by other transportation means or on-scene treatment and discharge (Jaslow *et al.* 1998).

The decision to refuse a patient transport to hospital may have significant medico-legal implications and the risk of litigation remains a very real concern among EMS providers (Goldberg *et al.* 1990). Some studies suggest that a significant proportion of patients may be left at the scene after being attended to by ECP's with minimal risk of missed interventions (Knight, Olson, Cook, Mann, Corneli and Dean 2003). Other studies suggest otherwise; When considered against the standard criteria for release from care, Selden, Schnitzer, Nolan and Veronesi (1991) found that non-transported patients were inappropriately left at home 22% of the time and Zacharia, Bryan, Pepe and Griffin (1992) described serious adverse events among patients who refused or were denied transport.

To date there are very few EMS systems that have engaged in investigating and developing a refusal of transport policy and recently there has been a significant decline in the number of those EMS systems engaged in such programmes (Knapp *et al.* 2009a).

The development of treat and refer policies, with lesser concerns over litigation, may be a safer and more acceptable alternative to simply refusing to transport patients deemed not to be in need of EMS intervention or hospital admission.

In the United States, a study to evaluate the feasibility and safety of implementing a treat and refer policy found that of 1,103 patients delivered to the Hennepin County Medical Centre, a large urban teaching hospital and level 1 trauma centre, 523 or 47% of the patients were potentially treatable by paramedics in the field with the proviso that they be referred for early follow-up at a clinic or hospital (Kamper *et al.* 2001). The study concluded however, that the implementation of a treat and refer policy would require substantial investment in terms of guideline development and training of paramedics to be able to apply those guidelines to the numerous array of clinical presentations.

In the United Kingdom Snooks *et al.* (2004b) conducted a prospective, controlled study among two ambulance stations in West London to develop and evaluate treat and refer protocols which would allow for the provision of self-care advice or onward referral after being treated by ECP's and left at the scene. The study found that although there were improvements in job turnaround times, the anticipated operational benefits were not demonstrated and safety concerns were identified. The study acknowledges the complexities involved in the development of treat and refer protocols and makes reference to the lessons learned about the design and implementation of treat and refer protocols as being valuable. The study recommends that further research and development of treat and refer protocols is needed to realise the potential benefits of such innovative changes in service delivery.

Another variation of the treat and refer protocols that may be considered is for EMS systems to offer alternative transport means to patients not deemed to require emergency care. Billittier *et al.* (1996) found, in a survey of 626 patients, that those patients who did not meet the criteria for EMS transport indicated that a lack of alternative transport prompted them to request an EMS response. The majority of these patients (82%) indicated that the use of an alternative means of transport, if available, would have been acceptable. The study concluded that offered alternatives would result in the decline of inappropriate use of EMS resources.

Snooks *et al.* (2004c) capably summarise the evidence for offering alternatives to EMS transport in a literature review of 31 papers. The study found that there is a paucity of evidence to support a clinically safe approach to identifying those patients that do not require EMS transportation. It also suggested that there was a significant risk that a minority of patients may require subsequent emergency care if left behind at the scene. The review however, concluded by suggesting that there was clear evidence concerning the inappropriateness and inefficiency of the current model of care and that, in the absence of sufficient evidence, further research in this area is urgently required.

2.8 Dispatch versus On-Scene Prioritisation

In order to investigate and fully understand the full extent of the issues relating to the inappropriate dispatch of EMS resources, it would be prudent to explore the literature relative to the association of dispatch prioritisation and on-scene triage or patient need.

In a study to compare the decisions made by an EMD system with apparent patient need, Palumbo *et al.* (1996) reviewed 320 emergency department records against the dispatch and run sheets of patients that were delivered to hospitals by ECP's in Cleveland, Ohio. The priorities assigned by the EMD, based on information provided by the caller, were compared with those assigned by a three member panel of physicians, based on emergency department presentation. There was a significant disagreement rate of 57% when allocating levels of priority across all four categories but general agreement of 74% was reached in the allocation of ALS versus BLS resources. It was concluded that there was a higher degree of EMS resource utilisation than what was actually required.

Following on the Palumbo study, a similar study conducted in Portland, Oregon, more favourably compared EMD prioritisation with paramedic field findings (Neely, Eldurkar and Drake 2000b). The extent to which patient condition and severity of condition codes assigned by the EMD matched those assigned by paramedics was examined. There was overall agreement in the assignment of patient condition codes and condition severity codes of 70% and 65% respectively.

Since these initial studies a number of studies have been undertaken at various locations throughout the United States and Europe with the aim of assessing the accuracy of EMD systems.

Sporer *et al.* (2007) in an attempt to determine the sensitivity and specificity of EMD assigned dispatch codes to predict the need for ALS medication or procedures, found that although there were high levels of sensitivity relating to high risk conditions, specificity levels were as low as 2%. A similar study by Sporer *et al.* (2008) was repeated in a larger EMS system producing similar results. The study concluded that there was only a modest ability of the EMD system to predict which patients would require ALS intervention. A third study by Sporer *et al.* (2010), compared EMD assigned priority codes with a Delphi process-derived level of pre-hospital intervention using EMS professionals in other systems. Again it was found that the EMD system was only moderately sensitive but non-specific. The study concluded that although the systems lowest priorities were predictive of no pre-hospital intervention, the highest priorities were of little predictive value for ALS intervention.

In Europe, two independent Swedish studies were undertaken to examine the reliability of EMD systems and their ability to accurately prioritise the dispatch of ambulances.

The first study, designed to identify discrepancies in priority setting between the EMD and the responding ECP, was conducted over a six month period during 2008 in Gothenburg, a metropolitan city with a population in excess of 500,000. The results of the study showed that there was a marked discrepancy between the EMD and the responding ECP priority setting. Notably, of the 9,208 patients declared to be a life threatening priority by the EMD only 2,813 or 27% of the patients were actually found to have life threatening conditions by the responding ECP on scene. On admission to hospital this figure dropped to just under 19% (Khorram-Manesh, Lennquist Montán, Hedelin, Kihlgren and Örtenwall 2010).

The second study, also conducted over a 6 month period, examined the reliability of the EMD system in use by the county of Jamtland, a sparsely populated area in the north of the country. The results of the study again found significant discrepancies between the EMD and the responding ECP prioritisation. Of the 1,709 patients declared to be a life threatening emergency by the EMD only 692 or 40% were found to have life threatening conditions by the attending ECP (Ek, Edström, Toutin and Svedlund 2011).

Variations in the results of the studies mentioned above may be contributable to any number of different factors including patient demographics and EMD systems used. It is clear however, that significant discrepancies do exist between the dispatch prioritisation of EMD's of whatever system and that further research in this area should be considered mandatory.

2.9 Response Time Targets

The time between the dispatch of an EMS unit and its arrival at the scene of the illness or injury is thought to have a direct bearing on the patient's clinical outcome. A number of studies have suggested that where response times are extended then rates of mortality and morbidity increase (Vukmir 2006). Conversely, shortened response times improve patient outcomes (Karch, Graff, Young and Ho 1998). Response times therefore, have a strong bearing on EMS responses in general and where true life threatening emergencies are identified by the EMD then a rapid response is advocated. It is clear then, that the consideration of time must be seen as an important factor in effectively determining whether a response can be deemed appropriate or not.

Although there are presently no formally recognised international response time standards the most recognised standard is that suggested by Alvarez & Cobb following studies conducted in the early 1970's (Baum, Alvarez III and Cobb 1974; Cobb, Baum, Alvarez III and Schaffer 1975). They found that there was a marked increase in the survival rates of out-of-hospital cardiac arrest which were attributable to: reduced response times of less than 8 minutes, early bystander CPR and layperson CPR education.

Later studies saw the emergence of the 8:59 standard (Eisenberg, Bergner and Hallstrom 1979) which allowed for the addition of 59 seconds for EMD processing. The 8:59 standard is the most universally accepted response time standard throughout the United States and the National Fire Protection Association recommends the arrival of ALS resources within 8 minutes of dispatch to 90% of incidents, excluding the EMD processing time or response interval (National Fire Protection Association 2010a; National Fire Protection Association 2010b). For responses in rural and wilderness areas the benchmark response times are 15 minutes and 30 minutes to 90% of all incidents respectively (Fitch 2007).

Response time targets and norms vary throughout the world. In the United Kingdom legislation requires that 75% of all category A (immediately life threatening) cases be responded to within 8 minutes of the incident location being established; whereas category B (serious but not immediately life threatening) and category C (neither immediately life threatening or serious) cases should have a response time of 14 minutes and 19 minutes in urban and rural areas respectively (Department of Health 2000).

The Nordic countries experience wide variations in response time. In a descriptive study by Langhelle *et al.* (2004) response time averages of less than 5 minutes to immediately life threatening cases are reported in Copenhagen City, Denmark, yet the requirement of the Norwegian government in reaching patients in remote areas, which are serviced primarily by physician manned rotor-wing air ambulances, is 45 minutes.

In Australia response times are typically measured at intervals of 5, 10 and 15 minute intervals with approximately 50% of responses complying with the 10 minute standard. However, wide variations in response times have been reported among Australian EMS operators, with delays frequently exceeding 30 minutes (Fitch 2007).

Many other developed and developing countries throughout the world show similar trends in EMS response time standards. In China, the most recent data shows ambulance response times to be approximately 9 minutes (Liu 2007) while in the Middle East, Israel reports average response times of 8 minutes (Ellis and Sorene 2008) with Iran maintaining an 8 minute response time to 81.15% of all cases (Bahrami, Maleki, Ezzatabadi, Askari and Tehrani 2011). Response times in Malaysia during 2004/2005 were significantly below the international standard with Shah, Ismail and Mohsin (2008) reporting average response times of just over 15 minutes.

Presently in South Africa the situation appears to be grave with response times reported to be well below the internationally accepted response time standards benchmarking an effective EMS system. In a recent study, Meents and Boyles (2010) found that only 3.3% of all cases dispatched in the Eastern Cape Province during a three month period over 2009, were reached in less than one hour. The average response time was just under four hours and, surprisingly, 16.7% of all requests for an ambulance were never dispatched. Anecdotal evidence and the authors experience further suggest that this is likely to be the case in many other parts of the country.

Despite the evidence being strongly in favour of reduced EMS response times being responsible for improved patient outcomes, there are some studies that suggest otherwise.

Pons and Markovchick (2002) suggest that there is no difference in the mortality rates of victims of traumatic injury when the 8 minute response time standards are exceeded. In a study conducted in Denver, Colorado, during 1994 and 1995 it was found that of 3940 patients who met the study criteria, there was no difference in survival rates when the 8 minute response time standard was exceeded. However, a number of study limitations were identified, the most significant being that the study did not take into account those patients that died on scene and were not transported. The authors frankly declared that the possibility existed that more patients were declared dead at the scene among the group with a greater than 8 min response time.

In a follow-up study, Pons, Haukoos, Bludworth, Cribley, Pons and Markovchick (2005) sought to evaluate the effect of response times on the outcomes of non-selected patients. Of 34,111 consecutive calls involving an emergency response during 1998, they found that there was no survival to hospital discharge benefit seen in patients in general when the response time was within eight minutes, although a significant benefit was seen in those patients with intermediate or high risk of mortality when the response time was less than four minutes. The authors of this study again acknowledged that there were a number of limitations which may have resulted in bias.

These studies, although fraught with limitations, suggest that there may be a need to more closely look at a means by which to identify those patients that will actually benefit from a shorter response time, even though the evidence in general gives strong support for applying the eight minute response time standard consistently across all emergency response categories, it is clear that more research is needed in this area.

2.10 Systems Status Management

For EMS systems to be able to deliver an effective, reliable and timely service to the populations they serve it is important that responding units are strategically managed in terms of accessibility, distribution and utilisation. This importance is reinforced when it is apparent that the failure of responding units to meet response time targets may result in unnecessary loss of life. Simply stated, when there are no EMS units available to respond at the centre closest to the reported incident, increased rates of morbidity and mortality may be seen. Hence, EMS systems should consider the design and implementation of systems which allow for the effective deployment of their resources in meeting the needs of patients, especially in life threatening and urgent situations.

Generally, for the deployment of EMS resources to be effective three inter-related key elements should be employed, namely: geographic information systems; demand pattern analysis; and dynamic location/relocation models. Each of these key elements will be discussed separately and in greater depth in the sections that follow.

2.10.1 Geographic Information Systems

Geographic Information Systems (GIS) use computer mapping software that develops relationships between different data sets spatially. This then allows for the graphic display and easy interpretation of relationships of population and environment over a specified geographical area. These systems have been effectively used as tools to study rates of injury and illness, identify populations at risk of injury and illness, evaluate public access to health care systems and develop and measure the effectiveness of preventative health care initiatives (Edelman 2007).

Over time, the use of GIS has now extended to EMS systems throughout the world, where varying degrees of success in their attempts to improve response time standards through optimal resource deployment have been reported.

In a case study using point location data from Iowa's Accident Location Analysis System (ALAS) over the period 1990 to 1995 Estochen, Souleyrette and Strauss (1998) illustrated the power of GIS by comparing actual EMS response times to accident scenes from fixed locations with those generated by the network analysis capabilities of GIS in estimating response times of strategically located EMS units. The results of the study showed that changes in the location of EMS units would result in an increase of approximately 7% - depending on the time of the day – in those accidents that could be reached within the 5 minute response time threshold. In conclusion the study found that by changing the location of EMS units, significant improvement in response times could be achieved with potential benefits in terms of improved patient outcomes and reduced costs.

In a similar study using GIS technology, Peleg and Pliskin (2004) offered a simulated, model-derived strategy for improving the deployment of ambulances to reduce response times in the Carmel and Lachish districts of an Israeli EMS system. Before using the GIS model, mean response times in the two districts were 12.3 and 9.2 minutes respectively, with 34% and 62% of calls responded within 8 minutes. When ambulances were re-positioned according to their model, more than 94% of calls met the 8-minute criterion. The study concluded that by adopting the GIS simulation model presented, EMS resources could be more effectively deployed, potentially resulting in increased rates of patient survival and improved cost-efficiency.

Similar results have been found in research where GIS technology has been applied towards identifying the geographic distribution of specific diseases for the purpose of improving public access to specialised EMS resources. In Singapore, Ong, Tan, Yan, Anushia, Lim, Leong, Ong, Tiah, Yap, Overton and Anantharaman (2008) found that there was a definite geographic-time distribution pattern of cardiac arrests in their study aimed at assessing the feasibility of a public access defibrillation programme. The study demonstrated the utility of GIS in the cost effective deployment of resources by type and geography of location.

Although the use of GIS shows promise for the future deployment strategies of EMS systems, some limitations are apparent or have been identified.

In an assessment of ambulance response performance using GIS among three communities in Southern Ontario, Canada, Peters and Hall (1999) identified that where EMS units are not available at the centre closest to the reported incident or where other extraneous variables may be present, considerable variations may be seen in response time performance. The study suggests that care should be exercised in identifying these anomalous calls which can adversely affect the overall performance evaluation.

Edelman (2007), more recently highlighted a number of additional GIS limitations which include the use of secondary data from multiple sources; a paucity of data relating to individual illness, injury and socio-economic status; and overestimation of illness and injury rates in areas where a small number of events have previously occurred.

Despite these limitations the implications for GIS use among EMS systems in optimising resource deployment remains predominantly strong due to its continued development through further research and fast-paced technological advancement.

2.10.2 Demand Pattern Analysis

Early attempts to determine the demand for EMS resources, with the purpose of curbing ever escalating operational costs, predominantly concentrated on predicting the type and frequency of EMS responses in relation to specific areas.

During the late 1960’s and early 1970’s a number of studies conducted in Los Angeles County in the United States discovered that by utilising a simple linear model employing socio-economic, land use and EMS variables, the demand for EMS resources could be accurately predicted (King and Sox 1967; Aldrich, Hisserich and Lave 1971; Siler 1975). These studies found that, despite a large, heterogeneous population, socio-economic and demographic characteristics can significantly influence the demand for EMS resources. The studies also recognised that a number of other variables, such as changes in weather or the perceptions of people towards the use of EMS, can further influence demand.

The demand for EMS resources also fluctuates constantly over time and patterns of change can be seen depending on the season or the month of the year; the week within the month; the day of the week; and the time of day (Ong, Ho, Tan, Koh, Almuthar, Overton and Lim 2009). Later researchers recognised this and present day models generally make use of an infinite number of spatial and temporal variables.

Demand pattern analysis typically uses 20 weeks of baseline data and one of three complex mathematical equations based on moving averages. It is designed to allow adequate response capacity during typically increased demand periods while minimising, or redeploying, excess capacity during non-peak periods (Brown, Lerner, Larmon, LeGassick and Taigman 2007). Although demand pattern analysis has been employed extensively among first world EMS systems, only recently was its ability to accurately forecast demand patterns scientifically evaluated.

The first published study to determine whether demand pattern analysis calculations are accurate based on the models described in the previous chapter was undertaken recently by Brown *et al.* (2007). The study found that demand pattern analysis at best correctly predicted call volumes up to 19% of the time with an over-prediction rate of between 74% and 86%. Call volumes were underestimated between 4% and 7% of the time. The study concluded that demand pattern analysis is a reasonable predictor of the demand for EMS resources.

The effective use of demand pattern analysis has also been reported by Ong *et al.* (2009) in a study conducted in Singapore. The study sought to use demand pattern analysis to predict emergency department attendance in determining adequate staffing levels. This prospective study conducted over a three year period at the Singapore General Hospital found that there was a clear and consistent pattern of patient attendance with seasonal, weekly and daily peaks in demand.

Although there is a paucity of evidence relating to the effectiveness of demand pattern analysis as a tool to determine trends in patient demand of EMS resources, initial studies clearly show great promise and further research and development in this area should be considered mandatory.

2.10.3 Dynamic Location/Relocation

Traditionally, EMS units that are not actively involved in responding to an incident, caring for and transporting a patient, or returning to their home base are expected to remain static, at their home base, until they are dispatched to respond to another incident within their area of responsibility. The problem with this approach is that shifts in demand occur constantly within the given area throughout the day and 'gaps' in coverage may be frequently experienced, especially during busy periods where the availability of EMS units to respond to another incident may be limited. This inevitably results in unacceptable delays and increased response times (Takei, Inaba, Yachida, Enami, Goto and Ohta 2010). Recently, EMS systems have looked towards the use of decision support tools that can effectively identify these 'gaps' and aid in the dynamic or real-time location and relocation of EMS resources.

Brotcorne, Laporte and Semet (2003) describe a number of different deployment plans and optimisation models used by EMS systems since the early 1970's. Two main models are identified, the earlier deterministic or static model which is used during the planning stage and ignores the random nature of EMS availability, and the later probabilistic model that recognise that EMS units operate as servers in a queuing system where constant fluctuations in availability are experienced. More recent developments have seen the advent of the dynamic model which recognises that the demand for EMS resources fluctuates constantly through time and location. These later sophisticated models involve the widespread adoption of computer software at several levels of decision making, using complex modelling and algorithmic sophistication, in the performance of mathematical programming solvers.

Various dynamic models have been proposed but each model has common characteristics. In short, each model recognises that the demand for EMS resources is affected by both time and location and that EMS units should not remain static but that they should be constantly relocated throughout their own and adjacent areas of responsibility.

Setzler, Saydam and Park (2009) importantly point out that a difference exists between dynamic deployment and real-time positioning. Dynamic deployment requires that EMS units are re-positioned in anticipation of changes in demand over the next few hours and primarily relies on demand pattern analysis. This allows for long term or intermediate term strategic and tactical capacity planning but does not help with short term deployment plans; Whereas real-time positioning requires that, where units are dispatched from one area, then other units are immediately relocated to ensure optimal cover of the entire operational area. Additionally, when a unit becomes available after finishing a call, it can immediately be dispatched from its current location to an outstanding call, or it can be repositioned in another area or to another base other than its own. Real-time positioning therefore relies considerably less on demand pattern analysis.

For effective dynamic location/relocation practice the demand pattern for EMS resources must be accurate with meaningful degrees of both temporal and spatial combinations. Briefly explained, this means that demand patterns for an area covering an entire year will not yield helpful results in determining the deployment of EMS units during the time of day because demand varies both in space and magnitude, as well as by day of the week (Rajagopalan, Saydam and Xiao 2008). Similarly, forecasting hourly demands for large areas, such as cities, counties or provinces, will not determine optimal EMS unit deployment (Setzler *et al.* 2009). To achieve accurate forecasts then, the demand for EMS resources should be shown in manageable time increments and smaller geographic areas.

The use of dynamic location/relocation models have been shown to be effective where these principles have been applied (Andersson and Varbrand 2007; Maxwell, Restrepo, Henderson and Topaloglu 2010) and although research and development into these models is in its infancy its future application in the optimisation of limited but vital EMS resources remains encouraging.

2.11 Summary

This chapter has defined the methods used in searching the available literature relating to the study and has provided an extensive review of the literature collected. At this stage it may be practical to offer a summary of the contents of this chapter before proceeding to the next.

Where the inappropriate use of resources among other EMS systems has been reported, the reasons have been found to be complex and varied. With the widespread misuse of EMS systems, greater demand for limited resources becomes inevitable. This leads to the frequent unavailability of units to respond to life threatening cases

To counter this, EMS providers worldwide have continued to research and develop sophisticated and innovative EMD systems while investigating alternative resource deployment and patient routing strategies.

Current research evidence suggests that where EMS providers make use of priority dispatch systems, such as MPDS and AMPDS, and compliance and quality assurance controls are in place; these systems are more effective than the EMD alone at correctly prioritising the call. However, wide variations in the accuracy of these systems have been reported and it is recognised that further research and development is needed.

Present day EMS systems generally employ one of two strategies associated with the deployment of their resources, the ‘all ALS’ or ‘multi-tiered’ system. Each system has its own distinct advantages or disadvantages and it appears as though decisions on which system to employ may be motivated by financial considerations. Although the ‘multi-tiered’ response system presently forms the basis of most EMS systems worldwide, it is evident that a paucity of evidence exists as to its effectiveness.

Preliminary studies aimed at triage by ECP’s on scene to decide upon appropriate care pathways, has to some extent been encouraging but research in this area is lacking.

Rapid EMS responses to emergency cases are supported by the evidence in general and the literature gives strong support for applying the eight minute response time standard consistently across all emergency response categories. It is evident however, that more research is needed in this area to effectively identify those patients that will, in fact, benefit from an EMS response time of less than eight minutes.

Strong, albeit limited evidence presently exists for the employment of systems status management and its associated modalities which include new and emerging technologies such as GIS, demand pattern analysis and ambulance location/relocation models. In those EMS systems where it has been implemented, greater successes have been achieved in attempting to optimise their limited but vital resources. Further research and development is needed and should be encouraged in this area.

A common theme among the literature reviewed appears to be an agreement that there is clear evidence concerning the inappropriateness and inefficiency of the current EMS models of care and that primary research evidence is lacking on how to safely develop EMS systems so that more efficient use of EMS resources can be better achieved. Further research is needed to safely develop these systems as a matter of urgency. Importantly, preliminary studies have consistently pointed to the need for caution.

The next chapter will now present the research methodology employed in conducting the study.

3 CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Chapter Overview

Research is frequently described as the cornerstone or hallmark of the development of a profession or discipline and it is becoming increasingly more important in modern day health care systems. In order for research to be meaningful it must consist of systematic inquiry that uses disciplined methods. It is important therefore, that the research methodology is meticulously recorded (Polit and Beck 2010).

This chapter records the research methodology. It firstly provides an outline of the research design along with justification for its use. Following this are sections which discuss the location and setting of the study; define the population and sample used; and describe the data collection and data analysis strategies. The final section discusses the ethical considerations in conducting the research.

3.2 Study Design

An optimal study design is one that is best for the research purpose in terms of achieving the objectives and/or answering the research questions. In choosing a specific research design Brink (2010) suggests that the researcher should draw on his or her expertise while considering the complexities of the problem, the purpose of the research and the researchers need to generalise the findings of the study. Additionally, it should allow for both time and cost efficiency within the scope of the research (Aldous, Rheeder and Esterhuizen 2011). Moreover, an evaluation, a term borrowed from social research, proposes designating a process to determine if a particular implementation of basic scientific findings is effective in the real world (Bausell 2006) or in other words research undertaken to see whether a program or activity is meeting or has met the objectives set for it.

In determining an optimal design the researcher adopted a three step pragmatic approach.

Firstly the researcher revisited the study purpose and research objectives while considering the available data and its units of analysis along with the need to generalise the study findings. Here it was concluded that the study would be better served by using a quantitative method. Table 3.3 illustrates this process.

Table 3.1: Decision table regarding type of research method to be employed

Purpose statement: The purpose of the study is to evaluate the appropriateness of EMS responses in comparison to patient needs in a South African urban EMS system				
Research objectives	**Available data**	**Unit of analysis**	**Need to generalise**	**Method to be used**
To analyse the EMS dispatch in terms of the level of prioritisation and the resources allocated to the response	Computerised dispatch logs	Statistical: Dispatch categories, priority codes and time periods	Yes	Quantitative
To evaluate the clinical needs of the patient once the EMS responding unit arrives on scene	Patient clinical report forms	Statistical: Injury/illness categories and triage codes	Yes	Quantitative
To compare the EMS dispatch with the clinical needs of the patient	Computerised dispatch logs/ Patient clinical report forms	Statistical: Comparison of data	Yes	Quantitative

Next the researcher sought to identify an appropriate study design. Keele (2010) refers to four levels of researchable questions that lead to a specific quantitative design. These questions were developed by Dickoff, James and Wiedenbach (1968) for practice orientated theory in nursing research but the principles can be equally applied to this study setting. The four levels of questions are described as factor-isolating, factor-relating, situation-relating and situation-producing:

- Factor-isolating questions seek to name and describe factors or variables of interest to the researcher and may ask “What is this?” The most fitting research design to answer these questions is the descriptive design. Basic descriptive designs can be added to by comparing two or more groups and are referred to as descriptive, comparative designs.
- Factor-relating questions seek to answer questions of relationship and ask “What is happening here?” A correlational research design is the most appropriate design in such instances.
- Situation-relating questions seek to examine causality and ask “What would happen if?” Quasi-experimental research designs are used here to evaluate an intervention when one of the requirements for a true experimental design, usually randomisation, is lacking.
- Situation-producing questions seek to answer “How can I make it happen?” and provide the most convincing evidence to support the value of an intervention. This is the highest level of research enquiry and involves a true experimental research design, often referred to as a randomised controlled trial or RCT.

Keele (2010) further offers a decision tree which aims to match the research design to the category of research enquiry. Figure 3.1 presents an adapted version of the decision tree.

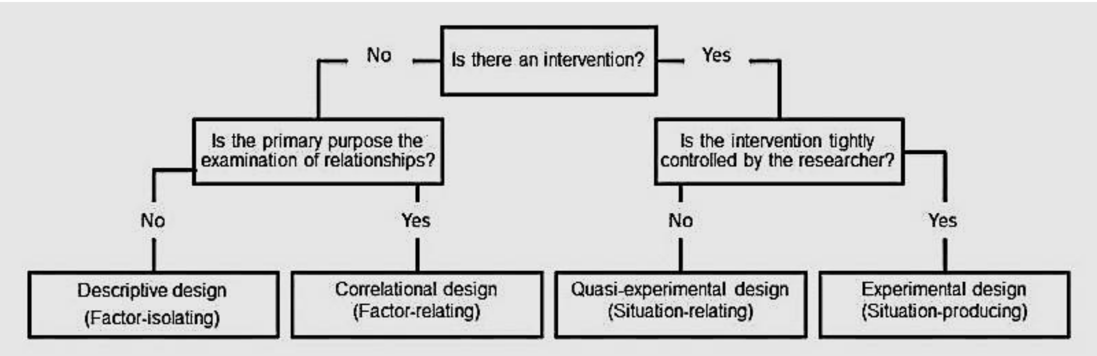


Figure 3.1: Quantitative research decision tree (Keele 2010)

The nature of this particular enquiry sought only to describe the variables under investigation, it did not involve an intervention nor was its primary purpose to examine relationships, and it can therefore be best described as factor isolating. This was the basis on which the descriptive design was considered to be the most appropriate. Moreover, because the study aimed to evaluate and compare differences in variables between two groups, the research design became a comparative descriptive design.

Once the research method had been defined and the most appropriate study design chosen, the third step of the sequence was to consider the time dimension that would be applied in collecting the study data. The major distinctions in categorising how studies deal with time sequencing during data collection follows (Brink 2010):

- Prospective designs aim to measure variables that will occur during the study or as the study progresses.
- Retrospective designs, often referred to as *post facto* designs, measure variables that have already occurred or are in the past.
- Cross sectional designs involve the collection of data at one point in time. Such a design is economical and easy to manage however it cannot properly infer changes and trends over time.
- Longitudinal designs involve the collection of data over an extended period of time. Such a design strengthens studies that aim to establish causality by examining changes over time.

For the purpose of this study a prospective, cross-sectional time frame was considered to be most appropriate data collection strategy. Prospective data collection ensured currency of the data and, because the study is descriptive in nature and does not attempt to investigate causality, the cross-sectional approach ensured efficiency.

In summary then, it was concluded that the research would be best conducted as a quantitative study, using a prospective, cross-sectional, comparative, descriptive design. The following section will discuss the validity of the research design as it relates to the study.

3.3 Validity of the Research Design

In order to establish whether the research design is effective in producing valid and compelling evidence there are a number of important considerations that need to be taken into account. Polit and Beck (2010) describe four aspects to consider in ascertaining the merits of a quantitative study. These four aspects are: statistical conclusion validity; internal validity; external validity; and construct validity.

Statistical conclusion validity refers to the ability of statistical tests to actually detect true relationships between variables, especially where inferential statistical tests are used to support these relationships. Statistical conclusion validity is particularly important when establishing causal relationships and great care should always be taken to prevent false conclusions (Polit and Beck 2010). In terms of this study however, simple descriptive statistics are primarily utilised and therefore the foremost consideration is in ensuring that there is statistical power through an adequate sample size. In determining a representative sample size the study considered the largest sample size that could be realistically achieved given accessibility to the data and time constraints. In consultation with key study role-players, including a statistician, it was considered that a sample taken over a consecutive 72 hour period was adequately sufficient to ensure statistical conclusion validity. The sampling strategy is discussed in more detail in section 3.8 of this chapter.

Internal validity refers to the extent to which inferences can be made in establishing causal relationships in experimental or quasi-experimental study settings (Polit and Beck 2010). There are no threats to internal validity relating to this study due to its descriptive design. Consideration of issues relating to internal validity is therefore not applicable to this study setting.

External validity relates primarily to the generalizability of a study to a greater population or setting. Another concept relevant to external validity is whether the study can be replicated at an alternative site achieving similar results, particularly where such a site differs in important characteristics. In such situations the strength of a study is enhanced (Polit and Beck 2010). For example, where this particular study has been undertaken in the urban area of eThekwini in the province of KwaZulu-Natal, could it be generalized or replicated to another urban area in KwaZulu-Natal, in urban areas in other provinces, such as the Western Cape or Gauteng province, or indeed in urban areas beyond the borders of South Africa? To answer this question there is a need to revisit the purpose of the study once again. Because the study aims to describe previously unknown phenomena in a particularly well defined setting and population, which will be further discussed in sections 3.7 and 3.8 of this chapter, the need to generalize to other settings or populations was not considered to be of paramount concern. The findings of this study however, can be well generalized to the entire urban population of KwaZulu-Natal, as intended, and other populations where similarities exist in terms of demographic profiles and Emergency Medical Service (EMS) systems.

Construct validity is a measure of whether the data collection instrument used adequately measures the abstract concept of interest (Polit and Beck 2010) and it is almost exclusively related to research relating to the social sciences, psychology and education where there is a great deal of subjectivity to concepts (Brink 2010). Often, there is no accepted unit of measurement and even fairly well known ones, such as the intelligence quotient or IQ scale, are open to debate. Construct validity is particularly important in research where, for example, feelings such as grief, happiness, satisfaction or pain are measured and where the study must generate its own data. Because this study is of a descriptive design and makes no attempt to use instruments to measure such abstract concepts or generate its own data there are no threats evident to its construct validity. The study has however collected existing data and the validity and reliability of the data and its collection methods will be discussed further in section 3.6 of this chapter.

In summing up, it is apparent that there are no threats to the validity of the study design and the evidence that has been produced is conclusive and reliable.

3.4 Research Setting and Site

The research setting may be defined as the places and conditions under which data is collected for a study or investigation. Polit and Beck (2010) suggest that there are two opposing settings under which research can be conducted and that these are influenced by the amount of control exerted by the researcher. The naturalistic setting, at one extreme, involves little or no control and is conducted in real world situations; whereas the laboratory setting, at the other extreme, involves conditions of strict control where manipulation of variables can occur.

The site of a study according to Polit and Beck (2010) generally refers to its overall location within a setting and can consist of a single site or multiple sites.

The data for this study was collected in a real world setting, where no manipulation of variables occurred, at a single site serving an entire community. The sub-sections that follow will more fully discuss the research setting and site as they relate to this study.

3.4.1 KwaZulu-Natal

KwaZulu-Natal is one of nine South African provinces and is situated on the eastern seaboard of the Republic. The province covers 92,100 km^2 or 7,2% of the total land surface of South Africa and up until recently had the largest population of almost 9,4 million people (The Provincial Decision-Making Enabling (PROVIDE) Project 2005). The latest population statistics however, show that it is the second most populous province in the country totalling just fewer than 11 million people with an average life expectancy of 48.4 years for men and 52.8 years for women. Notably the province has the highest number of children, with 23% of the country’s younger than 15 year old age group residing within its borders (Statistics South Africa 2011), 70% of its population is under the age of 35 years (Department of Health: KwaZulu-Natal 2010), and it has the highest rate of HIV infection which, according to the Joint United Nations programme on HIV/AIDS (UNAIDS), was reported to be 39% in 2009 (Dugger 2009)

Among the South African provinces KwaZulu-Natal is the third richest after Gauteng and the Western Cape and although the people of KwaZulu-Natal are relatively wealthy, the province is still marred by high poverty rates, inequalities in the distribution of income between various population subgroups, and high levels of unemployment (The Provincial Decision-Making Enabling (PROVIDE) Project 2005).

Disease profiles appear to be strongly linked to socio-economic deprivation and preliminary results of the KwaZulu-Natal burden of disease study show that a significant component of the burden of illness is attributable to communicable diseases and nutritional, maternal and peri-natal conditions (Department of Health: KwaZulu-Natal 2010).

KwaZulu-Natal is divided into eleven districts. One of these districts encompasses the City of Durban and its surrounding areas, known as eThekwini; the district comprises a metropolitan municipality with a district health system within the same borders. More than one third of the provinces population, approximately 34%, lives within the boundaries of eThekwini (Department of Health: KwaZulu-Natal 2010).

3.4.2 EThekwini Health District

Situated centrally on the coast of KwaZulu-Natal, eThekwini metropolitan municipality encompasses the greater city of Durban and surrounding areas. With a land area in extent of 2,292 square kilometres, Durban is the largest city in the province and is the third largest city in South Africa after Johannesburg and Cape Town. Durban is specifically famous for having the busiest port in South Africa. It is also seen as one of the major centres of tourism because of the city's warm sub-tropical climate and extensive beaches.

The population of eThekwini was last recorded in the 2007 community census at almost 3.5 million people (Statistics South Africa 2008). The population density of eThekwini is estimated at 1,394 people per km^2 and approximately 10% of the urban population live in under-developed informal settlements (Department of Health: KwaZulu-Natal 2010).

The eThekwini district health services are jointly provided by the KwaZulu-Natal provincial Department of Health and the eThekwini metropolitan municipality, with former contributing approximately 60% of services and the latter 40% (KwaZulu-Natal Department of Health 2001). The health district structure consists of primary, secondary and tertiary level hospitals, specialist hospitals, clinics, community health centres and mobile clinics. Table 3.2 below more fully presents the health structure of the eThekwini health district.

Table 3.2: eThekwini health district structure (KwaZulu-Natal Department of Health 2001)

eThekwini Health District	
Hospitals	16
District (1°)	*6*
Regional (2°)	*6*
Tertiary (3°)	*1*
Specialist	*3*
Community Health Centres	8
Clinics	39
Mobile Clinics	21

Linking these structures and integral to the efficiency of the health system is the provincial Emergency Medical and Rescue Service (EMRS), which operates throughout the province and within the boundaries of the eThekwini health district.

3.4.3 Emergency Medical and Rescue Service (EMRS)

The provincial EMRS provides an essential service to the entire population of KwaZulu-Natal. It is a public service utility with a provincial executive management team which reports directly to the provincial Minister of Health through the Head of Department. The organisation has as its mission statement "To provide an equitable, efficient and effective quality caring emergency medical rescue service within available resources through a transformed and amalgamated structure by a professional, disciplined and demographically represented staff." (Emergency Medical Rescue Services: Province of KwaZulu-Natal nd).

The organisation has an operational component with emergency and non-emergency tiers directed by district Emergency Medical Communications Centres (EMCC) along with an administrative support component as illustrated in Figure 3.2. There are eleven districts within the provincial structure and these districts share common boundaries with the provincial district health structures. Each EMRS district is headed by a district management team that reports directly to the provincial EMRS management team and liaises with other district health role players. The provincial EMRS operational structure also includes a provincial health operations centre and an aeromedical service.

The health operations centre aims to coordinate and integrate the functions of the district EMCC's providing strategic information dissemination. It also functions to collect and interpret data which is communicated to the executive management team and other key role-players.

The aeromedical service comprises of two rotor wing aircraft, which at present only have daylight flying capacity, and one fixed wing aircraft. The two rotor wing aircraft, one based in eThekwini, the other in Richards Bay on the KwaZulu-Natal North Coast, respond to immediately life threatening cases in remote or otherwise inaccessible areas and disasters or major incidents, whereas the fixed wing aircraft is primarily used over long distances for the transportation of patients between different regional, provincial or specialist hospitals.

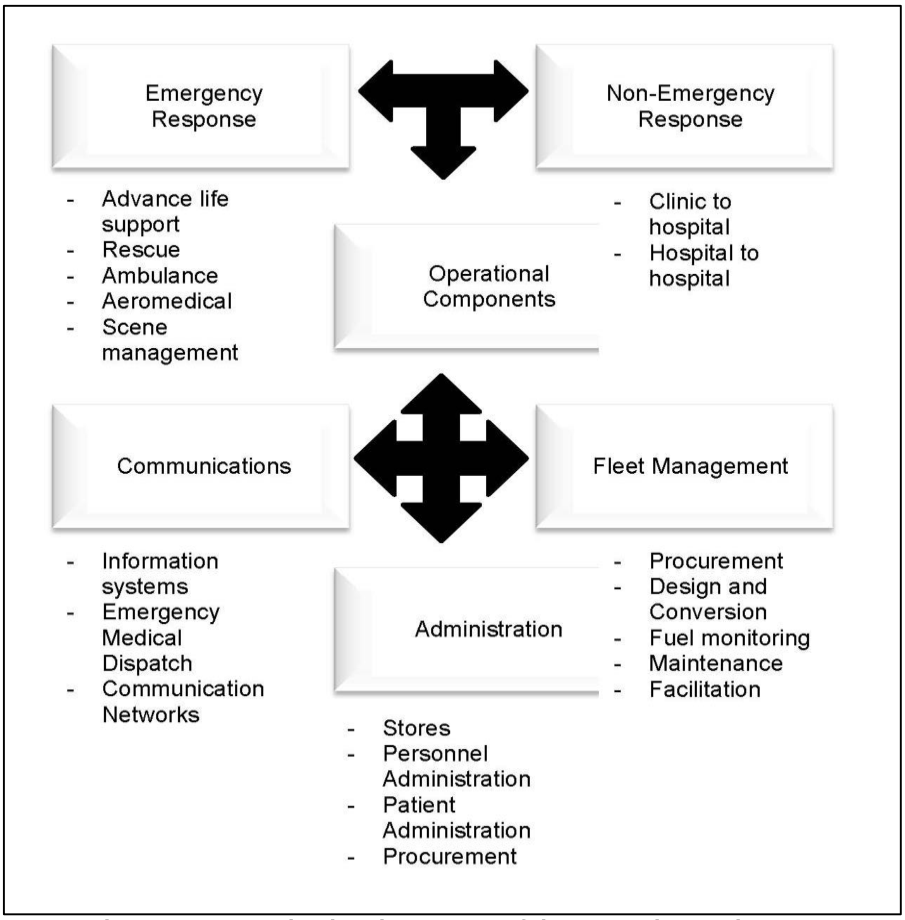


Figure 3.2: Organisational structure of the KwaZulu-Natal EMRS

Fundamentally, the EMRS operational component is made up of three distinct divisions: The EMCC; emergency operations; and planned patient transport. These divisions will now be discussed in more depth to allow for further clarity.

3.4.3.1 Emergency Medical Communications Centre

Accessed by the public through the national toll free 10177 telephone number, each district within the KwaZulu-Natal EMRS has its own EMCC with an information officer and a communications officer - reporting directly to the district operational manager - who are responsible to ensure its activities.

District EMCC's operate on a 24 hour basis and are manned by Emergency Medical Dispatchers (EMD) who coordinate operational activities within the district. Essentially, the district EMCC's are responsible for emergency call taking and processing along with the dispatching of appropriate EMRS resources. Another function of the EMCC's is to ensure that there is effective inter-agency communication with other organisations such as the South African Police Service (Emergency Medical Rescue Services: Province of KwaZulu-Natal nd).

The district EMCC's operate within a framework developed by the national department of health where dispatch targets are set at 15 minutes or less for all life threatening cases in urban areas and 40 minutes or less in rural areas (Department of Health: KwaZulu-Natal 2010). The total dispatch time is defined by EMRS as the period from the receipt of the call by the EMD to the time that the first EMRS unit is dispatched and a maximum of 5 minutes are allowed for the activity of receiving, logging and processing the call until the actual time of vehicle dispatch. (Emergency Medical Rescue Services: Province of KwaZulu-Natal nd).

The staff complement for the EMCC's are not dedicated personnel but are drawn from the operational division on a rotational basis and apart from standard EMS training to either Basic Life Support (BLS), Intermediate Life Support (ILS) or Advanced Life Support (ALS) level each individual is required to complete a basic EMD short course when being inducted into the EMCC environment. The course content however, is limited to basic communication skills and technical background with very little content relating to triage and call prioritisation. The course manual in fact lists only 14 'medical advice protocols' which consist of a set of reference cards containing a chief complaint, a series of key questions, pre-arrival instructions and dispatch priority advice (Pillay, 2003). The chief complaints are broadly categorised as: Assault; Breathing problems; Traumatic injuries; Unconsciousness/Fainting; Haemorrhage; Stroke; Stab/Gunshot wound;

Traffic accident injuries; abdominal pain; Allergies; Carbon monoxide inhalation; Cardiac/Respiratory arrest; Chest pain; and Diabetic problems.

EThekwini districts EMCC operates with a total staff complement of 88 individuals divided among four shifts with one supervisor per shift. Approximately 55% of these individuals have training to an ILS level leaving the remaining 45% with BLS training. There are no personnel allocated to the EMCC with skills at an ALS level. Table 3.3 below presents a breakdown of the EMCC staff complement over the study period.

Table 3.3: eThekwini district EMCC staff complement

Date	Shift	Qualification		Total	Function				
		BLS	ILS		OIC	SNR	DIC	DCO	DTO
23/11/2011	N	4	10	14	1	1	1	4	7
24/11/2011	D	7	11	18	1	1	1	4	11
	N	5	9	14	1	1	1	4	7
25/11/2011	D	6	16	22	1	1	1	4	15
	N	3	12	15	1	1	1	4	8
26/11/2011	D	7	11	15	1	1	1	4	11
	N	3	12	15	1	1	1	4	8
D = Day Shift (07:00 – 19:00) N = Night Shift (19:00 – 07:00)									
Legend:	BLS = Basic Life Support ILS = Intermediate Life Support OIC = Officer in Charge SNR = Supervisor				DIC = Dispatch Input coordinator DCO = Dispatch Channel Operator DTO = Dispatch Telephone Operator				

During a particular shifts duty period individual EMD's are allocated to specific tasks. With the exception of the supervisor who coordinates all activities, the task may be to either handle incoming calls or direct vehicle dispatch. To better understand the allocated tasks, the manner in which a typical call is handled will be reviewed.

The initial point of contact is usually through the toll free 10177 emergency telephone number which is immediately directed to a telephone operator. Should all telephone operators be busy then the call is placed in a queuing system on a first come first serve basis to be answered by the first available operator. The operator will initially ensure uninterrupted contact by being careful to immediately take down the contact details should contact be lost during the call. Only once the contact details have been established will the telephone operator then establish the nature of the request and the location of the scene. Based on the information given the operator will then offer pre-arrival instructions and decide on a priority allocation as follows (Emergency Medical Rescue Services: Province of KwaZulu-Natal nd):

- Red Code (Priority 1): A life threatening injury, illness or condition which demands the highest priority from the service.
- Yellow Code (Priority 2): A patient that requires hospitalization with serious illness or injury but which is not life threatening.
- Green Code (Priority 3): A patient whose illness or injury does not require urgent intervention.
- Blue Code (Priority 4): A patient who is obviously dead with no cardio-respiratory effort.

Once the telephone operator has recorded all of the pertinent information and ended the call, the case is passed to the supervisor who checks the details for completeness and accuracy while ensuring that the appropriate priority code has been allocated. It is also at this stage that the supervisor may choose to add to the standard BLS/ILS ambulance response by allocating more specialised units, such as an ALS response unit, or directing the dispatch of another agency such as the SAPS.

Following the supervisors input the case is finally passed to one of the four vehicle dispatchers, through the input coordinator, each overseeing their own geographical area of responsibility corresponding with established EMRS operational sub-districts or zones within the eThekwini district. The dispatcher, upon receiving the case details, will identify the closest available unit to the incident scene and dispatch it providing the responding Emergency Care Provider (ECP) with the incident specifics. Once the vehicle is dispatched all further communications with the responding ECP are directed by the dispatcher who is also responsible for recording the vehicles movements.

To optimise efficiency the eThekwini EMCC is supported by a state of the art computerised information and telecommunication system which operates within a province-wide consolidated system known as the GEM (C3) emergency readiness system. The GEM (C3) system comprises a range of integrated components and devices which include radio dispatch communications and paging equipment, CCTV cameras, real-time vehicle tracking and fleet management systems, and biometric remote access door-lock and intercom systems (Zetron International 2008).

The local district level switching component of the GEM (C3) system, the Zetron DCS-5020 Digital Console System, combines telephony with digital or analogue radio control and supports up to 28 channels and 15 screen-based operator consoles. In addition the DCS-5020 allows for flexibility, expansion and integration with a variety of other technologies (Zetron International 2008).

The operator consoles consist of an intuitive user interface, a desktop, and a touch screen that can easily switch between manual and automated functions. The consoles are also equipped with a conferencing capability, a PABX interface, and direct CCTV video streaming. Additionally, all audio conducted over the console is recorded onto a voice-logging system so that it can be retrieved and replayed, if necessary (Zetron International 2008).

Despite the advanced technology of the GEM (C3) and DCS-5020 systems there has been no integration with any form of computer aided priority dispatch and the allocation of a dispatch priority is wholly left to the subjective decision of the EMD. The system however, does allow for the allocation of an incident type and description.

Technical support for the entire system is overseen and coordinated by the South African based multi-national consultancy firm Africon, along with a number of specialists and suppliers in the field of telecommunications technology which includes the Altech group of companies. The system is also supported by a group of permanent technical staff drawn from the operational component of the EMRS organisation. These technicians, who are on call 24 hours of each day of the year, also ensure that effective communications are established and maintained at the scene of a disaster or major incident. For this purpose the province has two specialised communications vehicles, one of which is stationed in the eThekwini district.

3.4.3.2 Emergency Operations Division

The emergency operational division of the eThekwini district EMRS, supported by the EMCC, is responsible for the physical provision of emergency medical care to those people in need of such within its borders. Along with this responsibility comes the responsibility of expeditiously accessing patients that may not be easily accessible and transporting them to a point of definitive care appropriate to their condition. The structures and resources that have been made available to achieve this are now discussed in more detail.

The eThekwini emergency operations division, headed by the district operations manager, consists of four sub-districts each serving a particular geographical area (Figure 3.3). Each sub-district has an operational base along with a sub-district manager who is responsible for service delivery at a local level.

Within each sub-district there may be a number of established satellite bases or informal satellite points, known as ‘half-way houses’, at which resources can be strategically stationed to facilitate improved response times and increased public visibility and access. These satellite stations and half-way houses also allow for the real-time deployment of resources when shifts in public demand inevitably occur.

Mobile land resources throughout the district include a number of vehicles consisting of standard emergency ambulances which make up the bulk of the fleet, ALS/ILS response cars, light and heavy rescue units, mobile intensive care units, mobile communications centres, incident command units, and disaster support and mass casualty transport units. Added to this is an array of specialised trailers, among which is a mobile kitchen, and specialised ambulances, such as the recently introduced obstetric/neonate units.

Figure 3.3: Map of eThekwini with EMRS base locations (Geographic Information Systems Unit 2010)

Generally, a response to a patient in need is initially in the form of a standard emergency ambulance, which is manned by two ECP's, both of which are at least BLS qualified. This unit is equipped with minimum BLS equipment which includes oxygen, suction equipment, a bag-valve-mask resuscitator, and wound care sundries.

Should the patient be deemed to require more advanced management then an ALS response car is simultaneously dispatched. An ALS response unit is also manned by two ECP's, one of which is an ALS qualified paramedic, and these units carry additional equipment such as cardiac monitors, defibrillators, and mechanical ventilators.

If the patient should be found to require ALS intervention on scene and during transport then the standard emergency ambulance is easily converted to accommodate for the additional specialised equipment needs.

Additional specialised equipment, such as neonatal transport incubators, are stored at the sub-district bases and are easily accessed should they be required. This equipment can either be transported to the scene by another unit or the ambulance can be loaded and configured with the equipment prior to its leaving base.

Aeromedical resources consist of a rotor wing aircraft and a fixed wing aircraft, the rotor wing aircraft is primarily used for 'hot' responses within the eThekwini district attending to the seriously ill or injured in remote or otherwise inaccessible areas. The fixed wing aircraft on the other hand is primarily used for the long distance transfer or repatriation of patients between Durban hospitals and hospitals in other metropolitan centres throughout South Africa and internationally. Although these resources are stationed and mostly utilised by the eThekwini district they are a provincial resource and can be called upon by other districts to respond to any location within or without the province.

In terms of human resources there are three levels of ECP's that practice in eThekwini EMRS at BLS, ILS and ALS level and it is mandatory that each level is registered with the Health Professions Council of South Africa (HPCSA), a statutory body established in terms of the Health Professions Act: 56 of 1974, as amended (Republic of South Africa 1974). The HPCSA, in short, is committed to serving and protecting the public and providing guidance to registered healthcare practitioners. The organisation achieves its mandate by regulating the health professions in aspects pertaining to registration, education and training, professional conduct and ethical behaviour, ensuring continuing professional development, and fostering compliance with healthcare standards. (Health Professions Council of South Africa 2012).

The eThekwini EMRS aims to progress towards becoming a minimum ILS level service based on a ratio of 1 BLS to 1 ILS qualified individual per emergency ambulance thus ensuring that the service has 100% ILS level status. Additionally each sub-district base is required to have an ALS response unit available on a 24 hour rotational basis (Emergency Medical Rescue Services: Province of KwaZulu-Natal nd).

National benchmark norms also require that a minimum of 1 emergency vehicle be available per 10,000 people (Department of Health: KwaZulu-Natal 2010). Presently the eThekwini district has a scheduled vehicle status that amounts to 45 emergency vehicles at any one time but typically this figure is somewhat lower; unpublished statistics for November, 2011, show that the average vehicle status for the eThekwini district EMRS over a 24 hour period was only 37 emergency ambulances with 3 ALS qualified paramedic response units (Emergency Medical Rescue Service 2012). With a population of over 3.5 million this remains far below the national benchmark and currently eThekwini EMRS is only able to provide somewhere in the region of 1 emergency ambulance per 95,000 people according to the available statistics. Table 3.5 below presents the operational vehicle status over the study period.

Table 3.4: eThekwini operational vehicle status

Date	Shift	Ambulance	Paramedic
23/11/2011	19:00 – 07:00	38	2
24/11/2011	07:00 – 19:00	44	3
	19:00 – 07:00	38	2
25/11/2011	07:00 – 19:00	43	4
	19:00 – 07:00	34	3
26/11/2011	07:00 – 19:00	38	3
	19:00 – 07:00	38	2

3.4.3.3 Planned Patient Transport

Although planned patient transport data has not been gathered for the purpose of this study it is important that some background information is given to enable the reader to more fully understand the EMRS operational landscape. The use of planned patient transport resources may not be optimally utilised and emergency operations and planned patient transport often overlap roles and responsibilities. The need to describe the planned patient transport division will become clearer later in this section.

The planned patient transport division facilitates transportation of non-emergency scheduled referrals between health establishments within the district and throughout the province. This is achieved by utilising a number of vehicles of different patient carrying capacities and configurations that can cater for seated and stretcher patients and may range from heavy duty 65 seat buses to small minibus type vehicles.

Generally, patients are routinely transported between primary, secondary and tertiary level hospitals within the eThekwini district and repatriated to their respective hospitals of origin outside of the district by the eThekwini EMRS. Patients requiring to be transported from other district hospitals to hospitals within the eThekwini district are the responsibility of the referring districts EMRS.

Besides the transportation of scheduled non-emergency referrals the planned patient transport division is also responsible for the transfer of unscheduled non-emergency patients between hospitals. This service has recently been extended to include transportation between clinics and community health centres; however it is presently limited in terms of capacity and only operates during certain weekday periods. As a result many of the unscheduled non-emergency cases are transported by the emergency operations division.

Another responsibility of the planned patient transport division is to provide mass casualty transportation of patients involved in a disaster or major incident and the emergency operations division frequently call for its help. Many of the larger vehicles are able to be reconfigured to carry additional supplies and stretcher patients and the smaller vehicles can be reconfigured as standard emergency ambulances.

All planned patient transport vehicles are routinely equipped with standard BLS equipment and are manned by at least one BLS qualified individual.

3.5 Population and Sample

The study population relates to all EMRS responses undertaken in the eThekwini Health District of KwaZulu-Natal. Unpublished statistical data kept by the KwaZulu-Natal Department of Health indicates that the eThekwini Health District EMCC's average 24hr daily case load during 2010 was in excess of 400 emergency calls, showing consistent and steady increases in preceding years.

In consultation with the primary study supervisor and statistician these figures were used as the basis of establishing a sampling strategy that would generate a sufficient level of confidence with a sample size of approximately 1,500 emergency responses.

Purposive sampling consisted of those emergency calls placed over a single 72 hour period with the eThekwini Health District's EMCC; 24 hours of which included a weekend peak period. A month end period was chosen to ensure a sufficient sample size. By spreading the sampling over this period it was intended that the data collected would give a fair representation of the different categories of EMS cases responded to and the rates and frequencies of the responses.

The inclusion criteria for the sample were all emergency calls logged and physically dispatched by the eThekwini EMCC over the designated 72 hour period. Calls were excluded where documentation was found to be incomplete or where an actual dispatch did not occur, such as in cases that had been duplicated or were cancelled by the caller prior to dispatch.

3.6 Data Collection

Data were collected from the eThekwini district EMRS; a multi-tiered, public utility EMS system, as described earlier in this chapter. This is a modern system with an effective quality assurance programme where reliable dispatch data was accessed through the Zetron DCS-5020 digital console system's computer generated logs and detailed epidemiological and clinical data were obtained from patient report forms.

Initial data collection began in the eThekwini district EMCC only once permission had been granted by the provincial health department on Friday 18th November, 2011. Mutually agreed arrangements were made shortly thereafter with the eThekwini communications officer to access the EMCC premises over the period Monday 21st November, 2011 to Sunday 27th November, 2011. The former part of the week was used for general observation and the computer generated dispatch data were collected over the latter part of the week between the hours of 00:00:01 on the 24th of November 2011 and 23:59:59 on the 26th November 2011.

Vehicle Control Forms or VCF's (Appendix 7.1) were generated in portable document format (PDF) for each case that had been logged and dispatched by the on duty EMD's between the dates and times already mentioned. Upon termination of the case each VCF was then exported to the researcher's portable hard drive, which was connected to a vacant digital consul. Once the VCF's were exported they were checked for accuracy and completeness and if found to meet the study inclusion criteria were ranked in order of the time of dispatch, from earliest to latest, corresponding with the system generated sequential case reference number, and stored in three separate files which were created for each of the three days over which the data were collected.

The VCF's were then matched with the corresponding patient report forms, or PRF's (Appendix 7.2), on which the EMCC system generated case number is annotated by the responding ECP on dispatch. These were collected at a later date from the EMRS central archives and again were checked for accuracy and completeness. These documents, which are completed by the responding ECP for each and every case dispatched, comprise of five identical carbon copied documents one of which is filed in date order at the central archives for record purposes.

Once the VCF's were matched with the corresponding PRF's the relevant data fields were extracted and inputted to a proprietary statistical software package for analysis (Appendix 7.3). A total of 1689 records were collected of which 1385 were matched with complete data meeting the inclusion criteria. A total of 304 records were excluded, following consultation with the primary study supervisor, for failing to meet the inclusion criteria.

3.7 Data Verification

Once the data was inputted it was thoroughly checked by the researcher and the study supervisor who conducted trial statistical tests for accuracy. The dataset was then submitted to the contracted statistician who further checked the dataset and performed additional trial statistical tests.

3.8 Data Analysis

The IBM Statistical Package for Social Sciences version 19 (SPSSv19®) computer software was utilised for the purpose of coding and analysing data. The statistical output was then exported into standard Microsoft Word and Excel software programmes for layout and graphical representation.

Although the services of a professional statistician were secured for the purpose of providing advice (Appendix 7.4), the descriptive statistical analyses and the graphical and tabular presentations were performed solely by the researcher. The following details the statistical tests employed.

Descriptive statistics are procedures used to summarize, organize, and make sense of a set of scores or observations and are typically presented graphically, in tabular form or as summary statistics. Descriptive statistics include measures of central tendency, measures of dispersion or variability and frequency distributions. The following is a description of the tests used in performing the statistical analyses for this study:

- Univariate analysis, a simple descriptive analysis, was used in describing the distribution of single variables This analysis included measures of central tendency using the mean and median, and measures of dispersion using the range, percentiles, and quartiles of the data-set. Frequency distribution was measured using analysis of variance and standard deviations.
- Bivariate analysis, which also describes the relationship between two variables, included cross tabulation and Chi square tests:
    - Cross-tabulation: a display, usually presented as a contingency table, which presents the joint distribution of two or more variables simultaneously.
    - Chi square test: a procedure used to test the statistical significance of the cross tabulations.

Measures of dependence were also employed to establish significance in relationships between two or more variables. The Pearson's r correlation was used when the variables were continuous, and the Spearman's rho was used if one or more were not.

3.9 Ethical Considerations

Ethical issues inevitably arise in all aspects of conducting research but particular emphasis must be placed on the consideration of human rights when conducting health sciences research.

Following the Nazi atrocities of World War II, the Nuremberg code of 1947 was the first set of ethical guidelines developed to protect the rights of human research participants. The code comprises a set of principles that must be considered when conducting research among human participants (The Nuremberg Code 1949). Table 3.5 below summarises the application of the principles of the Nuremberg Code as they apply to this study.

Table 3.5: Summary of the application of the principles of the Nuremburg Code in relation to the study (The Nuremberg Code 1949)

Principles of the Nuremberg Code	Application to study
Voluntary consent of research participants	Voluntary consent was not required for the purpose of this study; there was no direct human participation.
Research should show benefit to society	The findings of the research may inform better use of EMS resources in providing life-saving interventions
Results of previous research should justify study	An in-depth literature review was undertaken highlighting the benefits of previous research
Research participants are protected from risk or harm	Protection from risk or harm was not necessary; there were no human research participants involved. Where data were collected there was no personally identifiable information.
Research bears no risk of death or disability	The study involved no risk of death or disability; there were no human research participants involved
The balance of risk to benefit is appropriate for the research	There was no risks identified in conducting the research however substantial benefits may be realised
Research participants have the right to withdraw	The research involved no direct human participation; the right to withdraw was not relevant in this context
Proper preparation and adequate facilities to prevent harm to participants	The research involved no direct human participation; no preparation or facilities were required to prevent harm in this context
Researcher is appropriately qualified to conduct the research	The researcher has more than 25 years of experience in the topic of research and has completed a research methodology course at bachelor degree level. The researcher was also supervised by experienced researchers for the duration of the study
Research must stop where harm may be caused by continuation	The research involved no direct human participation; no likelihood of harm ever existed.

The Helsinki declaration of 1964 included the added protection of two vulnerable groups that had been omitted in the Nuremberg Code; children and mentally incompetent persons (Brink 2010). The Helsinki Declaration was subsequently adopted by the World Medical Association and has since been amended by the World Health Organisation (WHO) in 1975, 1983, 1989 and most recently in 2000, with clarifications published in 2004 (Brink 2010; Polit and Beck 2010). Many governments throughout the world have since developed their own guidelines for adhering to ethical principles based on the declaration of Helsinki. Most notable is the code of ethics adopted by the National Commission for the Protection of Human Subjects of Biomedical and Behavioural Research. The commission produced a report, known as the Belmont report, which provided for a set of ethical guidelines under which research in the United States of America is conducted (Polit and Beck 2010).

The Belmont report articulates three fundamental principles relating to the ethical conduct of research: beneficence; respect for human dignity; and justice. The rights of research participants enshrined in the ethical principles and how they apply to this study are shown in table 3.6.

Table 3.6: The rights of research participants enshrined in the fundamental ethical principles and how they apply to the study (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research 1979)

Right of research participant	Application to study
Right to freedom from harm and discomfort	The study did not involve direct human participation therefore this right was assured. Where data were collected there was no personally identifiable information.
Right to protection from exploitation	The study did not involve direct human participation therefore this right was assured. Where data were collected there was no personally identifiable information.
Right to self-determination	The study did not involve direct human participation therefore this right was assured
Right to full disclosure	The study did not involve direct human participation therefore this right was assured
Right to fair selection and treatment	The study involved only one general population and the sample included all cases dispatched over a specific period thus ensuring fairness
Right to privacy	Data collection did not involve the collection of personally identifiable information. Data consisted of times, broadly categorised injury/illness patterns and general demographic information such as age and sex.

Additional security measures to ensure the safety of the electronic data, even though there was no person identifiable information, involved storage on a password protected and encrypted hard drive which was kept under lock and key at the Durban University of Technology. The data and data set remains in the safekeeping of the principle supervisor, where after a period of five years it will be destroyed.

The following outlines the processes that were followed in obtaining the necessary ethical approval in ensuring ethical integrity in the conducting of the research:

- The study was conducted following the guidelines of the Durban University of Technology's ethical considerations for the conduct of research in the Faculty of Health Sciences.
- The study proposal was submitted to the University's Institutional Research Ethics Committee (IREC) on Thursday 28th April, 2011 and after having been reviewed was found not to pose any significant ethical challenges. A certificate of ethical clearance was subsequently issued on Monday 9th May, 2011 (Appendix 7.5).
- Further ethical review was conducted by the KwaZulu-Natal Department of Health after having sought written approval to conduct the research (Appendices 7.6 and 7.7) and approval was granted, again with no ethical concerns, on Friday 18th November, 2011 (Appendix 7.8).
- Ratification by the higher degrees committee of the Durban University of Technology was granted on Friday 26th August, 2011 (Appendix 7.9).
- During the course of the research the study was additionally subjected to a safety monitoring and annual recertification process whereby ethical approval to continue with the research was extended to Wednesday 9th May, 2013 (Appendix 7.10).

3.10 Summary

The importance of methodologically sound research is paramount in ensuring that a study presents the most accurate, unbiased, interpretable, and replicable evidence possible. This chapter has highlighted the attempts by the researcher in ensuring such. It has discussed how the research method and design was arrived at and the study designs validity in conducting the research. This was followed by an in-depth and informative narrative outlining the study setting, population and sample. The chapter then went on to explain the data collection and data analysis processes and finished with the very important ethical considerations and how the study’s ethical integrity was assured in conducting the research.

The following chapter will present the results of the statistical analysis.

4 CHAPTER FOUR: RESULTS

4.1 Chapter Overview

In this chapter the main results of the data analysis are presented and discussed in relation to the study purpose; an evaluation of the appropriateness of Emergency Medical Service (EMS) responses in comparison to patient needs in a South African urban EMS system. The chapter specifically reports on the three primary objectives listed in chapter one: To analyse the EMS dispatch in terms of the level of prioritisation and the resources allocated to the response; to evaluate the clinical needs of the patient once the EMS responding unit arrives on scene; and to compare the EMS dispatch with the clinical needs of the patient. Each section makes use of tables, graphs and diagrams with the explained outcomes of statistical tests to help the reader more fully understand the data. These sections are preceded by sections describing the sample demographics, public demand for resources and the dispatch and response chronology. The final section summarises the chapter.

4.2 Patient Demographics

Completed data consisted of 1385 emergency responses of which there were a slightly higher number of female patients as compared to male patients of 699 (50.5%) and 645 (46.6%) respectively. The sex of the patient was unable to be established on 41 (2.9%) occasions. Patients ranged in age from new born to 99 years old. The mean age of the patients was 32.5 years for males and 33.1 years for females.

4.3 Resource Demand

The demand for resources varies widely during the time of the day. The line graph overleaf illustrates the fluctuations experienced in demand over the study period (Figure 4.1). The graph shows that there is a marked decline in the demand for EMS resources from the late night hours (21:00) until early morning (03:00) with a smaller decline seen around midday (12:00). Peaks in demand steadily climb from mid-morning (09:00) towards midday and again from mid-afternoon (14:30) into the late night hours.

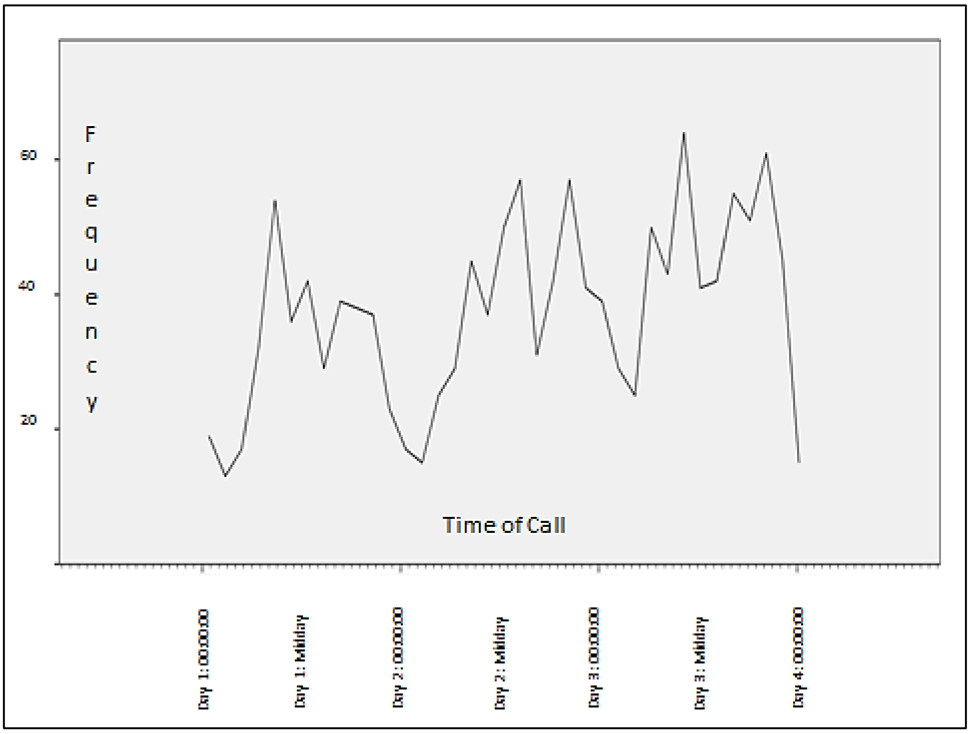


Figure 4.1: Fluctuations in the demand for EMS resources throughout the day

4.4 Dispatch and Response Chronology

The time of call to the time of dispatch or the EMD response interval for all cases irrespective of priority, worked out to the nearest minute, showed that the shortest EMD response interval was immediate with no time lapse and the longest was 9hrs 18min. The median EMD response interval across all priorities was 24min (IQR 48min). Table 4.1 presents an analysis of the median EMD response intervals with percentiles taken to the closest minute.

Table 4.1: EMD response interval percentiles

	Percentiles						
	5%	10%	25%	50%	75%	90%	95%
EMD Interval	4min	6min	11min	24min	59min	114min	151min

The variations in the median EMD response interval across the different priority allocations are illustrated below (Figure 4.2).

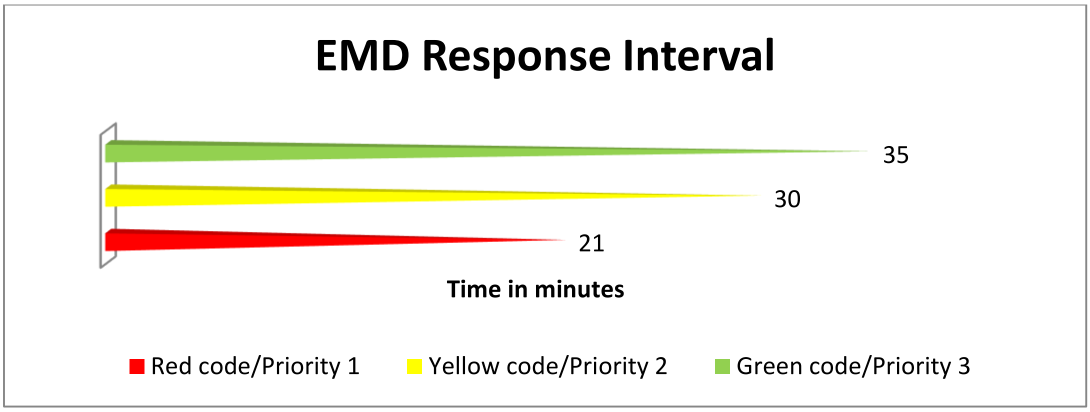


Figure 4.2: Median EMD response intervals across the different dispatch priorities

The EMS unit response interval, the time taken from dispatch to the time of the first unit arriving on scene, across all dispatch priority levels was shortest at 0min and longest at 5hrs 46min. The median travelling time was 24min (IQR 27min). Table 4.2 presents an analysis of the travel times with percentiles taken to the closest minute.

Table 4.2: EMS unit response interval percentiles

	Percentiles						
	5%	10%	25%	50%	75%	90%	95%
EMS Interval	0min	4min	13min	24min	39min	57min	70min

Figure 4.3 illustrates the variations in median travelling times across the different dispatch priority allocations.

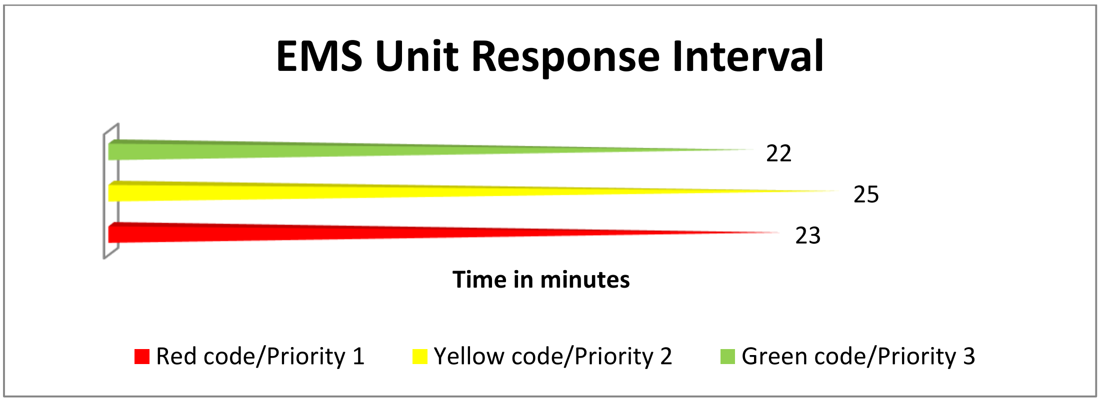


Figure 4.3: Median EMS unit response intervals across the different dispatch priorities

Overall response times, taken from the time of the initial call until the arrival of the first vehicle at the scene were shortest at 1min and longest at 10hrs 10min. The median response time irrespective of dispatch priority was 56min (IQR 59min). Table 4.3 presents an analysis of the overall response times with percentiles taken to the closest minute.

Table 4.3: Response time percentiles

	Percentiles						
	5%	10%	25%	50%	75%	90%	95%
Response time	14min	21min	34min	56min	92min	147min	202min

Figure 4.4 illustrates the variations in the median response time across the different dispatch priority levels.

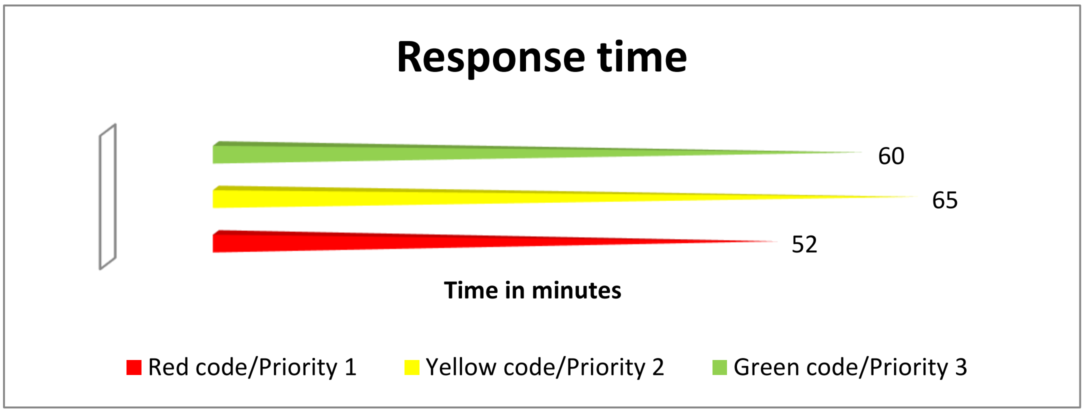


Figure 4.4: Median response times across the different dispatch priorities

To further analyse the overall response times, they were recoded into time increments of ≤4min, the response time at which it is believed that maximum benefit to patient outcome is achieved (Karch *et al.* 1998; Pons *et al.* 2005); ≤8min, the response time standard shared by many EMS systems internationally (Karch *et al.* 1998; Department of Health 2000; Fitch 2007; National Fire Protection Association 2010a; National Fire Protection Association 2010b); ≤15min, the South African response time norm to 'red code' or priority one patients (Department of Health: KwaZulu-Natal 2010); ≤40min, the South African response time norm to 'yellow code' and 'green code' patients (Department of Health: KwaZulu-Natal 2010); and >40min, response times that fall beyond acceptable norms (Vukmir 2006). Figure 4.5 shows a breakdown of the number and percentage of responses that occurred within each of the time increments described above.

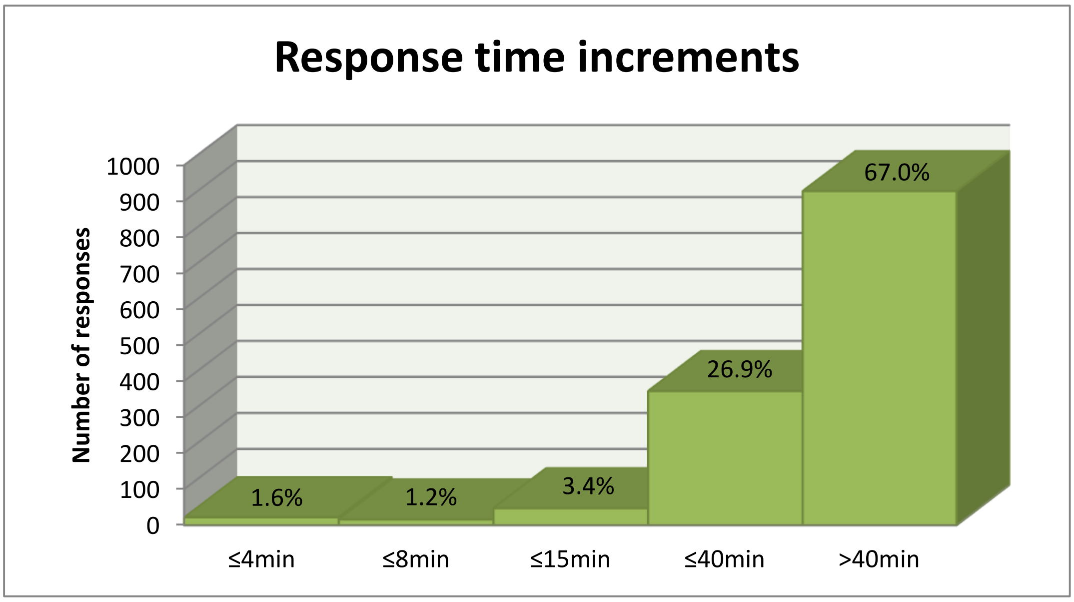


Figure 4.5: Incremental response times across all dispatch priorities

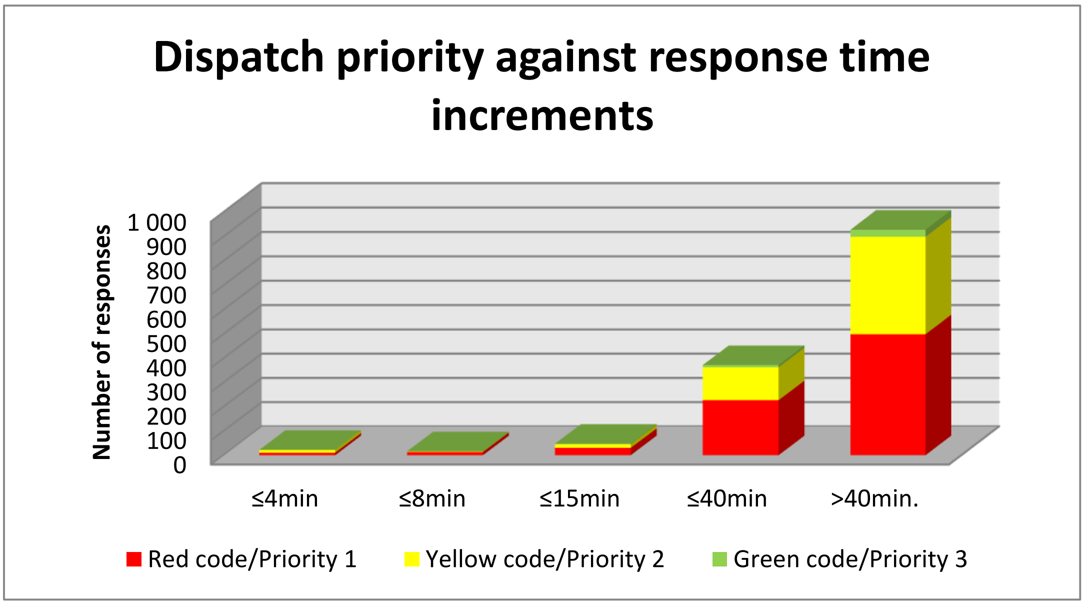


Figure 4.6: Dispatch priorities across the different response time increments

The number of responses were further broken down and grouped into dispatch priority allocations. Figure 4.6 and table 4.4 present breakdowns of the distribution of the dispatch priorities within the different response time increments.

Table 4.4: Incremental response times across the different dispatch priorities

		Triage Code on Dispatch							
		Red code/Priority 1		Yellow code/Priority 2		Green code/Priority 3		Blue code/Priority 4	
		Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %
Response time increments	<4min	10	1.3%	12	2.1%	0	0.0%	0	0.0%
	<8min	13	1.7%	2	0.4%	1	2.4%	0	0.0%
	<15min	30	3.9%	15	2.7%	2	4.9%	0	0.0%
	<40min	227	29.1%	136	24.1%	9	22.0%	0	0.0%
	>40min	499	64.1%	400	70.8%	29	70.7%	0	0.0%

4.5 Analysis of Dispatch Priority and Resource Allocation

This section presents an analysis of the data relating to the first objective described at the beginning of the chapter and provides sub-sections which describe dispatch priorities; incident type categories; incident type descriptions; EMD qualifications; and resource allocation.

4.5.1 Dispatch Priorities

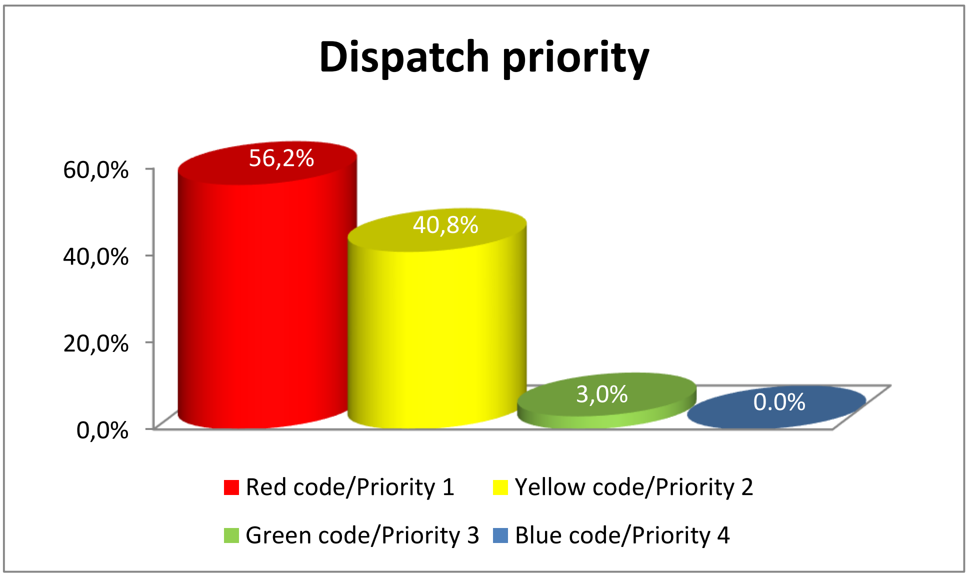


Figure 4.7: Percentage distribution of dispatch prioritisation

Red code or priority 1 dispatches occurred most frequently at 779 (56.2%) of all responses. This was followed by 565 (40.8%) yellow code or priority 2 dispatches and 41 (3.0%) green code or priority 3 dispatches. Figure 4.7

illustrates the levels of dispatch priority with percentage values across all dispatches.

4.5.2 Incident Type Categories on Dispatch

Dispatches, which are categorised into 8 different incident types by the eThekwini Emergency Medical Communications Centre (EMCC), show that medical cases accounted for the majority of dispatches whereas the least amount of dispatches fell into the disaster or major incident category. Table 4.5 presents the 8 categories of incident type with their dispatch frequencies.

It should be noted at this point that the motor vehicle accident incident type category stands alone. Dispatches to this category of incident are assessed and prioritised differently because such incidents often require specialised rescue equipment and additional manpower at the scene. The reasons for the maternity and obstetric category having been defined separately by the EMCC is for the purpose of distinguishing between imminent childbirth around the peri-natal period; maternity, and conditions relating to the ante-partum and post-partum periods of pregnancy; obstetric.

Table 4.5: Frequency of dispatch incident categories

Incident Category	Frequency	Percentage
Accident	78	5.6%
Assault	156	11.3%
Disaster/Major incident	10	0.7%
Inter-hospital transfer	385	27.8%
Maternity	20	1.4%
Medical	569	41.1%
Motor vehicle accident	92	6.6%
Obstetric	75	5.4%
Total	1385	100%

Table 4.6 overleaf shows how the dispatches were prioritised within the incident type categories.

Table 4.6: Dispatch priority allocation within the incident categories

Incident type at dispatch	Triage Code on Dispatch: Red code/Priority 1	Yellow code/Priority 2	Green code/Priority 3	Blue code/Priority 4	Total
Accident	48 (61.5%)	30 (38.5%)	0 (0.0%)	0 (0.0%)	78 (100.0%)
Assault	98 (62.8%)	58 (37.2%)	0 (0.0%)	0 (0.0%)	156 (100.0%)
Disaster/Major Incident	10 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	10 (100.0%)
Inter-Hospital Transfer	160 (41.6%)	185 (48.1%)	40 (10.4%)	0 (0.0%)	385 (100.0%)
Maternity	20 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	20 (100.0%)
Medical	304 (53.4%)	264 (46.4%)	1 (0.2%)	0 (0.0%)	569 (100.0%)
Motor Vehicle Accident	97 (94.6%)	5 (5.4%)	0 (0.0%)	0 (0.0%)	92 (100.0%)
Obstetric	52 (69.3%)	23 (30.7%)	0 (0.0%)	0 (0.0%)	75 (100.0%)
Total	779 (56.2%)	565 (40.8%)	41 (3.0%)	0 (0.0%)	1385 (100.0%)

4.5.3 Incident Descriptions on Dispatch

Within these broad incident type categories, dispatches are further broken down into more specific descriptions. Appendix 7.11 displays the full array of 72 specific case descriptions within the broader incident type categories. Figures 4.8 to 4.13 illustrate the most frequent descriptions within the incident type categories, excluding the disaster/major incident and inter-hospital transfer type categories for which no further description is allocated.

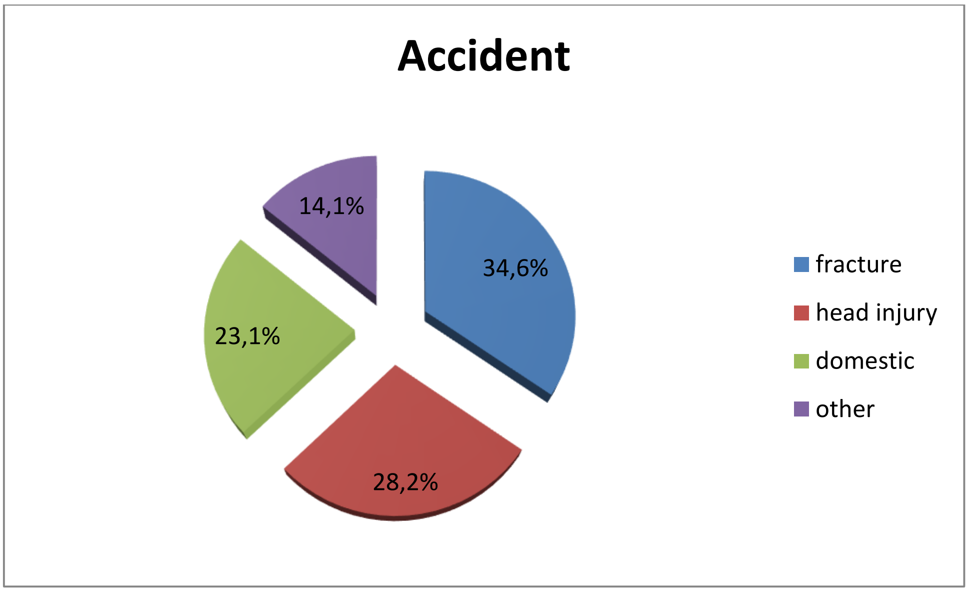


Figure 4.8: Frequency of incident description upon dispatch within the accident category

Within the accident category (Figure 4.8) fractures constitute the majority description of dispatches with 27 (34.6%) cases, followed by head injuries and domestic injuries with 22 (28.2%) and 18 (23.1%) cases respectively.

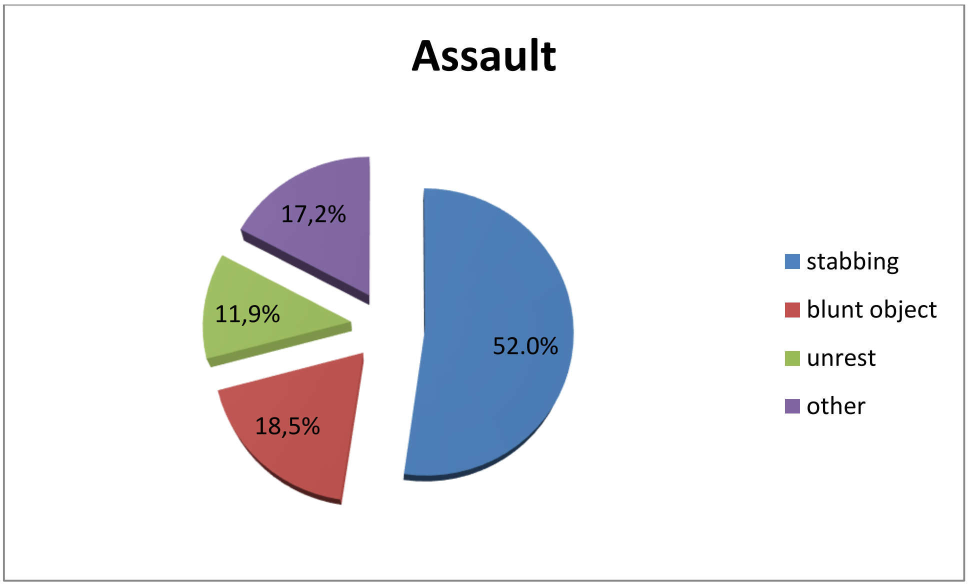


Figure 4.9: Frequency of incident description upon dispatch within the assault category

The assault category shows that dispatches to cases described as stabbings occurred most frequently with 79 (52.0%) cases. Incidents involving assault with a blunt object followed second and public unrest followed third, with 28 (18.5%) and 18 (11.9%) cases respectively (Figure 4.9).

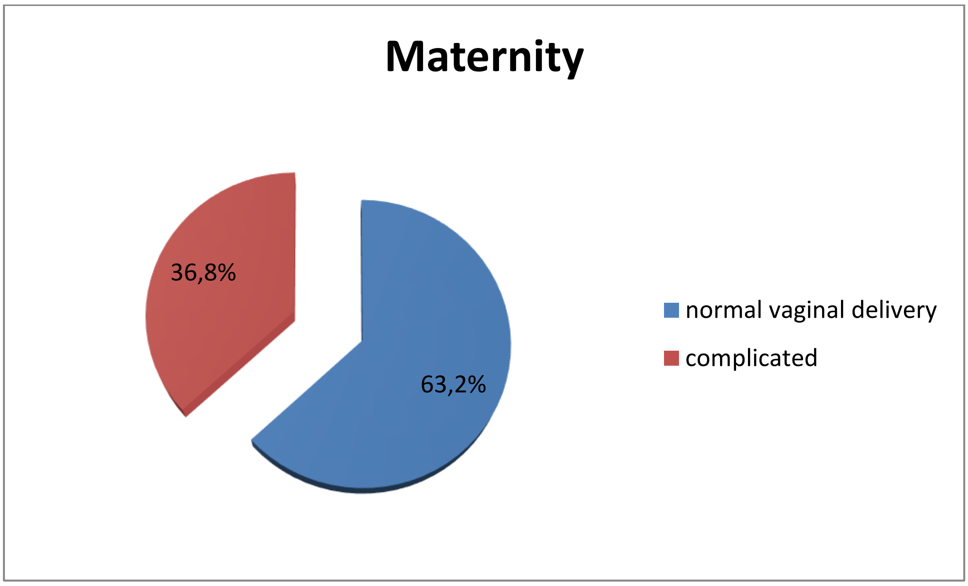


Figure 4.10: Frequency of incident description upon dispatch within the maternity category

Normal vaginal delivery describes 12 (63.2%) dispatches involving maternity cases, with complicated labour accounting for 7 (36.8%) cases (Figure 4.10).

In the medical category there are 34 specific incident descriptions, however for the purpose of visual representation some of the descriptions have been grouped into more broadly defined incident descriptions. Table 4.7 shows how the closely related aetiologies of the medical category descriptions with higher frequencies were grouped.

Table 4.7: Grouping of major medical category descriptions

New description	Previous descriptions
Collapse	Collapse: Conscious Collapse: Unconscious
Respiratory distress	Asthma Chronic obstructive airways disease Upper and lower respiratory tract infections Pneumonia Pulmonary tuberculosis
Convulsions	Epileptic Fitting/Convulsions

Table 4.8 shows how the medical category descriptions with unrelated aetiologies and lower frequencies were grouped.

Table 4.8: Grouping of minor medical category descriptions

New description	Previous descriptions
Other	Headache Hypertension Hypotension Kidney disorder HIV/AIDS Cancer related Abscess/Skin infection Pyrexia Cardiac failure Cerebro-vascular accident Diabetes Hypothermia Psychiatric/Psychological Poisoning Overdose

Figure 4.11 illustrates the descriptions in the new groupings where it can be clearly seen that conditions relating to respiratory distress constitute the highest frequency of dispatches in the medical category at 137 cases

(23.6%) with diarrhoea and vomiting, and collapse at 71 (12.5%) and 68 (12.1%) cases respectively.

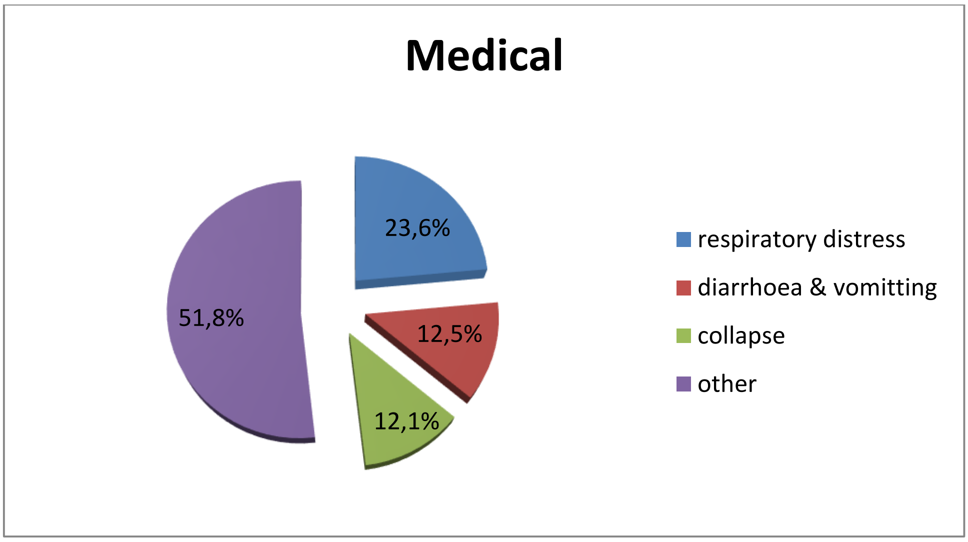


Figure 4.11: Frequency of incident descriptions upon dispatch within the medical category

The most frequent description of dispatches to motor vehicle accidents are incidents involving pedestrians, light motor vehicles, and multiple vehicles at 33 (35.9%), 25 (27.2%) and 22 (23.9%) incidents respectively (Figure 4.12).

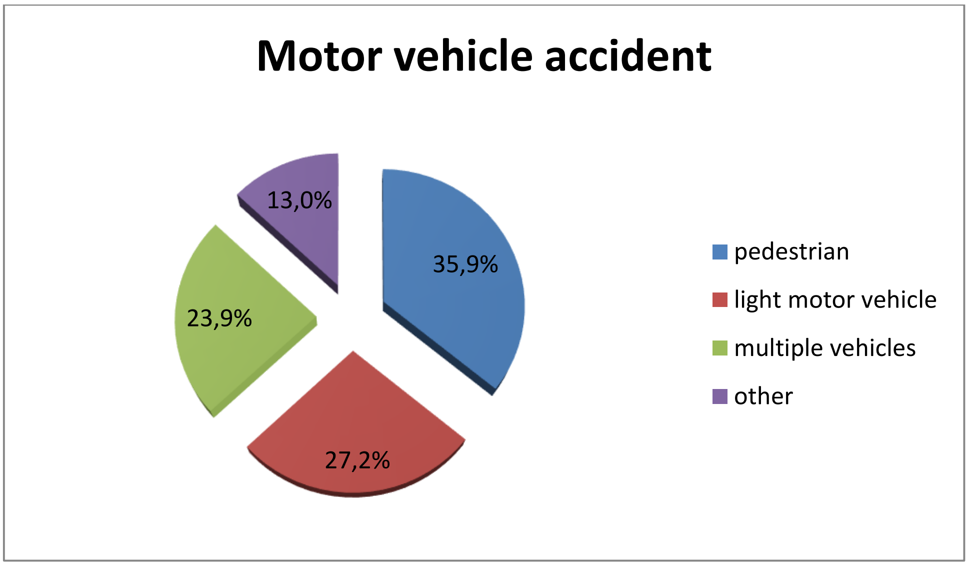


Figure 4.12: Frequency of incident descriptions upon dispatch within the motor vehicle accident category

The last of the category descriptions relate to dispatches to cases involving obstetrical emergencies. Figure 4.13 shows that 55 (73.3%) dispatches are described as in labour, with miscarriage or abortion accounting for 16 (21.3%) dispatches.

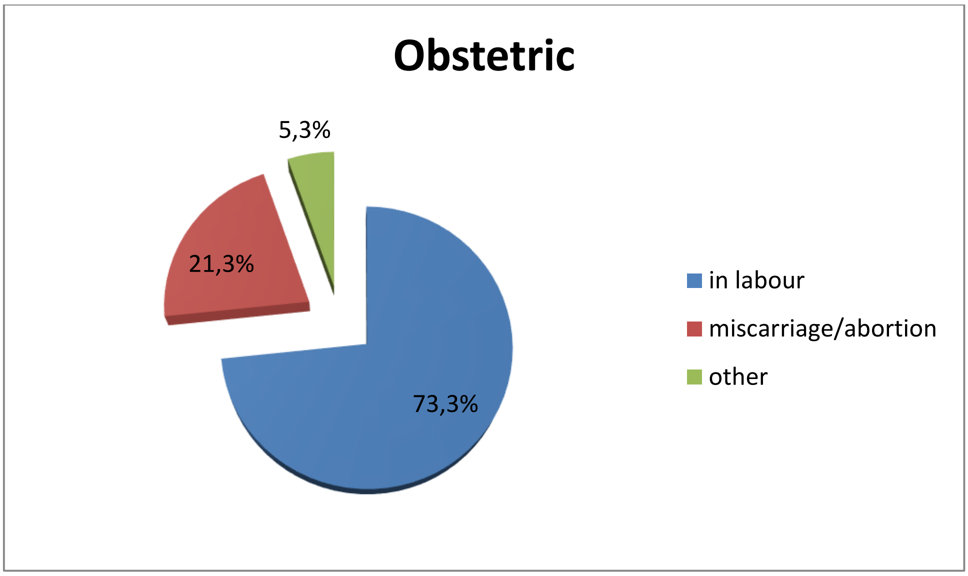


Figure 4.13: Frequency of incident descriptions upon dispatch within the obstetric category

4.5.4 Qualification Level of Emergency Medical Dispatchers

In terms of establishing whether any relationships exist between the levels of priority allocation on dispatch and the qualification of the Emergency Medical Dispatcher (EMD), the figures show that a greater percentage of red code/priority 1 and green code/ priority 3 dispatches occur among Basic Life Support (BLS) qualified EMD's whereas Intermediate Life Support (ILS) qualified EMD's have a greater percentage of yellow code/priority 2 dispatches (p = 0.003). Table 4.9 presents these differences.

Table 4.9: Allocation of dispatch priority across EMD qualification levels

		Triage Code on Dispatch				
		Red code/Priority 1	Yellow code/Priority 2	Green code/Priority 3	Blue code/Priority 4	Total
Dispatcher Qualification	Basic Life Support	348 (57.9%)	226 (37.6%)	27 (4.5%)	0 (0.0%)	601 (100.0%)
	Intermediate Life Support	431 (55.0%)	339 (43.2%)	14 (1.8%)	0 (0.0%)	784 (100.0%)
	Total	779 (56.2%)	565 (40.8%)	41 (3.0%)	0 (0.0%)	1385 (100.0%)

Differences were also found in the EMD response intervals between the different qualification levels. Table 4.10 presents these findings distributed through the different priority dispatch allocations and EMD qualifications.

Table 4.10: EMD response intervals between qualification levels

	Dispatch Priority					
	Red code/Priority 1		Yellow code/Priority 2		Green code/Priority 3	
	Dispatcher Qualification		Dispatcher Qualification		Dispatcher Qualification	
	Basic Life Support	Intermediate Life Support	Basic Life Support	Intermediate Life Support	Basic Life Support	Intermediate Life Support
Dispatch time (median)	20.0min.	21.0min.	38.8min	26.5min	23.0min	40.4min

Here it can be seen that the EMD response interval among ILS qualified EMD's is shorter in the yellow code/priority 2 patient category and lengthier in the red code/priority one and green code/priority three patient category when compared to BLS qualified EMD's. There was no significance found when comparing the EMD response interval of all levels of qualification across all of the dispatch priorities (p = 0.970).

4.5.5 Resource Allocation

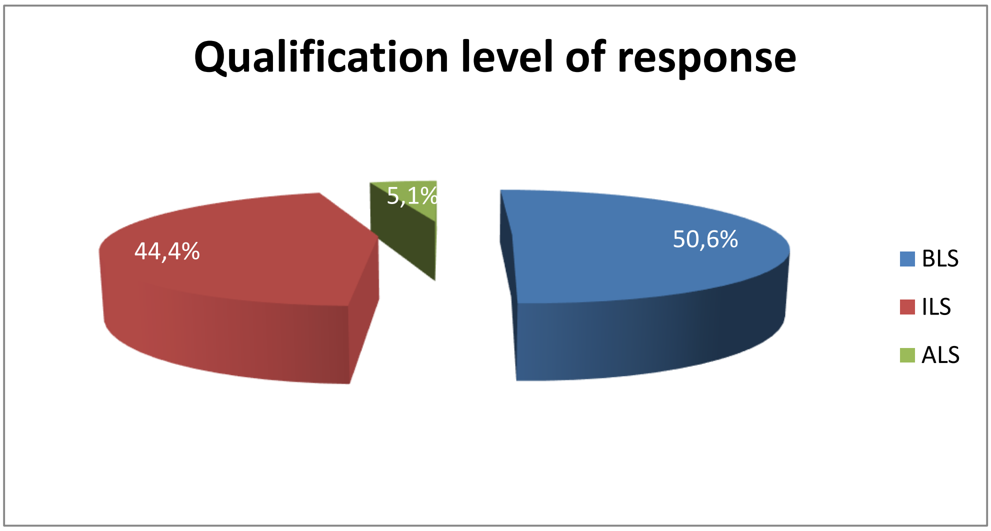


Figure 4.14: Qualification levels of response on dispatch

When looking at the resource allocation during the initial dispatch, the lowest level BLS qualified response occurred most frequently with 701 (50.6%) dispatches followed by 615 (44.4%) ILS dispatches. The least frequent level of response was at the Advanced Life Support (ALS) qualified level and comprised of 69 (5.0%) dispatches. The following pie chart shows the different qualification levels dispatched as a percentage (Figure 4.14). There was no correlation found between levels of resource allocation during dispatch and the qualification of the EMD ($p = 0.399$).

4.6 Evaluation of On-Scene Patient Clinical Need

This section presents an analysis of the data relating to the second objective described at the beginning of the chapter and provides sub-sections which will describe on-scene triage code findings; incident type categories; and incident descriptions. This will be followed by a description of the on-scene Emergency Care Providers (ECP) qualification along with a breakdown of the nature of on-scene interventions.

4.6.1 Triage Code Findings On-Scene

The priority allocation, or triage code, of patients once the responding units had arrived on-scene was 24 (1.7%) red code/priority 1, 906 (65.4%) yellow code/priority 2, 150 (10.8%) green code/priority 3 and 41 (3.0%) blue code/priority 4. Figure 4.15 displays these figures as percentages. A total of 264 (19.1%) patients could not be located for various reasons; the findings of which are reported on further in this section.

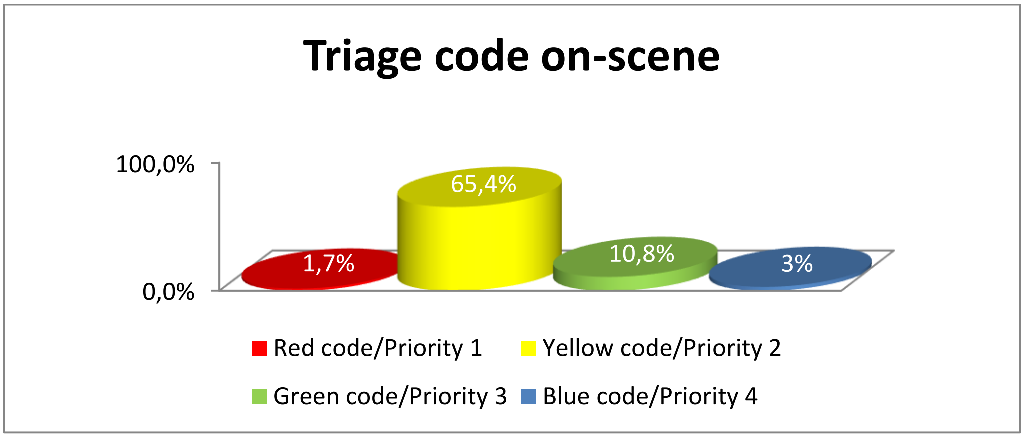


Figure 4.15: Triage code of patients on-scene

4.6.2 Incident Type Categories On-Scene

The on-scene incident categories are presented below in table 4.11 showing that the medical category accounted for the most cases, whereas the disaster or major incident category accounted for the least, with no reported cases.

Table 4.11: Frequencies of on-scene incident categories

Incident Category	Frequency	Percentage
Accident	108	9.6%
Assault	164	14.6%
Disaster/Major incident	0	0.0%
Inter-hospital transfer	3	0.3%
Maternity	120	10.7%
Medical	608	54.2%
Motor vehicle accident	63	5.6%
Obstetric	55	4.9%
Total	1121	100%

Table 4.12 presents the on-scene triage code within the incident type categories.

Table 4.12: On-scene triage code within the incident categories

	Triage Code on Scene				
Incident type on scene	Red code/Priority 1	Yellow code/Priority 2	Green code/Priority 3	Blue code/Priority 4	Total
Accident	0 (0.0%)	82 (75.9%)	24 (22.2%)	2 (1.9%)	108 (100.0%)
Assault	3 (1.8%)	114 (69.5%)	44 (26.8%)	3 (1.8%)	164 (100.0%)
Inter-Hospital Transfer	0 (0.0%)	2 (66.7%)	1 (33.3%)	0 (0.0%)	3 (100.0%)
Maternity	2 (1.7%)	110 (91.7%)	8 (6.7%)	0 (0.0%)	120 (100.0%)
Medical	16 (2.6%)	504 (82.9%)	56 (9.2%)	32 (5.3%)	608 (100.0%)
Motor Vehicle Accident	3 (4.8%)	43 (68.3%)	13 (20.6%)	4 (6.3%)	63 (100.0%)
Obstetric	0 (0.0%)	51 (92.7%)	4 (7.3%)	0 (0.0%)	55 (100.0%)
Total	24 (2.1%)	906 (80.8%)	150 (13.4%)	41 (3.7%)	1121 (100.0%)

4.6.3 Incident Descriptions On-Scene

Figures 4.16 to 4.21 present a further break down of the incident categories and illustrate the most frequent descriptions of the incidents as reported by the on-scene ECP.

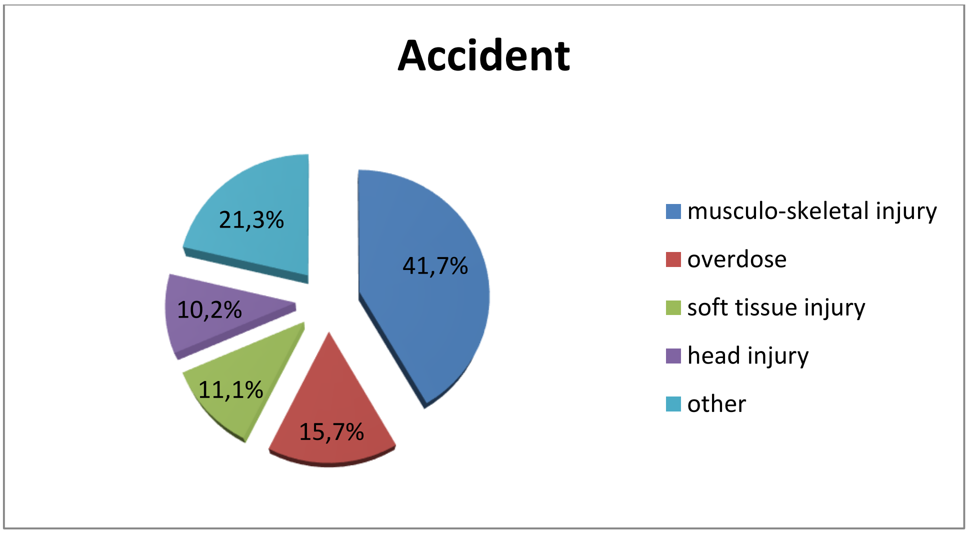


Figure 4.16: Frequency of incident description within the accident category upon arrival at scene

The accident category shows that fractures and musculo-skeletal injury account for the majority of descriptions, at 45 (41.7%) accidents attended, followed by accidental overdose and soft tissue injury at 17 (15.7%) and 12 (11.1%) cases respectively (Figure 4.16).

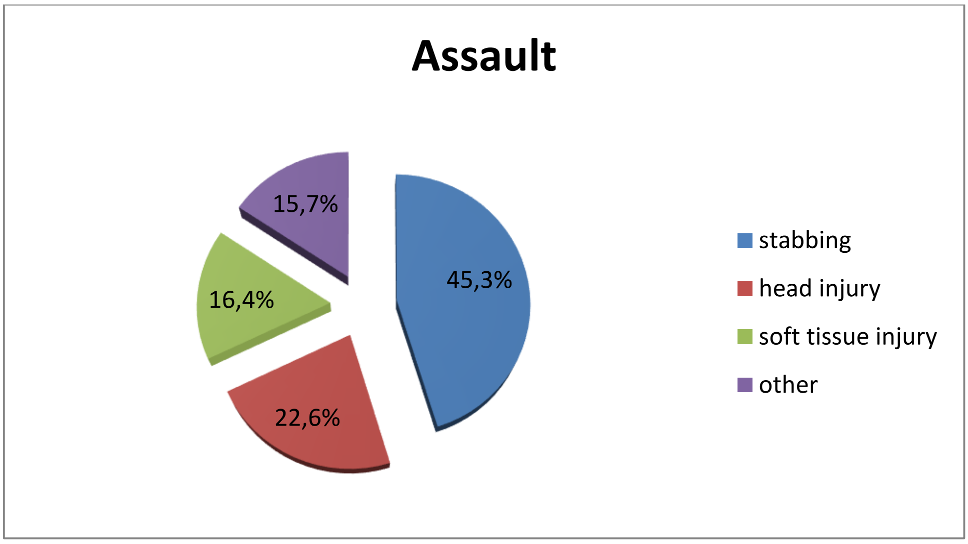


Figure 4.17: Frequency of incident description within the assault category upon arrival at scene

Descriptions within the assault category show that 72 (45.3%) cases attended to involved stabbings, with head injury and soft tissue injury accounting for 36 (22.6%) and 26 (16.4%) cases respectively (Figure 4.17).

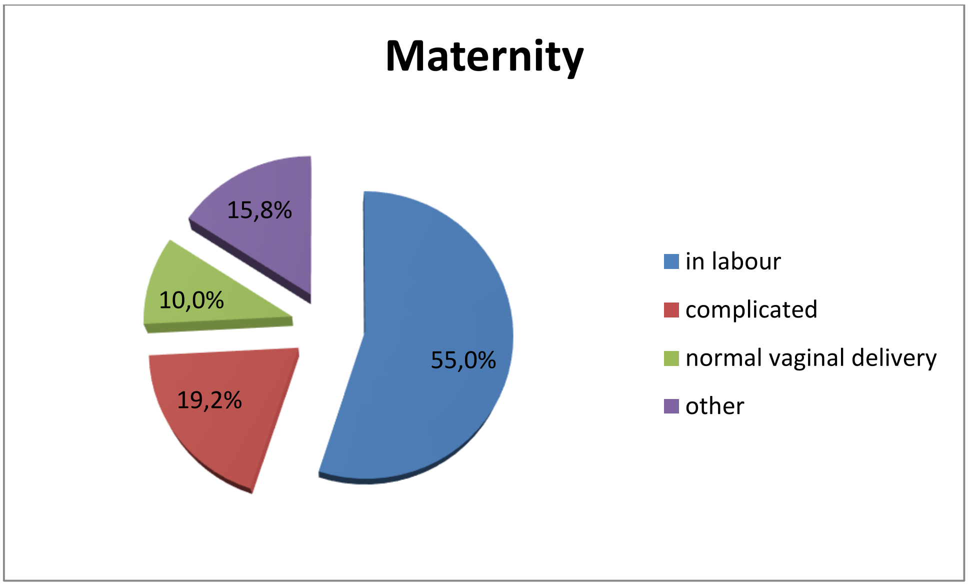


Figure 4.18: Frequency of incident description within the maternity category upon arrival at scene

The Maternity category descriptions show that 66 (55.0%) cases attended were patients in labour of which 23 (19.2%) were described as complicated. Normal vaginal delivery followed with 12 (10.0%) cases (Figure 4.18).

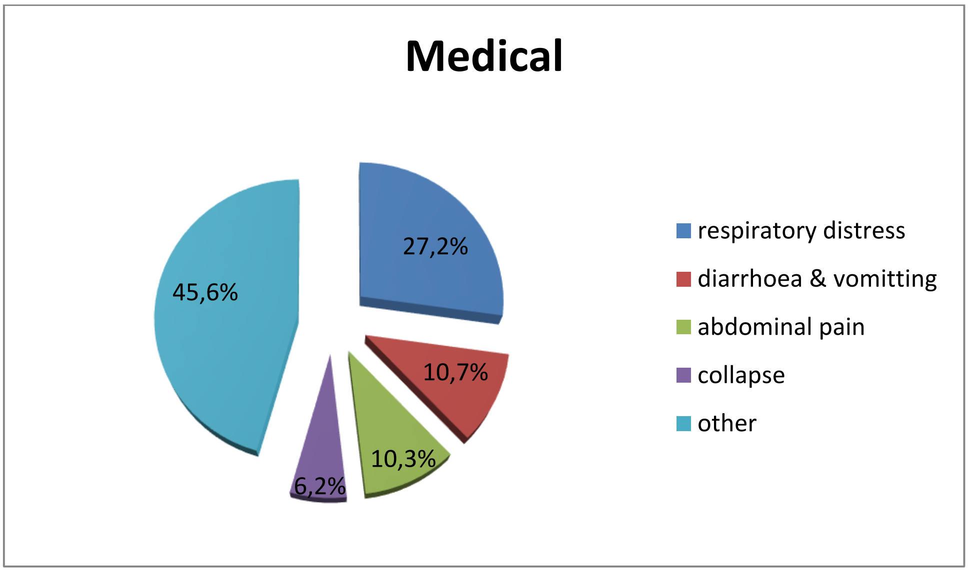


Figure 4.19: Frequency of incident description within the medical category upon arrival at scene

The medical category, grouped as previously described, show that incidents described as respiratory distress were attended to most frequently with 145 (27.2%) cases. Diarrhoea and vomiting followed with 57 (10.7%) cases and abdominal pain with 55 (10.3%) cases (Figure 4.19).

Patients involved in motor vehicle accidents were most frequently described as having suffered from musculo-skeletal injuries with 19 (30.2%) cases attended, followed by soft tissue injuries, head injuries and polytrauma with 16 (25.4%), 9 (14.3%) and 9 (14.3%) cases respectively (Figure 4.20).

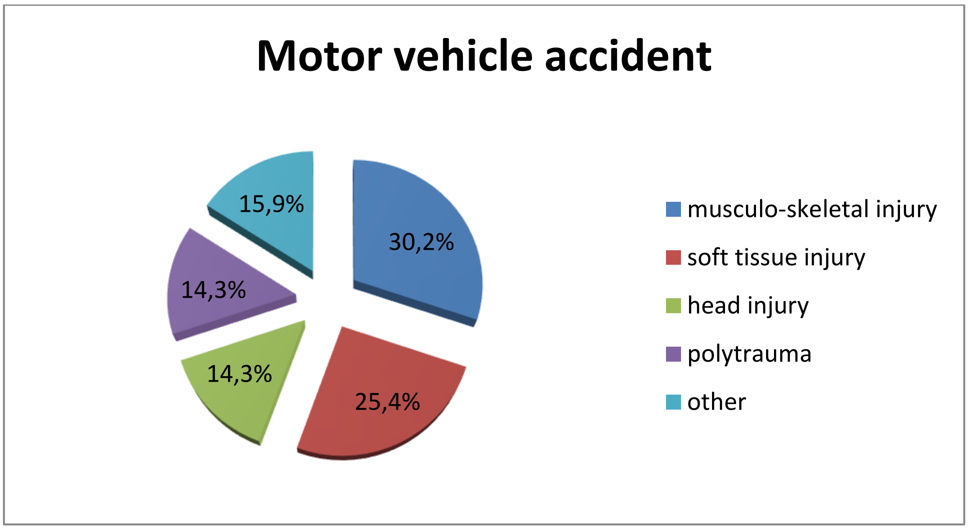


Figure 4.20: Frequency of incident description within the motor vehicle accident category upon arrival at scene

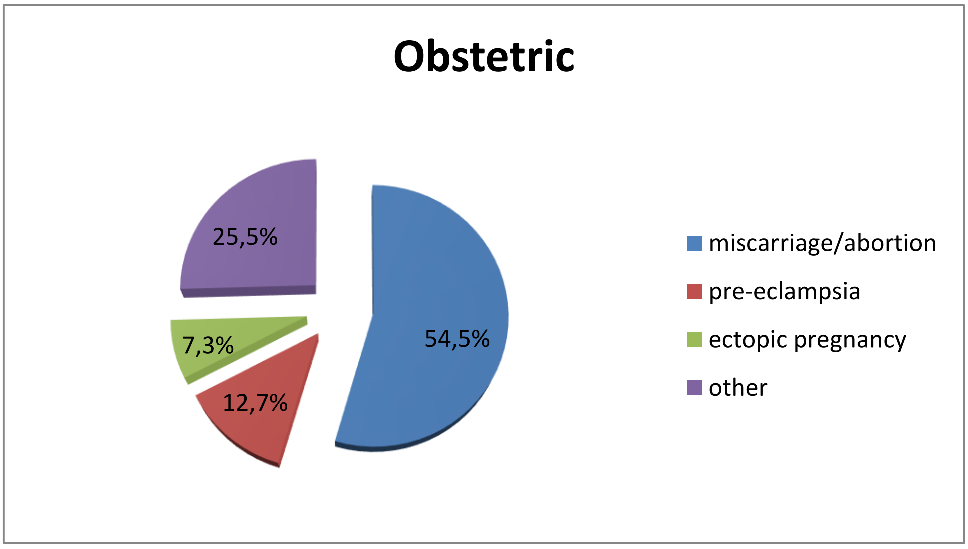


Figure 4.21: Frequency of incident description within the obstetric category upon arrival at scene

Obstetric cases were most frequently described on-scene as being a miscarriage/abortion 30 (54.5%) times with pre-eclampsia and ectopic pregnancy described 7 (12.7%) and 4 (7.3%) times respectively (Figure 4.21).

4.6.4 Qualification Levels of On-Scene Emergency Care Providers

In terms of establishing whether any relationships exist between the levels of priority allocation on scene and the qualification of the attending ECP, the figures show that the yellow code/priority 2 level triage allocation makes up the greatest percentage of patients across all qualification levels. However there are significant differences in the overall triage allocations across different qualification levels ($p < 0.001$). Table 4.13 presents these findings.

Table 4.13: On-scene triage code across Emergency Care Provider qualification

		Triage Code on Scene				
		Red code/Priority 1	Yellow code/Priority 2	Green code/Priority 3	Blue code/Priority 4	Total
Emergency Care Provider Qualification	Basic Life Support	9 (1.6%)	480 (85.9%)	61 (10.9%)	9 (1.6%)	559 (100.0%)
	Intermediate Life Support	10 (1.9%)	396 (76.3%)	84 (16.2%)	29 (5.6%)	519 (100.0%)
	Advanced Life Support	5 (11.6%)	30 (69.8%)	5 (11.6%)	3 (7.0%)	43 100.0%
Total		24 (2.1%)	906 (80.8%)	150 (13.4%)	41 (3.7%)	1121 (100.0%)

4.6.5 On-Scene Interventions

The nature of the intervention provided for all dispatches, including those patients that could not be found, were categorised into 5 groups comprising of: none required; transport only; BLS; ILS; and ALS. Table 4.14 overleaf offers a breakdown of these interventions.

Table 4.14: Frequencies of on-scene interventions

Nature of intervention	Frequency	Percentage
None required	381	27.5%
Transport only	432	31.2%
Basic Life Support	496	35.8%
Intermediate Life Support	56	4.0%
Advanced Life Support	20	1.4%
Total	1385	100%

Of the 1385 cases dispatched, a total of 970 (70.0%) patients were transported and delivered to a health institution. Patients not transported, irrespective of whether they received any intervention or not, totalled 415 (30.0%), which figure includes the 271 (19.1%) patients that could not be located. The reasons given for the non-transportation of patients are given in table 4.15 along with their frequencies and percentages.

Table 4.15: Reasons for non-transport of patients

Reason for non-transport	Frequency	Percentage
Attended by private service	16	3.9%
Case cancelled by caller	70	16.9%
Case duplicated	9	2.2%
Hoax call	15	3.6%
Patient absconded	47	11.3%
Patient transported privately	76	18.3%
Patient blue code on scene	41	9.9%
Patient refused transport	85	20.5%
Patient removed by law enforcement	9	2.2%
Unable to locate patient/scene	47	11.3%
Total	415	100%

Patients that were not transported but received an intervention totalled 34. A single patient received a BLS intervention after the call had been cancelled by the caller; 4 patients received BLS intervention before being transported privately; 3 patients received BLS intervention before being moved by law enforcement; and 26 patients who refused transport received BLS intervention 19 times and ILS intervention 7 times.

In total 1004 patients, constituting the 970 transported patients and the 34 non-transported patients, received an intervention.

4.7 Comparison of Dispatch and Patient Clinical Need

This section presents an analysis of the data relating to the third objective described at the beginning of the chapter and provides sub-sections which will compare differences in dispatch and on-scene findings and will specifically report on priority/triage allocations, incident type categories, and incident category descriptions. Following this will be a sub section highlighting the differences between the allocation of resources on dispatch and those actually required on-scene.

4.7.1 Dispatch Priority code versus On-scene Triage Code

When comparing the dispatch priorities to the on-scene triage codes there was again significant differences noted ($p < 0.001$). Figure 4.22 shows the differences between the overall dispatch priorities against the on-scene triage codes.

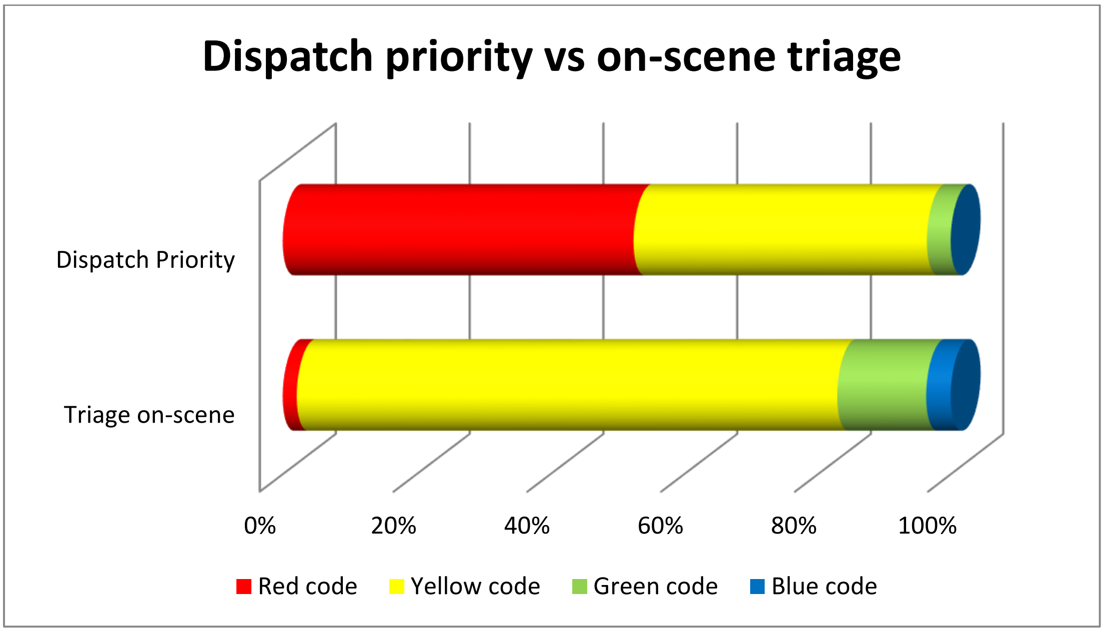


Figure 4.22: Comparison of dispatch priority against on-scene triage code

These differences are further cross-tabulated below (Table 4.16) with the figures in parentheses representing the percentage of on-scene triage codes that fell within the dispatch priority allocation.

Table 4.16: Comparison of priority/triage allocations between dispatch and on-scene

		Triage Code on Scene				
		Red code/Priority 1	Yellow code/Priority 2	Green code/Priority 3	Blue code/Priority 4	Total
Triage Code on Dispatch	Red code/Priority 1	14 (2.4%)	469 (79.8%)	68 (11.6%)	37 (6.3%)	588 (100.0%)
	Yellow code/Priority 2	7 (1.4%)	407 (82.6%)	75 (15.2%)	4 (0.8%)	493 (100.0%)
	Green code/Priority 3	3 (7.5%)	30 (75%)	7 (17.5%)	0 (0.0%)	40 (100.0%)
Total		24 (2.1%)	906 (80.8%)	150 (13.4%)	41 (3.7%)	1121 (100.0%)

Figures 4.23 to 4.25 following provide visual representations of the above percentages across the different dispatch priorities.

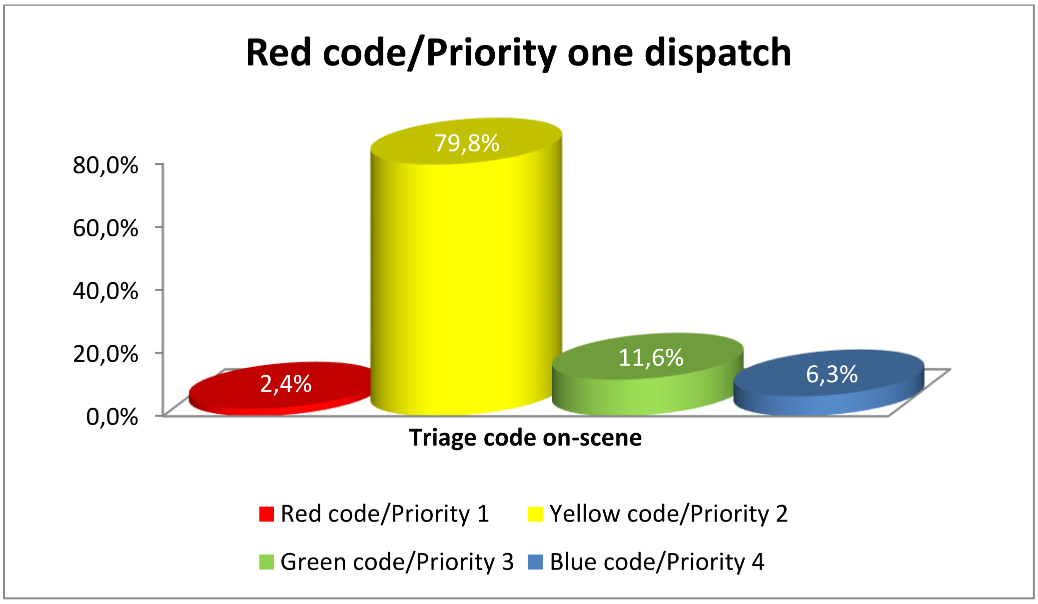


Figure 4.23: On-scene triage code within the red code/priority one dispatch

Within the red code/priority one dispatch category only 14 of 588 (2.4%) patients were actually triaged as red code by the on-scene ECP with the majority of patients falling into the yellow code category (Figure 4.23).

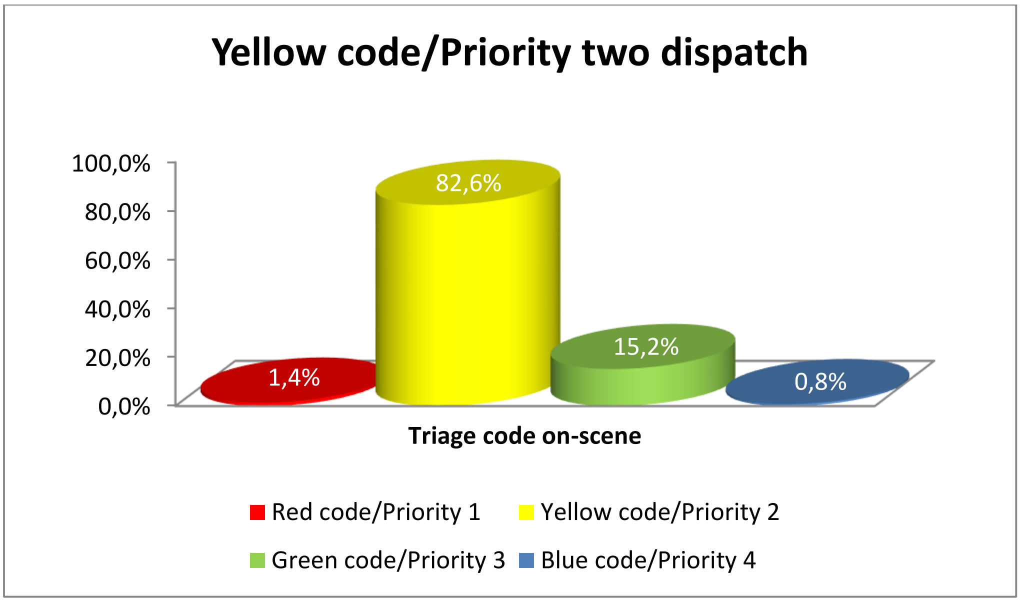


Figure 4.24: On-scene triage code within the yellow code/priority two dispatch

Figure 4.24 shows that of the yellow code/priority two dispatches almost 407 of 493 (82.6%) patients were indeed triaged as being yellow code by the on-scene ECP.

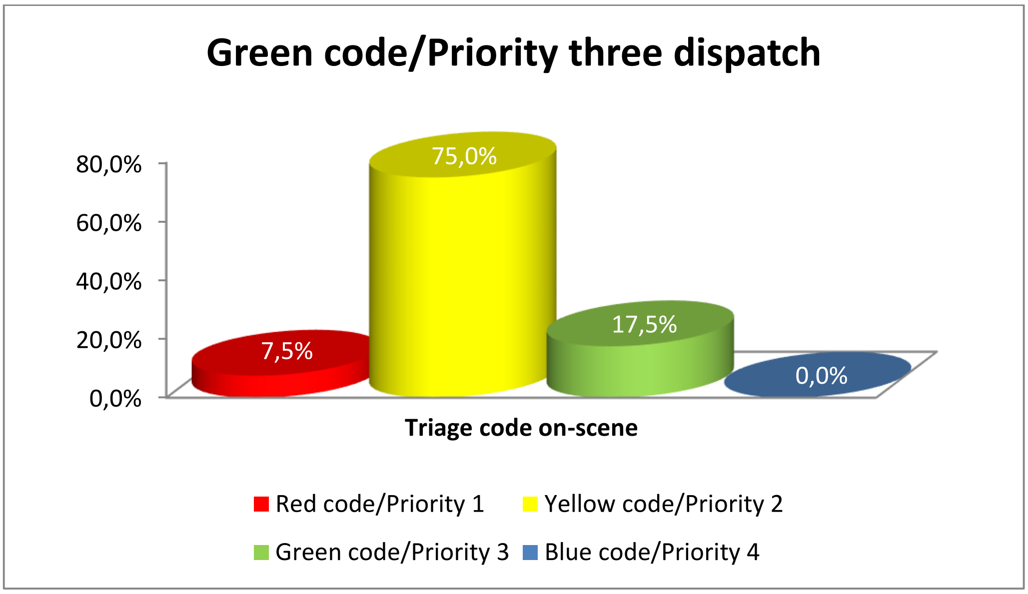


Figure 4.25: On-scene triage code within the green code/priority three dispatch

Green code/priority three dispatches show that of 40 patients, only 7 (17.5%) were actually green code on-scene. This category also shows the highest rate of under-triage where 3 (7.5%) of the patients were actually found to be red code and 30 (75%) were found to be yellow code by the on-scene ECP (Figure 4.25).

Table 4.17: Triage code on dispatch against triage code on scene through the different response time increments

Triage code on dispatch	Triage code on scene	Response time increments <4min. Count	Col N %	<8min. Count	Col N %	<15min. Count	Col N %	<40min. Count	Col N %	>40min. Count	Col N %
Red code/ Priority 1	Red code /Priority 1	0	0.0%	1	9.1%	1	4.5%	7	4.1%	5	1.3%
	Yellow code/ Priority 2	3	60.0%	7	63.6%	15	68.2%	129	76.3%	315	82.7%
	Green code/ Priority 3	1	20.0%	2	18.2%	5	22.7%	18	10.7%	42	11.0%
	Blue code/ Priority 4	1	20.0%	1	9.1%	1	4.5%	15	8.9%	19	5.0%
Yellow code/ Priority 2	Red code/ Priority 1	0	0.0%	0	0.0%	0	0.0%	2	1.6%	5	1.5%
	Yellow code/ Priority 2	10	83.3%	2	100%	9	69.2%	101	80.2%	285	83.8%
	Green code/ Priority 3	2	6.7%	0	0.0%	4	30.8%	22	17.5%	47	13.8%
	Blue code/ Priority 4	0	0.0%	0	0.0%	0	0.0%	1	0.8%	3	0.9%
Green code/ Priority 3	Red code/ Priority 1	0	0.0%	0	0.0%	0	0.0%	0	0.0%	3	10.7%
	Yellow code/ Priority 2	0	0.0%	1	100%	2	100%	7	77.8%	20	71.4%
	Green code/ Priority 3	0	0.0%	0	0.0%	0	0.0%	2	22.2%	5	17.9%
	Blue code/ Priority 4	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%

In trying to establish whether any relationships exist between differences in dispatch prioritisation against on-scene triage through the different response time increments a cross tabulation was performed (Table 4.17). There was no significance found in the table when applying the Pearson rho and Spearman correlation tests.

4.7.2 Dispatch versus On-Scene Incident Types

Significant differences were found when cross-tabulating the incident type categories on dispatch and on-scene (p = < 0.001). Table 4.18 overleaf presents these differences, with the figures in parentheses representing the percentage of on-scene incident types that fell within the dispatch incident type allocation.

Table 4.18: Comparison of incident type categories on dispatch and on-scene

Incident type at dispatch	Incident type on scene: Accident	Assault	Inter-Hospital Transfer	Maternity	Medical	Motor vehicle Accident	Obstetric	Total
Accident	34 (64.2%)	13 (24.5%)	0 (0.0%)	0 (0.0%)	6 (11.3%)	0 (0.0%)	0 (0.0%)	53 (100.0%)
Assault	4 (3.7%)	101 (93.5%)	0 (0.0%)	0 (0.0%)	2 (1.9%)	1 (0.9%)	0 (0.0%)	108 (100.0%)
Disaster/Major Incident	2 (50.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (50.0%)	0 (0.0%)	4 (100.0%)
Inter-Hospital Transfer	48 (13.0%)	46 (12.4%)	3 (0.8%)	62 (16.8%)	166 (44.9%)	15 (4.1%)	30 (8.1%)	370 (100.0%)
Maternity	0 (0.0%)	0 (0.0%)	0 (0.0%)	14 (82.3%)	2 (11.8%)	0 (0.0%)	1 (5.9%)	17 (100.0%)
Medical	18 (3.9%)	3 (0.7%)	0 (0.0%)	1 (0.2%)	427 (93.0%)	0 (0.0%)	10 (2.2%)	459 (100.0%)
Motor Vehicle Accident	2 (4.0%)	1 (2.0%)	0 (0.0%)	0 (0.0%)	2 (4.0%)	45 (90.0%)	0 (0.0%)	50 (100.0%)
Obstetric	0 (0.0%)	0 (0.0%)	0 (0.0%)	43 (71.7%)	3 (5.0%)	0 (0.0%)	14 (23.3%)	60 (100.0%)
Total	108	164	3	120	608	63	55	1121

4.7.3 Dispatch versus On-scene Incident Type Descriptions

When comparing the incident descriptions within the incident type categories, significant variations were again found ($p = <0.001$). Figures 4.26 to 4.30 present the differences between the common major incident descriptions within each incident type category.

The major common description within the accident category shows that there was a greater frequency of fractures and/or musculo-skeletal injuries found on scene with 45 (41.7%) cases whereas the initial dispatch description constituted 27 (34.6%) cases (Figure 4.26).

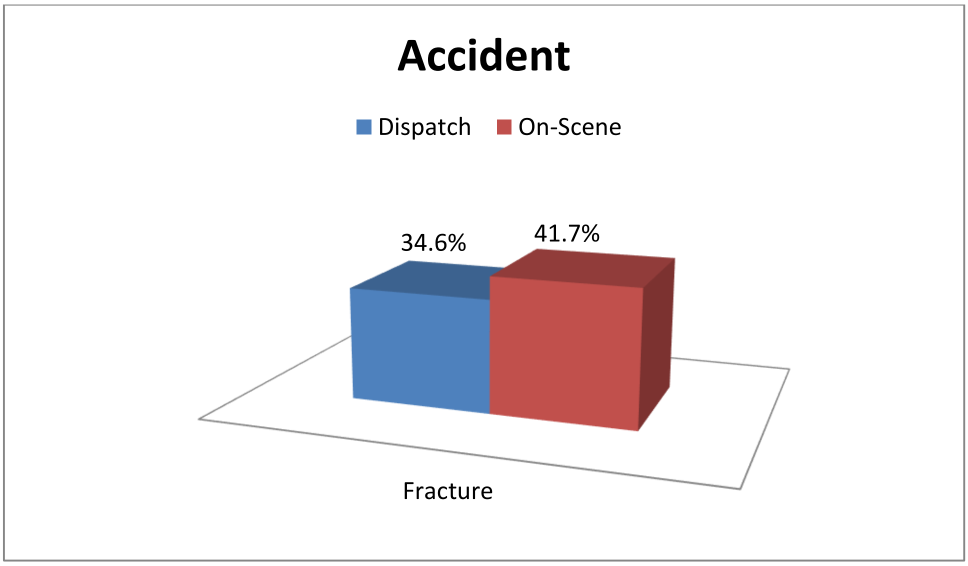


Figure 4.26: Incident description differences between dispatch and on-scene within the accident category

In the assault category the major description common to both dispatch and on scene showed that 79 (52.0%) dispatches to incidents described as stabbing occurred compared to 72 (45.3%) actually found on scene (Figure 4.27).

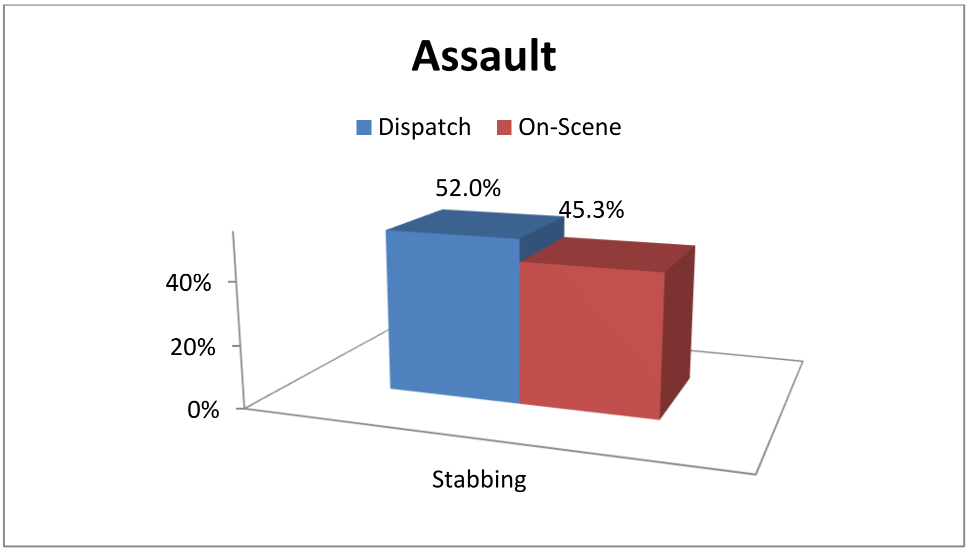


Figure 4.27: Incident description differences between dispatch and on-scene within the assault category

The maternity category showed that dispatches to cases described as complicated labour constituted 7 (36.8%) cases whereas 23 (19.2%) cases were actually described as such on scene (Figure 4.28).

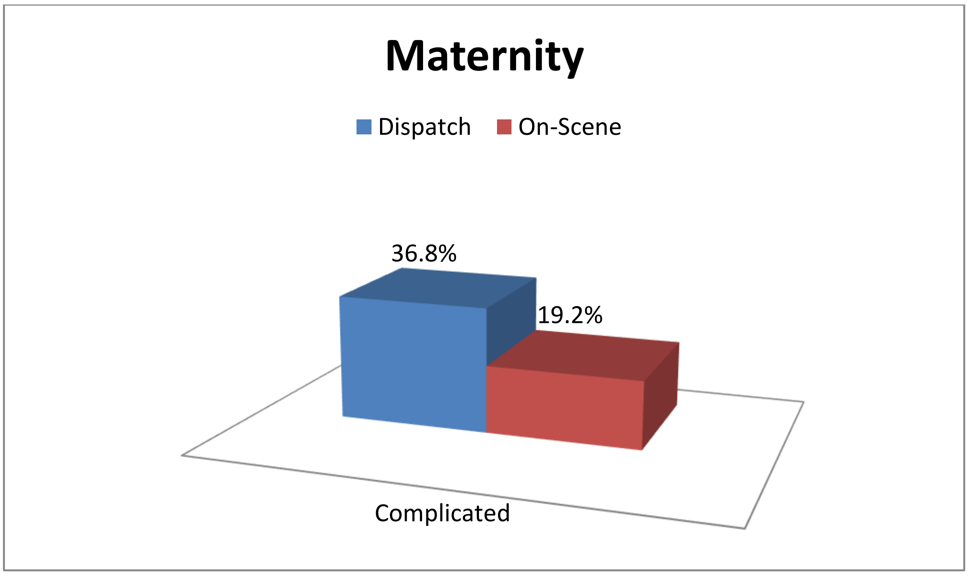


Figure 4.28: Incident description differences between dispatch and on-scene within the maternity category

Figure 4.29 shows that in the medical category, the major common description, respiratory distress, occurred less frequently during dispatch 137 (23.6%) times, compared to the on scene description, which occurred 145 (27.2%) times.

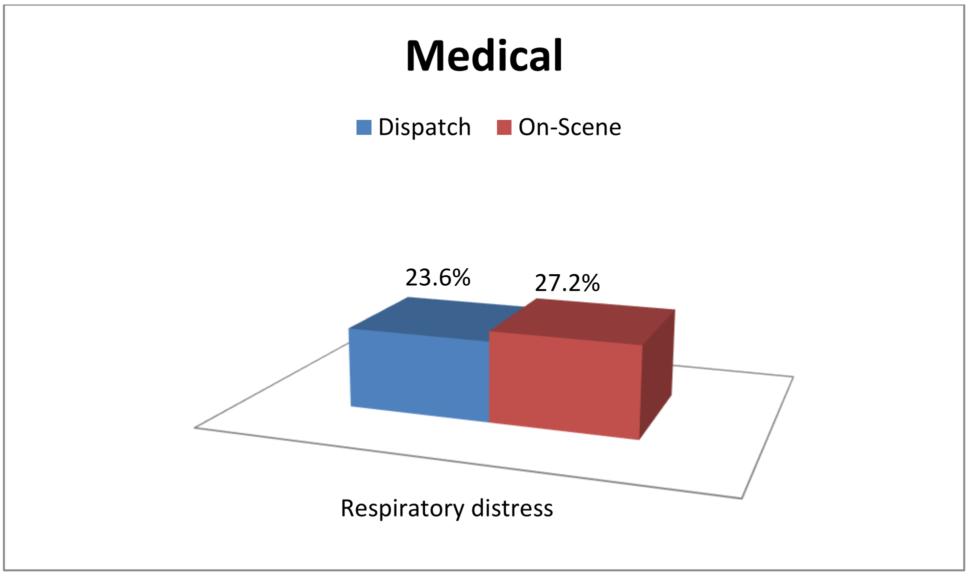


Figure 4.29: Incident description differences between dispatch and on-scene within the medical category

In the motor vehicle accident category there was no commonality found between descriptions on dispatch and those on scene. Motor vehicle accidents were simply described according to broadly defined categories on dispatch, such as involving pedestrians, light motor vehicles or heavy motor vehicles; whereas on scene descriptions generally described the nature of the injuries sustained by those involved in the motor vehicle accident.

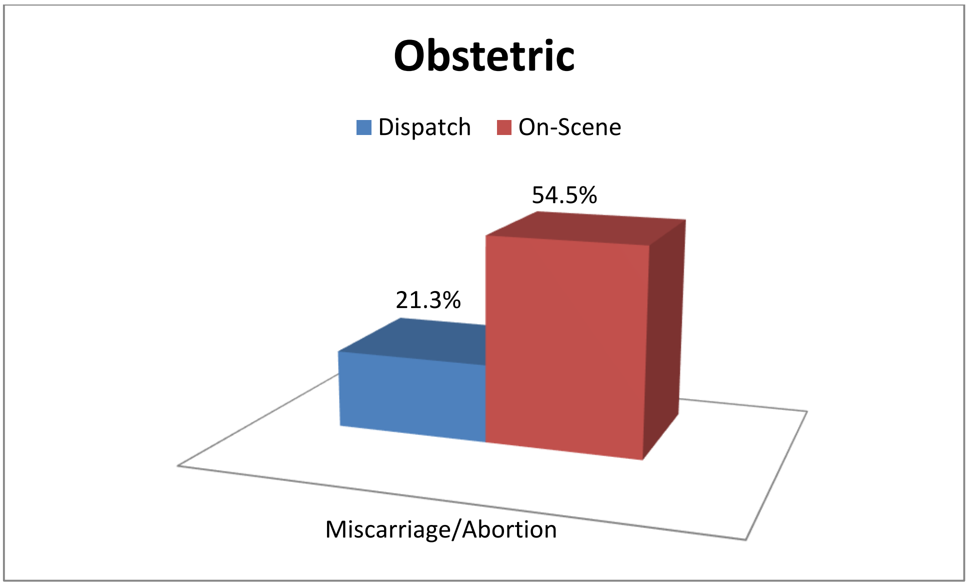


Figure 4.30: Incident description differences between dispatch and on-scene within the obstetric category

The obstetric category showed that a far greater frequency of incidents described as miscarriage/abortion occurred on scene when compared to dispatch at 30 (55%) and 16 (21.3%) cases respectively (Figure 4.30).

4.7.4 Dispatched Resources versus On-Scene Interventions

In trying to establish whether the needs of the patients were met by the resource allocation on dispatch in terms of the levels of care, three factors were taken into consideration: The qualification level of the senior ECP initially dispatched; the triage code allocated to the patient by the dispatched ECP once on-scene and the nature of the interventions required or provided.

Table 4.19 overleaf presents the qualification level of the ECP dispatched against the actual triage code allocation on-scene where significant variations are again seen ($p = < 0.001$).

Table 4.19: Qualification level of emergency care provider against triage code on-scene

		Triage Code on Scene				Total
		Red code/ Priority 1	Yellow code/ Priority 2	Green code/ Priority 3	Blue code/ Priority 4	
Emergency Care Provider Qualification	Basic Life Support	9 (1.6%)	480 (85.9%)	61 (10.9%)	9 (1.6%)	559 (100.0%)
	Intermediate Life Support	10 (1.9%)	396 (76.3%)	84 (16.2%)	29 (5.6%)	519 (100.0%)
	Advanced Life Support	5 (11.6%)	30 (69.8%)	5 (11.6%)	3 (7.0%)	43 (100.0%)
Total		24 (2.1%)	906 (80.8%)	150 (13.4%)	41 (3.7%)	1121 (100.0%)

To further analyse these figures the different qualification levels assigned on dispatch are presented separately under the different triage code allocations found on scene (Figures 4.31 to 4.34).

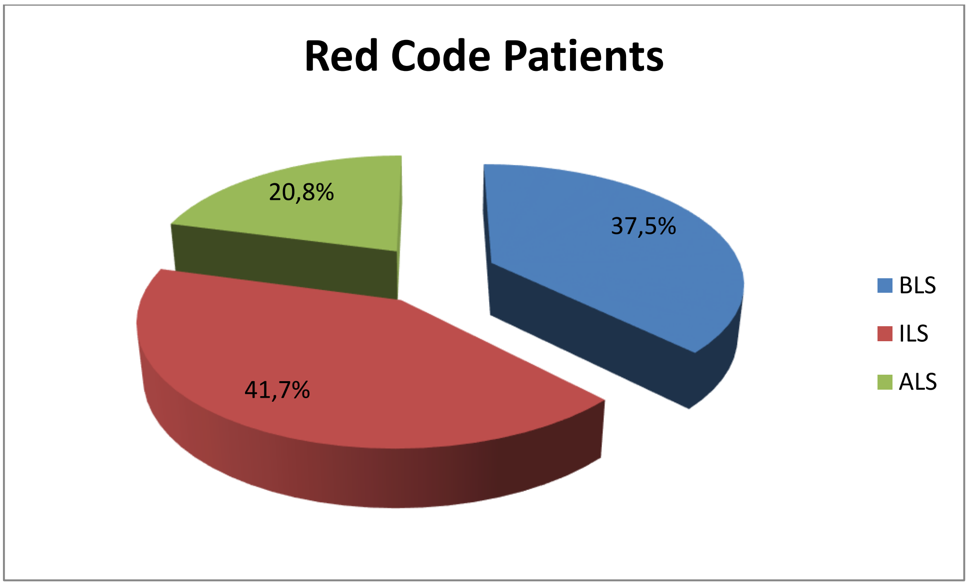


Figure 4.31: Qualification levels of emergency care provider against patients triaged as red code on scene

Figure 4.31 above shows that of all the patients triaged as red code on scene only 5 (20.8%) were provided with an ALS response whereas 10 (41.7%) patients received an ILS response and 9 (37.5%) received a BLS response.

Patients triaged as yellow code on scene received a BLS response 480 (53.0%) times followed by an ILS response 396 (43.7%) times. An ALS response occurred on 30 (3.3%) occasions (Figure 4.32).

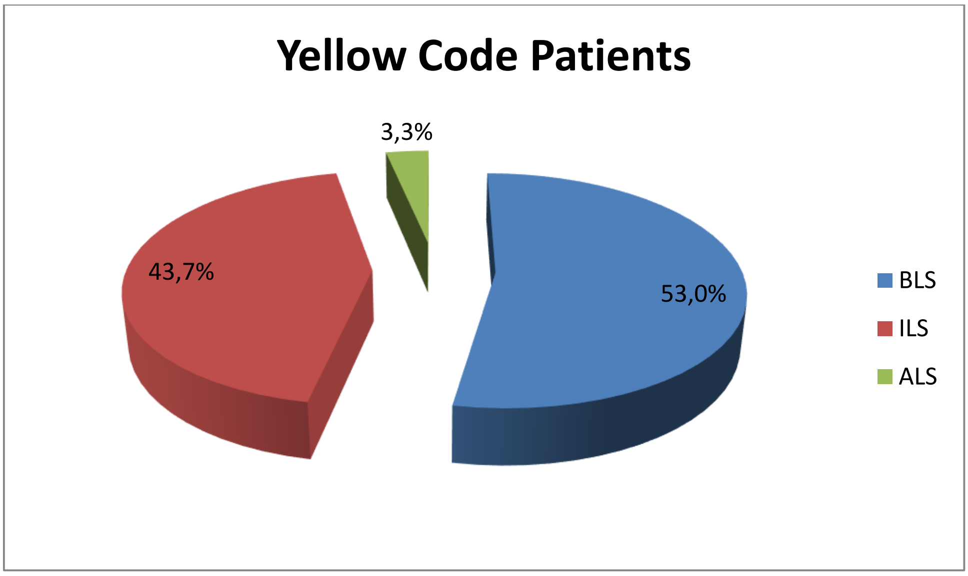


Figure 4.32: Qualification levels of emergency care provider against patients triaged as yellow code on scene

In the green code patient category (Figure 4.33), 61 (40.7%) patients received a BLS response with the major proportion of 84 (56.0%) responses being made up by ILS qualified personnel. ALS responses to green code patients totalled 5 (3.3%) responses.

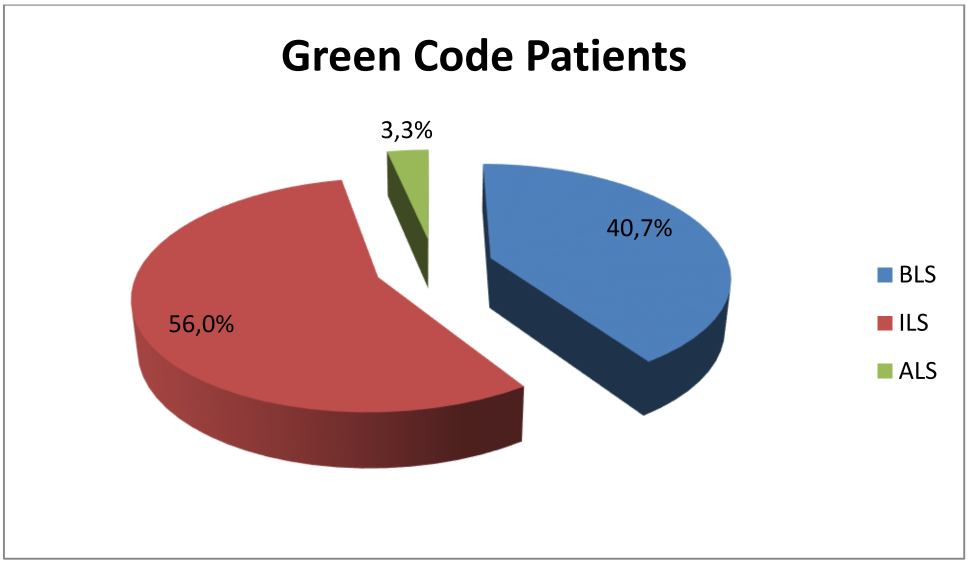


Figure 4.33: Qualification levels of emergency care provider against patients triaged as green code on scene

Where patients were found to be blue code on-scene an ILS response was provided on 29 (70.7%) occasions with BLS responses at 9 (22.0%). Response of ALS personnel comprised 3 (7.3%) responses (Figure 4.34).

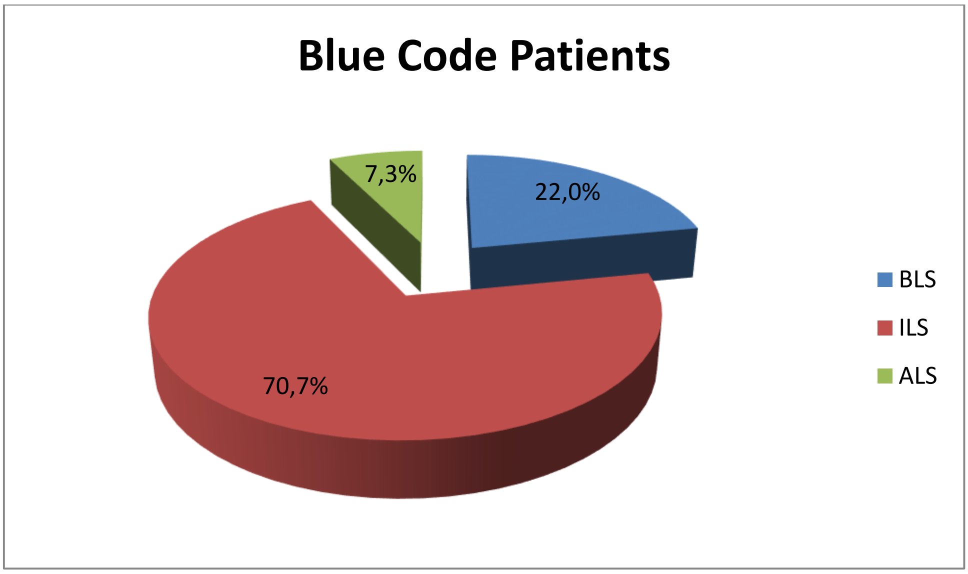


Figure 4.34: Qualification levels of emergency care provider against patients triaged as blue code on scene

In table 4.20 the qualification level of the ECP dispatched to the scene are compared against the nature of the on-scene interventions required or provided. Here again there were significant variations ($p < 0.001$).

Table 4.20: Qualification level of emergency care provider against on-scene intervention

		Nature of intervention					Total
		None required	Transport only	BLS	ILS	ALS	
Emergency Care Provider Qualification	Basic Life Support	178	216	294	9	4	701
		(25.4%)	(30.8%)	(41.9%)	(1.3%)	(0.6%)	(100.0%)
	Intermediate Life Support	164	213	193	39	6	615
		(26.7%)	(34.6%)	(31.4%)	(6.3%)	(1.0%)	(100.0%)
	Advanced Life Support	39	3	9	8	10	69
		(56.5%)	(4.3%)	(13.0%)	(11.6%)	(14.5%)	(100.0%)
Total		381	432	496	56	20	1385
		(27.5%)	(31.2%)	(35.8%)	(4.0%)	(1.4%)	(100.0%)

Here it can be seen that whereas BLS responses made up the bulk of responses, only 13 of 701 (1.8%) patients required an intervention at a higher level. Conversely, where ALS resources were dispatched 39 of the 69 (56%) patients required no intervention whatsoever and only 10 (14.5%) required an ALS intervention.

Table 4.21: On-scene Triage code allocation against the nature of intervention

		Nature of Intervention				
		Transport only	BLS	ILS	ALS	Total
Triage Code on Scene	Red code/Priority 1	1 (4.3%)	9 (39.1%)	5 (21.7%)	8 (34.8%)	23 (100.0%)
	Yellow code/Priority 2	344 (39.5%)	464 (53.3%)	51 (5.9%)	12 (1.4%)	871 (100.0%)
	Green code/Priority 3	87 (79.1%)	23 (20.9%)	0 (0.0%)	0 (0.0%)	110 (100.0%)
Total		432 (43.0%)	496 (49.4%)	56 (5.6%)	20 (2.0%)	1004 (100.0%)

Significance was again found when comparing the triage code given to the patient on-scene by the responding ECP against the nature of the intervention required or provided ($p < 0.001$). It is apparent that although patients were triaged as red code on-scene the nature of the intervention did not necessarily equate to an ALS intervention. In contrast 12 patients triaged as yellow code required or received an ALS intervention (Table 4.21).

4.8 Summary

This chapter has presented and briefly discussed the results of the statistical tests that the collected data was subjected to in relation to the purpose and objectives of the study. The chapter that follows will provide further analysis and greater depth of interpretation and discussion of the results as they apply to the study.

5 CHAPTER FIVE: DISCUSSION

5.1 Chapter Overview

This chapter will present an interpretation of the results of the research in relation to the wider context in which it is located. Specifically, it aims to address the primary research question: Is there a significant level of mismatch between the Emergency Medical Service (EMS) resources dispatched compared to actual patient need among South African urban EMS systems?

To do this the chapter has been divided into four sections which correspond with each of the four secondary research questions posed in chapter one. Each section will present a brief review of the results relative to each of these questions followed by further interpretation and discussion. The final section will provide a summary of the chapter.

5.2 Response Times

This section aims to address the first of the secondary research questions:

- Is the demand for EMS resources met in terms of acceptable response time norms and standards?

5.2.1 Review of the Results

The results of the study show that there are marked variations in the public demand for EMS resources in the eThekwini health district throughout different times of the day which are similar to variations reported among other EMS systems (Brown *et al.* 2007; Ong *et al.* 2009). Over the 72 hour period of the study peaks in demand were seen across each of the days towards midday and again in the late hours of the evening. The greatest peak in demand for resources was seen on the third day, a Saturday, just before midday with caller demand reaching in excess of 60 calls for an EMS response per hour. There was a steady decline in the demand for resources on each of the days from just before midnight until the early hours of the morning, with caller demand dropping to under 25 requests for an EMS response between the early hours of 02:00 and 05:00. Although less prominent, declines in demand were also seen in the early afternoon hours of each day where call rates dropped to between 30 to just over 40 calls per hour.

Considering that the eThekwini Emergency Medical and Rescue Service (EMRS) has a maximum capacity which allows for 45 staffed and operational ambulances being available at any one time (Emergency Medical Rescue Service 2012), it is evident that the demand for EMS resources far outweighs capacity, particularly during peak call periods. In reality, over the period of the study, the maximum capacity was never reached with the average daily availability of emergency ambulances totalling only 39. (Table 3.6).

Where capacity cannot meet with demand there is inevitably a backlog of cases that builds up and the rate of build-up is directly related to the increases in levels of demand. This is reflected in the delays experienced throughout the response time continuum over peak demand periods.

Emergency Medical Dispatcher (EMD) response intervals were generally found to be far in excess of the organisations set target of 5 minutes, with a median EMD response interval of 24 minutes (IQR 48min) across all priority levels. The highest priority red code showed a slightly improved EMD response interval of 21 minutes, with yellow code and green code recorded at 30 and 35 minutes respectively. The number of EMD response intervals that fell within the organisations set target of 5 minutes amounted to only 99 (7.1%) of the total 1385 cases dispatched, this constituted 63 (8.1%) of 779 red code cases, 35 (5.5%) of 565 yellow code cases and 1 (2.4%) of 41 green code cases. EMD response intervals in excess of an hour totalled 332 (24%) and the number that fell within the 59 second rule advocated by Eisenberg *et al.* (1979) a standard which has since been widely adopted throughout the United States (National Fire Protection Association 2010a; National Fire Protection Association 2010b), totalled only 10 (< 0.01%).

The EMS unit response interval also varied considerably with the longest recorded at 5 hours and 46 minutes and the shortest being immediate. The median EMS unit response interval however, was just 24 minutes (IQR 27min) with more than 90% of cases being reached in less than an hour.

The overall response time, the time taken from the initial call until arrival of the first unit on scene, was longest at 10 hours and 10 minutes and shortest at less than a minute. The median response time across all priorities was 56 minutes (IQR 59min) with just under half (46.4%) of all cases having a response time of more than an hour and almost one in ten (9.5%) exceeding 2½ hours.

In breaking down the response times across the different dispatch priorities it was found that the median response time to a red code or priority one case was 52 minutes. Yellow code cases took 1 hour and 5 minutes and green code cases an hour. In the case of the highest priority red code dispatch only 53 (6.2%) of the 1385 cases met with the South African governments national imperative, which stipulates that EMS responses to emergency cases in urban areas should not exceed 15 minutes (Department of Health: KwaZulu-Natal 2010). Had the 8 minute international standard been applied (Department of Health 2000; National Fire Protection Association 2010a; National Fire Protection Association 2010b) then only 23 (1.7%) of the cases would have met the criteria.

The longest response time to a red code case in the pre-hospital setting was recorded at a staggering 5 hours and 21 minutes, this to a patient suspected of having taken an accidental overdose. More alarming is a response time of over 10 hours to a critically ill red code patient that required to be transferred for a specialist intervention at another health care facility. The potential for even longer response times to a red code patient may be realistically set at over 15 hours. If one were to take the longest delay in dispatch, 9 hours and 18 minutes, added to the longest travelling time, 5 hours and 46 minutes, recorded during this study then the total response time would have been 15 hours and 4 minutes. Such delays are in stark contrast to response times reported elsewhere, where average response times of anything greater than 15 minutes are viewed as being significantly below the international norm (Shah *et al.* 2008).

The preceding paragraphs clearly identify three areas where challenges may need to be addressed in attempting to improve response times in line with identified national and international norms and standards. These are managing increases in demand, limiting delays at the point of dispatch and reducing travelling times to the scene.

5.2.2 Increased Demand

The challenges in meeting demand in the Province of KwaZulu-Natal have been considerable. The Provincial Department of Health has not been able to comply with the target national norm of 1 emergency vehicle per 10,000 population, a figure which compares favourably with other first world EMS systems (British Columbia Ambulance Service 2012; United States Department of Labour 2013), but is currently functioning at 1:44,000 as reported in the department's 2010 - 2014 strategic plan (Department of Health: KwaZulu-Natal 2010). The situation in the urban district of eThekwini appears to be even more dire, with the results of this study suggesting that the ratio of emergency vehicles to population is somewhere in the region of 1:95,000. These figures suggest that the province as a whole is under-resourced but more importantly they show that the resources are unevenly distributed, particularly within the eThekwini district.

Although it is evident that there is a great need to invest in additional resources in order to correct the imbalances described above, the eThekwini EMRS would require a ten-fold increase in its resources involving considerable expenditure in terms of the purchasing of extra vehicles and equipment along with the remuneration of additional personnel. Rather a cautious approach should be adopted where a balance can be made between the costs of increasing resources with the simultaneous introduction of optimisation strategies.

Systems status management is a strategy that may be used among EMS systems to achieve improved optimisation levels while maintaining system costs (Ong *et al.* 2009). Systems status management typically includes the use of geographic information systems, demand pattern analysis and dynamic location/relocation models.

The literature shows that the use of GIS, when properly implemented using primary data sources, can significantly optimise EMS resource deployment and this has been effectively shown in EMS systems throughout the world (Estochen *et al.* 1998; Peleg and Pliskin 2004; Edelman 2007; Ong *et al.* 2008). Similarly, promise in the use of demand pattern analysis (Brown *et al.* 2007; Ong *et al.* 2009) and dynamic location/relocation models (Andersson and Varbrand 2007; Maxwell *et al.* 2010) has been reported.

Another optimisation strategy that should be considered is to simultaneously attempt to limit or reduce the number of inappropriate requests for EMS resources through educational and public awareness campaigns.

The literature shows that the reasons for inappropriate requests for EMS responses are thought to be complex and varied (Slovis *et al.* 1985; Rucker *et al.* 1997; Svenson 2000; Kawakami *et al.* 2007; Vardy *et al.* 2009) and that over time there has been a steady increase in the number of inappropriate requests to which EMS systems worldwide are expected to respond (Gibson 1977; Morris and Cross 1980; Rademaker *et al.* 1987; Frank and deVilliers 1995; Chen *et al.* 1996; Camasso-Richardson *et al.* 1997; Hipskind *et al.* 1997; Palazzo *et al.* 1998; Snooks *et al.* 1998; London Department of Health 1999; Victor *et al.* 1999; Gratton *et al.* 2003b; Patterson *et al.* 2006; Vardy *et* *al.* 2009). The rates of inappropriate calls have been reported to be between 11.3% (Snooks *et al.* 1998) and 68% (Frank and deVilliers 1995) with rates of refusal of service or non-transportation reported to be between 30% (Hipskind *et al.* 1997; Gratton *et al.* 2003b) and 32% (Chen *et al.* 1996). These findings support the results of this study with the figures showing that of the 1385 cases responded to by the eThekwini EMRS, 813 (58.7%) of the patients required either no intervention whatsoever or a means of transport only. The rates of refusal of service or non-transportation of patients were also similar with 415 (30.0%) cases resulting in non-transportation.

The main purpose of a public education campaign is to change behaviour through a series of endeavours designed to inform people about specific issues. Public education campaigns, which may vary in complexity, have been found to be effective over time within the wider health care sphere (Craig Lefebvre and Flora 1988; MacKie and Hole 1992; Payne, Fang, Fogle, Oser, Wigand, Theisen and Farris 2010) and EMS systems with public education initiatives focused on timely access and appropriate utilization of EMS systems and their resources have realised successful outcomes. Most notable is the "Make the Right Call" campaign initiated throughout the United States at the turn of the millennium (Delbridge, Chew Jr, Conn, Krakeel, O'Malley, Ryan, Spaite, Stewart, Suter and Wilson 1998).

5.2.3 The EMD Response Interval

Although there are no internationally acknowledged norms informing the optimal time allowance for dispatching an EMS unit, the time spent during dispatch is nevertheless recognised as a critical component of the overall response time. A number of EMS systems have developed their own standards however, most notable of which is the United States' National Fire Protection Association (2010a); National Fire Protection Association (2010b) standard which allows 59 seconds for the dispatch of an EMS unit.

The Emergency Medical Dispatcher (EMD) response interval is the period from the receipt of the call to the time that the first EMS unit is dispatched and, despite the scarcity of evidence in the literature, the eThekwini EMRS advocates a maximum time allowance of 5 minutes across all dispatch priorities (Emergency Medical Rescue Services: Province of KwaZulu-Natal nd). The results of this study however show that the organisation is falling dismally short of meeting its set target with only 99 (7.1%) of the 1385 dispatches meeting the set criteria. Indeed, an alarming 460 (59.1%) of 779 cases prioritised as life threatening red code cases are only dispatched after the organisations overall 15 minute response time target has already elapsed.

Throughout the total response time continuum the lengthiest delays were seen during the EMD response interval and the primary reason for these delays appears to be as a result of the mismatch between public demand and available resources. Nevertheless EMD response intervals, especially to those cases that are genuinely time critical, may be significantly reduced by properly allocating the available resources to those cases that are determined to have the greatest need; this can be achieved through the detailed interrogation of callers to allow for the correct assignment of dispatch priorities and resources. Additionally the dispatch priority should be assigned at a number of different levels based on the determined urgency of the need. These issues and how they can be addressed will be discussed in greater depth further on in the chapter.

Even though there is clearly a need to address the issues mentioned in the preceding paragraph, the appropriateness of the presently stipulated dispatch time allowance of 5 minutes across all dispatch priorities is questionable; with little basis for its support and a profound paucity of evidence as to its relevance a review should be encouraged. Perhaps a measure of dispatch time against the different dispatch priorities would better serve the development of accurate dispatch time standards which should be based on sound empirical evidence. In short the focus here should rather be on limiting dispatch times according to dispatch priorities - such as immediately life threatening red code cases should be dispatched within 1 minute whereas less serious yellow and green code cases could be safely delayed for longer periods.

Other factors that may contribute to the delays experienced during dispatch are the absence of clearly defined priority dispatch protocols and a lack of EMD training; these are again issues which will be discussed further on in the chapter.

5.2.4 The EMS Unit Response Interval

Added to the delays experienced during the dispatch phase are delays in the travelling time to scene, otherwise known as the EMS unit response interval. The eThekwini EMRS statistics here, although far from ideal, are a little more encouraging when compared to the delays experienced at dispatch, with 1 in 10 cases being reached within 5 minutes and more than 90% of all cases being reached in less than an hour. Compared to other EMS systems throughout the world however, the eThekwini EMS unit response interval is considered to be sub-optimal where EMS unit response interval targets to immediately life threatening cases are generally set at under 8 minutes or less, including the EMD response interval (Department of Health 2000; Langhelle *et al.* 2004; Fitch 2007; Liu 2007; Ellis and Sorene 2008; National Fire Protection Association 2010a; National Fire Protection Association 2010b; Bahrami *et al.* 2011). In this study only 23 (3.0%) of the 779 cases dispatched to immediately life threatening cases complied with the international EMS unit response interval target.

The reasons recorded for delays were varied and mostly unavoidable. These included inability to locate patients, impassable roads, extreme weather conditions, mechanical failure and vehicle collision. Additionally, staff working long shift hours inevitably require breaks to overcome fatigue and attend to bodily needs. Many of the delays however, were caused as a result of having to re-route units that had already been dispatched; frequently units dispatched to lower priority yellow and green code cases were stood down to attend to higher priority red code cases. Here again it is evident that the lack of available resources was the major contributor to delays.

In systems where adequate resources exist dynamic location/relocation has been employed as a part of the systems status management strategy to improve travelling times to scene (Brotcorne *et al.* 2003; Andersson and Varbrand 2007; Maxwell *et al.* 2010). This requires that EMS units are re-positioned in anticipation of changes in demand over the medium to long term and primarily relies on demand pattern analysis (Setzler *et al.* 2009).

Dynamic positioning can be further complemented by real time positioning which allows for the deployment of EMS units in the short term (Setzler *et al.* 2009). Real time positioning requires that, when units are dispatched from one area, then other units are immediately relocated to ensure optimal cover of the entire operational area. Additionally, when a unit becomes available after finishing a call, it can immediately be dispatched from its current location to an outstanding call, or it can be repositioned in another area or to another base other than its own.

Both dynamic location/relocation and real time positioning are practiced to a small and infrequent extent by the eThekwini health district EMRS, such as during high-profile deployment of units on major routes into Durban over the peak holiday seasons and the emergency medical cover of major sporting events hosted by the city. However, additional resources which are not available under normal circumstances are procured for such occasions.

As pointed out earlier, significant improvements have been noted in terms of reducing travelling times, and overall response times, among a number of EMS systems employing dynamic and real time positioning strategies (Brotcorne *et al.* 2003; Andersson and Varbrand 2007; Maxwell *et al.* 2010) but caution is warned as to its proper implementation (Rajagopalan *et al.* 2008; Setzler *et al.* 2009). In particular, a lack of adequate resources is considered a major stumbling block to the proper implementation of dynamic and real-time positioning strategies (Peters and Hall 1999).

5.2.5 The Response Time Continuum

The preceding sections have discussed the different phases of the response time continuum. This section looks at the response time continuum as a whole.

The South African government has set an EMS response time target of under 15 minutes to red code or priority one cases in urban areas throughout the country. The results of this study however show that the eThekwini health district EMRS falls disturbingly short with a mere 53 (6.8%) of the 779 cases dispatched as red code meeting this criteria. Similar failures have also been reported in other areas of South Africa (Meents and Boyles 2010) and this implies that the problem may be more widespread.

Compared with international norms and standards, which in most cases advocate an 8 minute Advanced Life Support (ALS) response time (Department of Health 2000; Langhelle *et al.* 2004; Fitch 2007; Liu 2007; Ellis and Sorene 2008; National Fire Protection Association 2010a; National Fire Protection Association 2010b; Bahrami *et al.* 2011), the South African 15 minute response time may be considered as sub-standard. If the 8 minute international standard were to be applied to this study then only 85 (2.8%) of all 1385 cases dispatched, or more importantly 23 (3.0%) of the 779 red code cases dispatched, would have qualified. Moreover, if the United States’ first responder standard of 4 minutes were to have been applied (National Fire Protection Association 2010b), then only 22 (1.6%) of all 1385 cases dispatched or 10 (1.3%) of the 779 dispatched as immediately life threatening would have met the criteria.

In terms of the national patient charter of South Africa, everyone has the right of access to health care services including receiving timely emergency care (Health Professions Council of South Africa 2008). It can be argued therefore that not only are the response times found in this study failing the principles of the patients' charter in terms of timely emergency care but so too are the department of health's existing response time standards.

5.3 Patient Priorities, Incident Categories and Incident Descriptions

This section addresses the second of the secondary research questions:

- Do priority levels, incident categories and incident descriptions assigned on dispatch routinely match those assigned by responding units on scene?

5.3.1 Review of the Results

The results of the study show that there are significant differences across the board when comparing the allocation of levels of priority, incident categories and incident descriptions between those EMS personnel assigned to EMD duties and those performing operational Emergency Care Provider (ECP) duties ($p = < 0.001$: CI 99%).

Most prominent were the differences seen between the prioritisation of red code cases on dispatch with those actually found on scene. The red code priority allocation constituted the greatest frequency of cases dispatched at 779 (56.2%) of the total 1385 cases dispatched yet only 14 (1.8%) of these cases were actually found to be red code on scene. Blue code cases, those cases where patients were found to be dead on scene but were initially red code cases on dispatch, constituted a further 37 (4.7%) and 191 (24.5%) cases could not be located. These figures represent a staggering over-triage rate of 93.5% in the red code dispatch category ($p = < 0.001$: CI 99%).

The yellow code category, following on from red code in terms of frequency, constituted 565 (40.8%) of all cases dispatched. Here the differences were not so pronounced with 407 (72.0%) of these cases actually found to be yellow code on scene with 75 (13.3%) cases not being located. There were 75 green code cases representing an over-triage rate of 13.3%, and 4 blue and 7 red code cases representing an under-triage rate of 1.9% ($p = 0.001$: CI 99%).

The least frequent green code dispatch category made up only 41 (3%) of the total cases dispatched. Here again there was a marked difference between the prioritisation of green code cases on dispatch with those actually found on scene. Of the green code dispatches 7 (17.0%) cases were actually found to be green code on scene and 1 (2.4%) case was not located. In this category there was an under-triage rate of 80.5% constituting 30 yellow code and 3 red code patients found on scene ($p = < 0.001$: CI 99%).

Overall the results showed that the actual on-scene priority allocations of all the 1385 cases dispatched was made up of 24 (1.7%) red code, 906 (65.4%) yellow code, 150 (10.8%) green code, and 41 (3%) blue code. A total of 264 (19.1%) patients could not be located.

In reviewing the incident categories and descriptions, significant inconsistencies were again found between what information was recorded on dispatch with what was actually found on scene ($p = < 0.001$: CI 99%). The most noticeably examples in the incident type category are the accident category, where 24.5% and 11.3% of cases dispatched as accidents were later found to be assault and medical cases respectively, and the obstetric category, where 71.7% of cases were later categorised as maternity cases.

There were also significant differences between the incident descriptions within the incident type categories ($p = 0.001$: CI 99%). Here the most noticeable differences were seen again in the maternity and obstetric categories. In the maternity category, complicated labour was given as a description in 35% of cases dispatched yet only 19% were actually found to be cases involving complicated labour; and in the obstetric category, 55% of cases were found to be miscarriage/abortion cases on scene yet only 21% were described as such on dispatch.

The reasons for the inconsistencies described above may be related to the absence of a formal system in which the structured interrogation of the caller is mandated along with the lack of a standardised triage and incident reporting procedure between the Emergency Medical Communications Centre (EMCC) and the operational component of the organisation.

5.3.2 Medical Priority Dispatch Systems (MPDS)

The eThekwini EMRS differs considerably in its approach to priority dispatch compared with many other EMS systems throughout the world (Pozner *et al.* 2004; Black and Davies 2005). Presently, there are no procedures in place to ensure the thorough and structured interrogation of callers; only three levels of dispatch priorities are routinely allocated by the district's EMCC; and there are no protocol based systems which offer callers pre-arrival instructions.

The failure of the existing system can be clearly demonstrated by the extremely high rates of over-triage seen in this study, especially in the red code category which shows an over-triage rate of 93.5% ($p < 0.001$: CI 99%). These rates are unacceptably high when compared to those elsewhere where over-triage rates as low as 10% have been reported. (Lammers, Roth and Utecht 1995). Such levels of over-triage not only result in the gross misuse of valuable and limited resources which could be better used elsewhere but may also pose serious dangers to the general public and other road users by the use of emergency response procedures (Clawson 2002; Anderson 2008)

Added to this are the rates of under-triage where the potential for loss of life exists. Indeed this may just be the case when one considers that almost 6% of cases dispatched as yellow code cases in this study were later found to be red code or blue code cases and 7.5% of green code dispatches were later found to be red code. However, in comparison to other studies the overall under-triage rate compares favourably at 3.6%, with rates of between 4% and 7% being reported elsewhere (Lammers *et al.* 1995).

The use of evidence based dispatch systems, particularly those incorporating formal computer aided decision making methodology, such as the MPDS and AMPDS, have proven to be invaluable in determining the most appropriate response to patients on the basis of apparent need among EMS systems elsewhere (Curka *et al.* 1993; Thakore *et al.* 2002; Heward *et al.* 2004; Flynn *et al.* 2006; Sporer *et al.* 2007; Cone *et al.* 2008). Not only do these systems improve time critical responses to critically ill and injured patients, they can also limit unnecessary responses to those patients where there is no clear indication for an EMS response (Dale *et al.* 2003; Dale *et al.* 2004).

In the interests of optimising the use of limited resources, the eThekwini EMRS may consider the implementation of a locally researched and developed MPDS system in line with the recommendations of the United States' National Association of Emergency Medical Service Physicians (2008) which advises that the use of formal medically approved EMD protocols should be considered an essential element of all EMS systems.

5.3.3 Incident Reporting Standards

Close scrutiny of the incident reporting terminology and methods used between the EMCC and the operational component of the eThekwini EMRS shows that there is a distinct lack of standardisation. This can be clearly demonstrated by the results of this study along with a simple comparison of the incident type category and description options available for assignment by the EMD on the computerised system at the EMCC (Appendix 7.11), with the list of incident categories and descriptions included in the patient report form used by the on-scene ECP (Appendix 7.2).

Complete, consistent and accurate reporting and documentation should fundamentally meet the legal, regulatory and auditing requirements of an organisation. Most importantly and especially in the EMS context they allow for optimization in the use of resources, improvements in efficiency and coordination, and facilitation of research, all of which contribute to quality improvement. According to the College of Physicians and Surgeons of Ontario (2000) this is achieved through:

- Quality of care: ensuring consistency and quality in patient care by providing detailed health status information with justification for any interventions.
- Continuity of care: allowing other health care practitioners to quickly access and understand the patient's past and current health status.
- Assessment of care: allowing external audit, investigations, invoicing and self-reflection.
- Evidence of care: providing legal evidence in regulatory, civil, criminal, or administrative matters.

Additionally, where data are coded they should accurately reflect the patients' condition and the services provided to them. According to the American Health Information Management Association (2007), for coded data to be effectively translated to functional information it should be applied uniformly, according to the same coding rules, conventions, guidelines and definitions thus reducing administration costs, enhancing data quality and integrity, and improving decision making.

It is evident that the eThekwini EMRS' existing policy and methods of reporting and documenting its operations can be significantly improved and in the interests of continued quality assurance a review should be encouraged.

5.4 Qualification Levels

This section addresses the third of the secondary research questions:

- Are priority levels, incident categories and incident descriptions consistently and accurately applied through all qualification levels of EMS personnel?

5.4.1 Review of the Results

The results showed that Basic Life Support (BLS) qualified EMD’s were slightly more likely to dispatch cases with red and green code priorities, at approximately 58% and 4.5% of cases respectively, when compared to Intermediate Life Support (ILS) qualified EMD’s, at 55% and 2%. However, ILS qualified EMD’s were more likely to dispatch cases prioritised as yellow code 43% of the time compared to BLS qualified EMD’s at 38%. Although these figures may be arbitrary they do suggest that the lower qualified BLS qualified EMD may be more cautious in their assignment of the higher priority red code case with a slightly higher over triage rate when compared to the ILS qualified EMD. Conversely, it appears that the ILS qualified EMD is less likely to under triage cases into the green code category.

Time differences in the EMD response interval were also found to vary with quicker ILS processing times to red and yellow code cases of almost 2 minutes. Greater variations in time were seen in the green code dispatch priority where ILS qualified EMD’s took almost 25 minutes longer in the dispatch processing time than BLS qualified EMD’s. Here again it appears as though the greater experience of the ILS qualified EMD’s may be a contributing factor to the slightly improved EMD response intervals seen among the red and yellow code cases. Additionally, the delays seen in the dispatch of green code cases among ILS qualified EMD’s may have allowed for improved EMD response intervals in the red and yellow code category.

The average EMCC staff complement over the period of the study comprised 12 ILS and 5 BLS qualified EMD’s. Proportionately, the BLS qualified EMD’s were responsible for allocating dispatch priorities to the greater part of two thirds of the cases received, averaging 120 cases each, compared to the 65 cases prioritised by each of the ILS qualified EMD's. This suggests that either the BLS qualified EMD's work harder or, more realistically, the ILS qualified EMD's are less likely to undertake telephone operator duties but are rather designated to radio dispatch and case input supervisor duties.

There is nothing in the literature to either support or refute these findings with a profound paucity of evidence as to their cogency. Moreover, the situation whereby there are different levels of medically qualified EMD's drawn from an operational environment is rather unique to EMS systems in South Africa, with systems elsewhere having a dedicated EMD component following its own standardised career and training pathways. What studies have been undertaken primarily focus on computer aided caller interrogation and dispatch processes, generally limiting their findings to the effectiveness of priority dispatch systems as a whole (Flynn *et al.* 2006; Sporer *et al.* 2007; Sporer *et al.* 2008; Sporer *et al.* 2010) and effective EMD training and compliance (Griggs *et al.* 1977; Clawson 1981; Clawson *et al.* 1998; National Association of Emergency Medical Service Physicians 2008).

Variations in the allocation of priority levels through the different qualification levels were also seen in the operational component of the organisation. On scene ALS qualified ECP's were more likely to triage patients in the red and blue code category compared to BLS and ILS qualified ECP's; with the most noticeable difference being seen in the red code category where there was a five-fold increase in the rate of patients triaged as red code. These variations however, are probably directly related to the fact that ALS qualified ECP's are only dispatched to cases initially prioritised as red code; or infrequently where an ILS or BLS qualified individual requests ALS assistance for a patient initially prioritised as yellow or green code on dispatch and subsequently found to be red code on scene.

Variations were also seen in the triage rates between on scene BLS and ILS qualified ECP's in the yellow and green code categories where it was found that ILS qualified ECP's are more likely to triage a patient as green code, at just over 16% of cases, compared to BLS qualified ECP's at less than 11%.

The variations described above are not unique to the eThekwini EMRS (Pointer *et al.* 2001; Levine *et al.* 2006) and may point to gaps in the education and training of personnel through the different functional levels of the organisation. The following sections will discuss separately the issues surrounding the education and training of personnel involved in the emergency medical dispatch and operational environments.

5.4.2 Emergency Medical Dispatch

The role of education and training in supporting effective medical priority dispatch among EMS systems has been well established over time (Griggs *et al.* 1977; Clawson 1981; Clawson *et al.* 1998; Heward *et al.* 2004). More recently, studies have shown that when decisions are left to the subjectivity, anecdote or experience of individual EMD's, inaccuracies and inconsistencies become more evident (Clawson *et al.* 2007b). Such inconsistencies have been shown to exist in the results of this study which in turn suggests that the existing levels of education and training relating to priority dispatch in the eThekwini EMRS are somewhat lacking.

Presently, the EMD component of the eThekwini EMRS is comprised of operational personnel with different levels of EMS qualifications and varying degrees of experience (Table 3.3). Generally, those personnel with ILS qualifications have longer service with more experience; whereas BLS qualified personnel have less experience with shorter lengths of service. Both qualification levels may or may not have worked operationally, some personnel having been inducted into the EMCC environment immediately upon employment, while others are frequently rotated through the EMCC from their operational home bases.

Although most personnel assigned to the EMCC are required to have undertaken an EMD short course where the use of the most basic decision based algorithms are advocated in deciding upon a dispatch priority (Pillay 2003), there was no evidence of any recognised medical priority dispatch system being employed during the period of this study.

Of greater concern is that, despite the lack of any form of priority dispatch being employed, the majority of calls for an EMS response are answered by the least medically qualified personnel. These are the very individuals who are responsible for interrogating the caller and are critical to the assignment of an appropriate response.

Considering that the EMD system currently employed by the eThekwini EMRS does not presently allow for or integrate any dispatch software, such as MPDS, one would think that a strict education and training policy and the employment of the most senior medical personnel in establishing patient need would be mandatory in order to ensure the most appropriate response and the best use of resources.

Where systems have implemented strict education and training policies, particularly in conjunction with a computer aided MPDS, and employed appropriately trained medical personnel major successes have been realised in optimising the EMD process. Such successes have been more than adequately demonstrated by the largest EMS system in the world, the London Ambulance Service (Heward *et al.* 2004).

5.4.3 Operational Division

As in the case of the personnel allocated to the EMD function of the eThekwini EMRS, personnel in the operational component have similarly varying levels of qualification and degrees of experience. Unique to the operational environment however, is the addition of the ALS qualified ECP.

Here too, inconsistencies were seen in the application of triage codes to patients once the responding units had arrived on scene. The differences seen in the frequencies of triage allocations between the BLS, ILS and ALS level ECP also suggests that there is also a need for improved education and training, albeit to a lesser extent than that seen among EMD’s.

Overall, triage by EMS systems has been notoriously inaccurate (Pointer *et al.* 2001; Levine *et al.* 2006), however improvements have been observed with the use of a recognised triage scale or protocol (Dunne *et al.* 2003). More recently, the American field triage decision scheme (American College of Surgeons 1986) has been adopted as a national standard in the United States of America (Centers for Disease Control and Prevention 2008) and notable successes in triaging patients to non-traditional destinations have been reported among major EMS systems utilising a properly implemented triage policy in the United Kingdom (Snooks *et al.* 2004a).

Such triage protocols may serve as the template for field triage protocols among South African EMS systems, with some local and regional adaptation reflecting the operational context in which they function. For example, protocols may be modified to population density, such as densely urban or extremely rural, and resources available, such as the presence or absence of a specialized trauma centre.

In South Africa, a protocol known as the South African Trauma Scale (SATS) has been developed and proposed for use by emergency medical personnel in the hospital and pre-hospital environments, across both the public and private sectors (Emergency Medical Society of South Africa 2012). The protocol aims to effectively standardise triage practices among all levels of South African health care providers and may be particularly useful to EMS systems, such as the eThekwini EMRS.

5.5 Clinical Need and Resource Allocation

This section addresses the last of the four secondary research questions:

- Do the different levels of response assigned on dispatch adequately and routinely meet the clinical needs of patients in terms of resource allocation?

5.5.1 Review of the Results

Three criteria were used in determining whether the level of resources dispatched appropriately matched the needs of the patient. Basically, the study chose to look at whether the qualification level dispatched met the needs of the patient in terms of the triage priority and the nature of the interventions required on scene.

The results of the study unambiguously demonstrate that the present methods used by the eThekwini EMRS of prioritising and allocating resources according to patient need are failing, particularly when considering that of 779 (56.2%) dispatches prioritised as red code cases by the EMD, only 24 (1.7%) were actually classified as such by the ECP attending the scene. This represents a staggering disagreement rate of 96.9% which compares unfavourable with modest rates as low as 26% reported elsewhere (Palumbo *et al.* 1996).

The failure of the existing system is further supported by the results in that of the 24 patients that were actually found to be red code on scene only 5 (11.6%) were initially dispatched an appropriate ALS response. More surprisingly and alarming is that of the 41 patients found to be blue code on scene only 3 (7%) were initially dispatched an ALS response. Conversely, of the cases where an ALS dispatch did occur over 80% of the patients were found to be either yellow or green code.

Similar failures are evident when comparing the interventional requirements on scene with the level of dispatch. Of the 69 cases to which ALS resources were dispatched to scene, 42 (60.9%) required either no intervention whatsoever or a means of transport only. ALS interventions were required in another 10 instances where ALS resources were not available initially.

Although similar discrepancies in determining the need for ALS interventions among life threatening cases have been seen in EMS systems elsewhere (Sporer *et al.* 2007; Sporer *et al.* 2008; Khorram-Manesh *et al.* 2010; Sporer *et al.* 2010; Ek *et al.* 2011) such high levels of inappropriate ALS dispatch to lower priority patients has not been seen. Indeed EMS systems employing MPDS have reported high levels of sensitivity in identifying the lowest priority patients predictive of no pre-hospital intervention (Sporer *et al.* 2010).

In total an ALS intervention was required in only 20 patients constituting 1.4% of the total 1385 dispatched cases which again does not compare with figures presented elsewhere which suggest that the need for ALS interventions in modern day EMS systems can be anywhere between 9% (Lu *et al.* 2006) and 30% (Scalice 1978). The remainder of the interventional needs comprised of those delivered at a BLS qualified level which made up 496 (35.8%) of the total 1385 cases dispatched followed by those delivered at an ILS level qualification at 56 (4%) cases. This left the bulk of 813 (58.7%) dispatches either requiring no intervention or a means of transport only, a figure which equates with a single study conducted in South Africa (Frank and deVilliers 1995) and numerous international studies reporting rates of between 11.3% and 68% (Gibson 1977; Morris and Cross 1980; Rademaker *et al.* 1987; Chen *et al.* 1996; Camasso-Richardson *et al.* 1997; Hipskind *et al.* 1997; Palazzo *et al.* 1998; Snooks *et al.* 1998; London Department of Health 1999; Victor *et al.* 1999; Gratton *et al.* 2003b; Patterson *et al.* 2006; Vardy *et al.* 2009) .

The analysis of the on scene triage code allocated to the patient against the interventional requirements showed that some patients triaged as red code were managed by applying lower level interventions at BLS and ILS levels. Conversely, patients triaged as yellow code on scene received ALS interventions. In particular, Inconsistencies were seen in the red code group of patients where only 8 of 23 (34.8%) patients received an ALS intervention.

It is clear from the results presented that the allocation of appropriate resources aimed at meeting patient needs is not being achieved and cannot be effective due to the high levels of inconsistencies reported. Of particular concern is the alarmingly high level of cases where EMS resources are routinely dispatched to cases that either require no intervention or a means of transport only. Such cases contribute to almost 60% of the total eThekwini EMRS case load.

There is undoubtedly a very urgent need for the eThekwini EMRS to review its existing policies relative to the decisions made in the allocation of resources based upon patient need. Adopting evidence based alternatives to the traditional dispatch of emergency ambulances and the transportation of patients to primary admitting centres may be a process in which to achieve this.

Fundamentally, the process should involve offering alternatives at the point of dispatch and again at the point of physical patient contact. Neely's Multiple Option Decision Point (MODP) model, discussed in chapters one and two (Neely *et al.* 1997), may be such a process by which to achieve this.

5.5.2 Alternatives to Dispatch

Currently all public requests for EMS services in the eThekwini health district are afforded the luxury of an immediate response, which includes a fully manned and equipped emergency ambulance and sometimes additional ALS resources (Emergency Medical Rescue Services: Province of KwaZulu-Natal nd). Frequently however, the system is completely overwhelmed where resource availability cannot meet such high levels of demand as evidenced by the unacceptable delays experienced in the EMD response intervals presented earlier. This inevitably results in there being no units left to dispatch to any further requests for help and a backlog of cases develops at a rapid pace.

When such backlogs occur it is extremely important that what resources are available are properly utilised and apportioned. The subjective and arbitrary approach to dispatch currently employed by the eThekwini EMRS however, may be contributing significantly to compounding the backlogs creating further chaos. Here it is abundantly clear that the present system lacks structured caller interrogation and there is little evidence of the use of even the most basic priority dispatch algorithms.

To meet the challenges described above the answer may be to substantially increase the availability of resources, which might include increases in workforce, fixed resources and mobile resources, all of which will involve considerable costs. Another answer would be to look at evidence-based alternative response modalities, such as those suggested by the Neely MODP model, which are proven to be appropriate to patient needs while simultaneously containing system costs (Neely *et al.* 1997). The main question here is, should all patients that request an EMS response be provided with an emergency response or should they be routed to an alternative service provider?

The alternative routing of patients at dispatch is a relatively new concept and, although great caution should be adopted at this point of the decision making process, some successes have been reported (Neely *et al.* 1997; Neely *et al.* 2000c; Dale *et al.* 2003; Schmidt *et al.* 2003; Dale *et al.* 2004). The NHS direct and NHS 111 services employed in the United Kingdom are notable example of systems whereby a patient calling for an EMS response may be offered advice on the self-management of the illness or injury, be directed to a general practitioner or primary health facility, or offered a scheduled NHS basic transport service (National Health Service 2013). Interestingly, this service also offers an online service which assists patients with self-diagnosis and offers advice on the most appropriate point of contact in relation to their condition.

For such a system to work effectively however there must be integration with other health care agencies across all levels in providing an optimal response to patient needs, particularly within the district and primary health care structures along with public and private transport service providers

Additionally, caution must be shown with the implementation of any system designed to offer alternatives to a traditional response and where such systems are employed a recognised MPDS and on-going EMD training – aimed at ensuring compliance in its application – should be considered mandatory along with further substantial investment in research and on-going development (Neely *et al.* 2000a; Neely *et al.* 2000c; Snooks *et al.* 2002; Dale *et al.* 2003; Schmidt *et al.* 2003; Dale *et al.* 2004).

5.5.3 Alternatives to Transport

The second point of the Neely MODP model proposes that decisions may also be made in the routing of patients once the responding unit arrives on scene (Neely *et al.* 1997). An all too familiar scenario, certainly in the researchers experience, is that a unit is dispatched to a case considered to be life threatening, such as to a high speed vehicle collision with suspected entrapment, only to find out that once on scene the patient has a minor injury, such as a small abrasion. Similar scenarios have been reported throughout time in other EMS systems locally (MacFarlane *et al.* 2005) and internationally (Gibson 1977; Morris and Cross 1980; O' Leary *et al.* 1987; Rademaker *et al.* 1987; Gardner 1990; Pennycook *et al.* 1991; Brown and Sindelar 1993; McCleay *et al.* 1995; Billittier *et al.* 1996; Palazzo *et al.* 1998; Marks *et al.* 2002; Gratton *et al.* 2003b; Patterson *et al.* 2006). In such cases it may be prudent to offer the patient an alternative to hospital transportation.

Presently, eThekwini EMRS transports all patients to hospital irrespective of their condition, unless the patient specifically refuses to be transported, and although it is acknowledged that some patients are transported to other destinations, such as local community health centres, this appears to be the exception rather than the norm.

The problem with the present system is that when patients are transported with minor illness or injuries, sometimes over long distances, the responding unit remains unavailable to respond to another case until such time as the patient has been delivered to a hospital. If such a patient were to be transported to a local primary health clinic or treated on scene and referred for further management then the unit would become available much earlier.

The present system of transporting all patients to a hospital, irrespective of the severity of their illness or injury, inevitably results in the wastage of expensive and limited resources that could be better utilised elsewhere. Another factor to consider is that this additional burden is in turn added to the emergency admitting and outpatient departments particularly at already under-resourced government hospitals (Schaefer *et al.* 2002).

Should the eThekwini EMRS embrace the concept that not all patients need to be delivered to a hospital, savings may be seen in terms of shorter travelling distances, reduced job turnaround times, reduced waiting periods and a reduction in the overall time that the patient spends seeking care. Such savings have been realised in other EMS systems where benefits have been seen in optimising the EMS systems operational efficiency and increasing the patients' level of service satisfaction (Schaefer *et al.* 2002; Snooks *et al.* 2004a).

Further benefits may also be realised should programmes of treatment on scene with referral for further patient management (Kamper *et al.* 2001); treatment on scene with patient discharge (Knight *et al.* 2003); and EMS initiated refusal of transport (Jaslow *et al.* 1998; Knapp *et al.* 2009b) be implemented. Even though caution is advised in implementing such programmes (Selden *et al.* 1991; Zacharia *et al.* 1992), recent studies suggest that such approaches are indeed feasible and can be beneficial provided that guidelines are properly researched, developed and applied (Kamper *et al.* 2001; Snooks *et al.* 2004b).

Complementing these programmes, consideration could also be given to the introduction of schemes which allow for alternative means of transport. Such schemes could, for instance, include the issuing of passes for scheduled public transport, such as buses, mini-buses or taxi cab type transports, or there could be routinely scheduled non-emergency patient transport vehicles, with wheelchair and stretcher accessibility, which could perhaps travel daily circuitous routes through major population areas with less frequent routes for rural areas. Such schemes would provide a less costly and labour intensive mode of transport to those patients that require nothing more than a convenient means of transport to a nearby health facility. Indeed, Billittier *et al.* (1996) found that an 82% majority of patients deemed not to have required EMS transport would have gladly accepted an alternative means of transport had there been one available.

One of the major stumbling blocks to the implementation of systems similar to those described above, is the fear that the failure of the system may result in litigation (Goldberg *et al.* 1990), this mainly due to the concern that some patients may require emergency care after being incorrectly identified as not needing EMS transport. Snooks *et al.* (2004c) identified this as a significant risk in a review of the literature but her study concedes that the present model of care is inappropriate and inefficient and that urgent research is required to support a clinically safe approach to offering alternative modes of transport.

Perhaps the answer is to look at the existing model and ask whether it is appropriate for present day needs. The existing EMRS multi-tiered model is typical of many EMS systems throughout the world and it has been in existence since the late 1970’s and early 1980’s with little in the way of change. However, In the United Kingdom variations to the traditional model have been introduced with the addition of a variety of modalities through different levels of service provision. These include the introduction of purpose made vehicles specific to patient needs which allow for the provision of urgent, non-urgent and scheduled modes of transport. Added to this are first response units which consist of non-patient carrying vehicles with ALS qualified ECP’s. This system effectively allows for more accurate patient triage and diagnosis on scene by senior qualified personnel who will then decide, based on the patients clinical condition, upon the most appropriate options for further patient management, including patient routing and mode of transport (London Ambulance Service NHS Trust 2013). Such a system prevents the misuse of resources, frees up emergency ambulances when they are not required, reduces bottlenecks at hospital admitting sections, and allows for better planning of non-urgent or scheduled transport.

Here again, integration with other agencies with clear communication consultation and cooperation between the different role players, along with the use of technology, should be considered critical to success.

5.6 Summary

This chapter has provided detailed interpretation of the results and thorough discussion relating to the primary and secondary research questions described in chapter one and at the beginning of this chapter. The following chapter will conclude the study.

6 CHAPTER SIX: CONCLUSION

6.1 Chapter Overview

This chapter presents a summary of the study highlighting the important conclusions drawn from the previous chapters with recommendations for further implementation and research. This is followed by a section which describes the limitations of the study.

6.2 Summary

A review of chapter one will show that this study initially proposed that there is presently a significant mismatch between the dispatch of Emergency Medical Service (EMS) resources and actual patient need among South African urban EMS systems which results in high levels of inappropriate emergency responses. The study then sought to either prove or disprove this statement by answering the primary and secondary research questions through an objectively structured approach, whereby data were collected from the eThekwini Emergency Medical and Rescue Service (EMRS) and examined in the context of what was already known on the subject.

The findings of the study clearly support that such a significant mismatch does indeed exist and points toward a profound failure of the present system, particularly that utilised by the eThekwini EMRS, where the inappropriate use of EMS resources has resulted in a structure which is severely overburdened and ineffective. Such failures have similarly been experienced in varying degrees by other EMS systems throughout the world since the 1970's (Gibson 1977; Morris and Cross 1980; O' Leary *et al.* 1987; Rademaker *et al.* 1987; Gardner 1990; Pennycook *et al.* 1991; Brown and Sindelar 1993; McCleay *et al.* 1995; Billittier *et al.* 1996; Palazzo *et al.* 1998; Marks *et al.* 2002; Gratton *et al.* 2003b; Patterson *et al.* 2006).

Clearly then, fundamental changes to the present system are needed, particularly in South Africa where the present government supports a re-engineered primary health care system including:

- The complete transformation of healthcare service provision and delivery;
- The total overhaul of the entire healthcare system;
- The radical change of administration and management; and
- The provision of a comprehensive package of care (Republic of South Africa, 2011).

The eThekwini EMRS and other EMS systems in South Africa should see this as an opportunity to align themselves with these imperatives in their attempts to optimise service delivery. The following sections will offer recommendations for doing so.

6.3 Recommendations for Implementation

Currently, the system employed by the eThekwini EMRS provides the superfluity of responding rapidly to all requests for an EMS response, even those of perceived lower priority need. Factoring the future growth in service demands, it is obvious that meeting these demands cannot be achieved without committing to significant increases in resources which will inevitably involve considerable costs. To limit these costs however, alternative or improved evidence based modalities, proven appropriate to patient needs, should be simultaneously employed. Six areas in particular have been identified by the study for inclusion.

6.3.1 Systems Status Management

Development of a systems status management programme, incorporating dynamic location/relocation, demand pattern analysis and Geographic Information System (GIS) technologies specific to the local context should be commenced to dramatically improve resource utilisation. Such a system will allow for the real time adjustment of EMS capacity through the accurate plotting of injury and disease profiles relative to socio-economic and geographical variables throughout the eThekwini health district.

6.3.2 Medical Priority Dispatch System

A recognised Medical Priority Dispatch System (MPDS) which has been developed and adapted for local conditions through on-going research should be incorporated into the eThekwini Emergency Medical Communications Centre (EMCC) to allow for improvements in the prioritisation and allocation of resources based on systemic caller interrogation.

Complementing this should be the introduction of Emergency Medical Dispatcher (EMD) specific education, training and developmental policies aimed at ensuring strict compliance with MPDS protocol and practice. A robust quality assurance programme should be considered an integral component of such a programme.

6.3.3 Response Time Standards

The appropriateness of the presently stipulated dispatch and response times criteria across the response time continuum is questionable; with little basis for its support and a profound paucity of evidence as to its relevance a review should be encouraged. The development of acceptable dispatch and response time standards should be based on sound empirical evidence which should take into consideration the different priority levels and modes of response.

6.3.4 Alternative Response Modes

The eThekwini EMRS should look at realistic ways of incorporating alternative models of response in order to promote system efficiency. This can be done at the point of dispatch and again at the point of physical patient contact. However, in order to establish mutually acceptable and safe alternative response modalities designed to optimally meet patient needs at both points, effective integration with other health care agencies should be considered mandatory.

6.3.5 Public Awareness

The need to promote public awareness in the proper use of what limited resources are available should be considered equally crucial to the points listed above. Educational campaigns directed through the mass media may be one such method in which to do this.

6.3.6 Reporting Standards

Accuracy and consistency in reporting and documentation standards through all levels of service provision should be ensured thus limiting difficulties in the analysis of data when determining such things as service demand and patterns of injury and illness.

At the same time the introduction of a standardised triage scoring system, such as the South African triage scale (SATS), would ensure consistency in the application of accurate patient prioritisation allocations.

6.4 Recommendations for Research

The value of research is undisputed as a crucial driver of innovation and socioeconomic wellbeing. Its purpose in the EMS field is to determine the efficacy and efficiency of standards of care and the systems that deliver it. Currently however, there are two major impediments to the development of quality EMS research in South Africa.

6.4.1 National Research Agenda

A national agenda for EMS related research does not presently exist in South Africa, and there is no central source for EMS research. Research designed to improve EMS service delivery options in line with this study should be considered a crucial step towards realising progress in the EMS field.

The development of a National research agenda relating to the provision of EMS in South Africa will encourage research on a wider scale, identifying research priorities, determining research goals and assisting with the development of research funding opportunities. Critically, those public and private organizations responsible for EMS structures, processes, and outcomes throughout South Africa must collaborate to ensure that such an agenda is developed.

6.4.2 National Integrated Information System

Although a national health information system presently exists in South Africa it remains largely inaccessible to the EMS industry and the benefits of its application has not yet been fully realised.

Development of a national EMS integrated information system, such as Teamsun in China (Teamsun 2012), NEMSIS in the United States (National Emergency Medical Service Information System 2005) and VACIS in Australia (The Council of Ambulance Authorities Inc. 2009) must be developed locally in order to provide integration between EMS and various other emergency services and health care agencies. This should be considered fundamental to the data collection that is necessary to undertake research in determining EMS efficacy and efficiency in South Africa.

Accurate and routine systemic data collection will provide high quality valid data for the purpose of EMS based clinical research which will facilitate an evidence base to clinical practice among EMS systems in South Africa.

Added to this, the data collected will provide information which may:

- enable comparisons between patient assessments at the dispatch, on-scene and hospital stages of a response, for the purpose of refining dispatch protocols;
- establish the level of compliance with clinical protocols and procedures and assist in determining training needs;

- provide a standard approach to documenting patient assessment and treatment;
- provide the means by which specific cases can be audited, reviewed and investigated to ensure the continuity, quality and safety of patient care.

6.5 Limitations of the Study

There were two main limitations that were identified throughout the study which were beyond the scope of the research.

The first limitation was where the study did not take into consideration fluctuations in the demand for EMS resources over different seasons of the year where, for instance, weather patterns and public holiday periods may have influenced demand. Also demand across smaller socio-demographic areas within the greater geographical context may have differed significantly. A larger sample size over an extended study period which includes these variables may generate results which can add significantly to the value of this study.

The second limitation was where the reasons for delays in travelling times to the scene were not recorded. Future studies should include the rates and frequencies of mechanical failure and vehicle collisions and perhaps record travelling times measured against distance and topography. These additional observations may also yield results which may add to the studies value.

7 APPENDICES

Appendix 7.1: Vehicle Control Form (VCF) of the eThekwini EMCC 155

Appendix 7.2: Patient Report Form (PRF) of the eThekwini EMRS 157

Appendix 7.3: Consolidated IBM statistics data input 158

Appendix 7.4: Quotation for statistical analysis 159

Appendix 7.5: Durban University of Technology Institutional Research Ethics Committee certificate of ethical clearance 160

Appendix 7.6: Letter of permission to conduct research in the eThekwini district EMRS 161

Appendix 7.7: Letter of permission to conduct research in the KwaZulu-Natal Department of Health 163

Appendix 7.8: Letter of approval to conduct research with the KwaZulu-Natal Department of Health 164

Appendix 7.9: Ratification of research by the Higher Degree Committee of the Durban University of Technology 165

Appendix 7.10: Safety monitoring and annual recertification letter of approval from the Durban University of Technology Institutional Research Ethics Committee.. 167

Appendix 7.11: Description of dispatch within the incident type category .. 168

Appendix 7.1: Vehicle Control Form (VCF) of the eThekwini EMCC

[redacted]

Incident Specifics

Printed on 8/5/2011 at 8:25:45 AM by (ECP (I)) None

IR Number	2011080135XXX	Operator:

Incident Type

Incident Type
Incident Type Description

Incident Details

Incident Addresses — Territorial Code
Street Name and Number, Apartment
Floor, Province
Building

Incident data
Telephone Numbers

Caller Address — Territorial Code
Street Name and Number, Apartment
Floor, Province — *Kwazulu Natal*
Building

Caller Data
Family Name & First Name
Caller Tel. Number
Telephone Numbers

Incident Detail

Incident Date	Call Date	Undesired	Estimate Damage	People Injured	People Killed

Additional Info
Incident Description

Time (min) to complete phase

	Registered	Dispatch	Accept	Enroute	Interveened	Documented	Complete
Incident Time	0 Day 00:05:05	0 Day 00:05:33	0 Day 00:00:01	0 Day 00:32:37	0 Day 00:13:21	0 Day 00:44:05	0 Day 01:40:42
Allowed Time	00:01:00	00:01:00	00:01:00	00:01:00	00:01:00	00:01:00	00:06:00

Vehicle Detail

Vehicle Number	Resp. Type

Crew Members

Vehicle Number	Rank	Unit	Department	Crew Member	Name

Incident History

Rank, Name	Workstation	Log	Log Type	Log Comment

Page 1 of 2

29

[redacted]

Completion Detail

Completion

Patients

ID Number		**Birthdate / Age**	
Institution Ref.		**Blood Group**	
Name		**Telephone Numbers**	
Address		**Gender**	
Condition	*Red - Critical, Life threatening*	**Diagnoses**	*MED RD*
Emergency Contact			
Doctor			
Allergies			
Notes			

[redacted]

Appendix 7.2: Patient Report Form (PRF) of the eThekwini EMRS

PROVINCE OF KWAZULU-NATAL: HEALTH SERVICES I 124431
AMBULANCE RETURN

AMBULANCE REQUEST FROM		OPERATIONS ORDER NO.	YR	MTH	DAY	R	DEPOT	SEC	SBS	CSE No.

AT H PER RADIO TELEPHONE OTHER PATIENT'S NAME

PHONE CODE

PATIENT PICK-UP POINT GUIDE PICK-UP POINT

SEX	AGE									
M F	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	>90

VEHICLE CALL SIGN Z S

AMBULANCE NO A

PATIENT DELIVERY POINT

DISPATCH CODE R Y G

ACCIDENTS	ASSAULTS	MEDICAL	MATERNITY
DOMESTIC	BLUNT	HEART ATTACK	ABORTION
WCA/IOD	PENETRATION	HEART FAILURE	ECTOPIC
SPORT	LOW VELOCITY	ASTHMA	PID
MVA-DRIVER	HIGH VELOCITY	COAD	ECLAMPSIA
MVA-PASSENGER	STABS	CVA	STILLBIRTH
MVA-M/CYCLIST	GUN SHOTS	DIABETES	APH
MVA-CYCLIST	SUICIDE	EPILEPSY	NVD
MVA-PEDESTRIAN	OTHER	POISONINGS	BREECH
MVA-OTHER		OTHER	COMPLICATED
PAEDIATRIC	(SPECIFY OTHER BELOW)		RET PLACENTA
PREMATURE			PPH
OTHER			OTHER

	CREW No.'s
SENIOR	
JUNIOR	

CREW QUALIFICATION CODES	
L	LEARNER AMBULANCEMAN
B	ECP QUALIFIED
A	ECP (i) QUALIFIED
C	ECP (a) QUALIFIED

BASE CREW INFORMED H

AMBULANCE MOBILE H

GUIDE FOUND H

ON SCENE H

ASSISTANCE REQUESTED H

ESV	RRU	RES	MED	RTI	SAP	PS	CP	FIRE	OTHER

MOBILE FROM SCENE H

RE-ROUTED OPERATIONS H

ORDER NO

YR	MTH	DAY	R	DEPOT	SEC	SBS	CSE No.

CLINICAL INFORMATION	STATUS	VALUES	TIME
			H H H H H H H

PROVINCIAL DIAGNOSIS

ASSESS EVERY 15 MINS OR LESS
TRAUMA SCORE

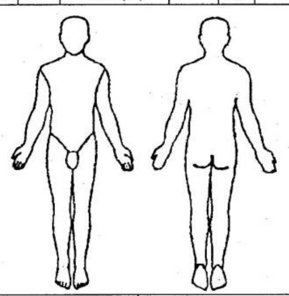
RESP (BPM)	10-25	3	
	<25	2	
	<10	1	
	0	0	
PULSE (BPM)	70-100	3	
	<70>100	2	
	<50>120	1	
	<30>180	0	
B/P (SYS)	100-120	3	
	<100>120	2	
	<70>180	1	
	UNREC	0	
GCS 3-15	15	3	
	10-14	2	
	7-9	1	
	<7	0	
LONG BONE #S	NONE	4	
	1 ONLY	3	
	2 ONLY	2	
	>2	1	
	PELVIS	0	
	SPINE	-	
TRAUMA SCORE-16			
MINUS LOAD/FACTOR			
SATS 1			
DEXTROSTIX			

ASSESS ONCE ONLY
LOADING FACTORS

AGE		WOUNDS		# 'S		DISEASE		SYS INJ	
<5 >60	<1 >70	PNT ING	HGH VEL	COM PND	COM PLT	IN ACT	ACT	<3	>3
-1	-2	-1	-2	-1	-2	-1	-2	-1	-2
X		X		X		X		X	

LOADING FACTOR TOTAL

BURNS % TEMP (#C) W.T K.G



EMERGENCY PROCEDURES YES NO H

HOSPITAL INFORMED YES NO H

PERSON INFORMED

AT DESTINATION H

TRAUMA UNIT OUT-PATIENT NO

ADMISSION TRIAGE CODE: R Y G B

SATS 2

TIME RELEASED H

TIME RE-FUELLED (IN) H

TIME RE-FUELLED (OUT) H

TIME AVAILABLE FOR NEXT CASE H

ODOMETER READINGS	
MILEAGE END OF TRIP	
MILEAGE START OF TRIP	
DISTANCE TRAVELED (KMS)	

VEHICLE REGISTRATION NUMBER	SENIOR'S NAME
N	

CHECKED	NAME
TIME H	DATE

SUPERVISOR'S NAME

DATE

MEDICAL MANAGEMENT

SUCTION		MASK SUIT	
O/P AIRWAY		ECG	
OXYGEN		DEFIB	
28% MASK		CERVICAL COLLAR	
40% MASK		DRESSINGS	
E/T TUBE		SPINAL CORD	
BAG		TRAUMA BOARD	
MECH. VENT		SCOOP STRETCHER	
ENTONOX		ZIP STRETCHER	
IVI PERIPHERAL		KRAMER SPLINTS	
IVI CENTRAL		TRAC III	
IV R/LACTATE		OTHER (SPECIFY)	
IV 5%D/W			
IV DARROWS			
REMARKS			

TRIAGE CODE			
R	Y	G	B

INJURY FORCE
MILD
MODERATE
SEVERE
EXTREME
D.O.A

ODOMETER READINGS	
POINT OF DELIVERY	
POINT OF PICK-UP	
TOTAL KILOMETRES	

31

Appendix 7.3: Consolidated IBM statistics data input

Data Analysis.sav [DataSet1] - IBM SPSS Statistics Data Editor

File Edit View Data Transform Analyze Direct Marketing Graphs Utilities Add-ons Window Help

	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
1	IRno	String	6	0	Incident Report ...	None	None	4	Left	Nominal	Input
2	Date	Date	10	0	Incident Date	None	None	8	Left	Nominal	Input
3	EMDq	Numeric	1	0	Dispatcher Qua...	{1, Basic Lif...	None	4	Right	Nominal	Input
4	Inctype1	Numeric	3	0	Incident type at...	{1, Accident...	None	6	Right	Nominal	Input
5	Incdesc1	Numeric	8	0	Incident descrip...	{1, abdomin...	None	6	Right	Nominal	Input
6	Code1	Numeric	1	0	Triage Code on ...	{1, Red cod...	None	5	Right	Nominal	Input
7	Call_in	Date	12	0	Time of Call	None	None	8	Left	Scale	Input
8	Call_dis	Date	12	0	Time call dispat...	None	None	8	Left	Scale	Input
9	At_scene	Date	12	0	Time on scene	None	None	8	Left	Scale	Input
10	ECPq	Numeric	1	0	Emergency Car...	{1, Basic Lif...	None	4	Right	Nominal	Input
11	Station	Numeric	3	0	Base station	{1, Claremo...	None	5	Right	Nominal	Input
12	Ptsex	Numeric	1	0	Sex of Patient	{1, Male}...	None	5	Right	Nominal	Input
13	Ptage	Numeric	3	0	Age of Patient	None	None	5	Left	Scale	Input
14	Inctype2	Numeric	3	0	Incident type o...	{1, Accident...	None	6	Right	Nominal	Input
15	Incdesc2	Numeric	8	0	Incident descrip...	{1, abdomin...	None	6	Right	Nominal	Input
16	Code2	Numeric	1	0	Triage Code on ...	{1, Red cod...	None	5	Right	Nominal	Input
17	Physio	Numeric	1	0	Normal physiol...	{1, Yes}...	None	5	Right	Nominal	Input
18	ALS	Numeric	1	0	Was ALS assis...	{1, Yes}...	None	3	Right	Nominal	Input
19	Int	Numeric	1	0	Nature of interv...	{1, None req...	None	3	Left	Nominal	Input
20	Relcode	Numeric	2	0	Release code	{1, Attended...	None	8	Right	Nominal	Input
21											
22											
23											
24											
25											
26											

Data View | Variable View

IBM SPSS Statistics Processor is ready

Data Analysis.sav [DataSet1] - IBM SPSS Statistics Data Editor

File Edit View Data Transform Analyze Direct Marketing Graphs Utilities Add-ons Window Help

1 : IRno 3

Visible: 20 of 20 Variables

	IRno	Date	EMDq	Inctype1	Incdesc1	Code1	Call_in	Call_dis	At_scene	ECPq	Station	Ptsex	Ptage	Inctype2	Incdesc2	Code2	Physio	ALS	Int	Relcode	var
1	3	2011/11/24	1	6	80	1	1 00:06:33	1 00:12:47	1 01:21:08	2	4	2	26	8	80	2	1	2	2	11	
2	6	2011/11/24	2	5	56	1	1 00:08:26	1 00:09:47	1 00:21:40	1	10	2	16	5	46	2	1	2	2	11	
3	7	2011/11/24	1	8	46	2	1 00:12:27	1 00:34:11	1 01:02:57	2	3	2	17	5	46	2	1	2	2	11	
4	9	2011/11/24	2	6	64	1	1 00:16:43	1 00:31:05	1 00:31:22	2	10	1	8	6	7	2	1	2	2	11	
5	12	2011/11/24	1	2	10	1	1 00:24:59	1 00:28:21	1 00:28:37	2	6	1	47	.	.	.	.	2	1	3	
6	13	2011/11/24	1	7	47	1	1 00:29:37	1 00:36:55	1 00:46:28	2	12	1	28	7	95	2	1	1	3	11	
7	17	2011/11/24	1	8	46	2	1 00:37:30	1 00:50:44	1 01:02:49	2	10	2	21	5	46	2	1	2	2	11	
8	18	2011/11/24	1	6	78	2	1 00:40:01	1 01:06:37	1 01:06:37	1	6	2	6	.	.	.	.	2	1	7	
9	23	2011/11/24	1	6	78	2	1 00:53:39	1 01:02:39	1 01:02:39	2	11	2	23	.	.	.	.	2	1	6	
10	24	2011/11/24	1	8	46	1	1 00:54:40	1 01:25:08	1 01:53:46	2	11	2	23	5	46	2	1	2	2	11	
11	25	2011/11/24	1	6	7	1	1 00:57:09	1 01:14:35	1 02:40:53	1	7	1	36	6	81	3	1	2	2	3	
12	28	2011/11/24	2	6	24	1	1 01:03:37	1 02:02:08	1 02:25:32	2	6	1	36	.	.	.	.	2	1	6	
13	31	2011/11/24	1	6	78	2	1 01:21:40	1 02:04:03	1 02:27:44	2	12	1	21	.	.	.	.	2	1	8	
14	33	2011/11/24	1	6	24	2	1 01:27:12	1 02:01:26	1 02:14:20	2	12	1	20	6	24	3	1	2	2	11	
15	34	2011/11/24	1	6	37	2	1 01:27:50	1 01:37:10	1 01:55:04	1	5	2	28	6	37	2	1	2	2	11	
16	36	2011/11/24	1	4	43	1	1 01:32:47	1 01:55:34	1 02:30:11	2	7	2	37	5	57	3	1	2	3	11	
17	39	2011/11/24	1	6	24	2	1 01:37:32	1 02:01:44	1 02:19:30	2	12	1	40	6	94	2	1	2	2	11	
18	42	2011/11/24	1	4	42	1	1 01:40:36	1 01:58:10	1 02:39:37	2	8	2	59	6	3	2	1	2	2	11	
19	43	2011/11/24	1	2	23	1	1 01:40:59	1 02:39:40	1 02:58:43	2	7	1	31	2	36	2	2	2	4	11	
20	46	2011/11/24	1	1	36	1	1 01:51:16	1 02:06:29	1 02:16:18	1	2	1	23	2	36	2	1	2	2	11	
21	49	2011/11/24	1	6	7	1	1 01:53:16	1 01:59:09	1 02:05:31	2	10	1	58	6	7	2	1	2	2	11	
22	50	2011/11/24	1	8	46	1	1 01:54:13	1 02:04:13	1 02:21:34	2	4	2	26	5	46	2	1	2	2	11	
23	52	2011/11/24	1	8	46	2	1 01:55:42	1 02:01:53	1 02:41:14	2	11	2	28	5	46	2	1	2	2	11	
24	53	2011/11/24	1	6	81	1	1 01:56:49	1 02:04:55	1 02:17:35	2	10	1	48	6	14	2	1	2	2	11	
25	55	2011/11/24	1	6	76	2	1 02:15:43	1 02:58:27	1 03:14:36	1	6	2	7	6	76	2	2	2	2	11	

Data View | Variable View

IBM SPSS Statistics Processor is ready

Appendix 7.4: Quotation for statistical analysis

DEEPAK SINGH
Registered Scientist
Database and Statistical Analysis

(Pr. Sci. Nat.) (No. 400027/96)

P. O. Box 24002
Hillary
4024

(Cell): 083-775-9239
singhd@telkomsa.net

15 June 2011

Mr P. R. Newton
Student Number: 19301652
Department of Emergency Medical Care & Rescue
Durban University of Technology
4000

Sir

Statistical Analysis for Master of Technology: Emergency Medical Care

The following services will be rendered to you:

1. Coding of data.
2. Analysis
3. Output in Word format.

The statistical aspect of the research will encompass the following:

- Descriptive statistics using frequency and cross-tabulation tables and various types of graphs
- Inferential statistics using correlations
- Testing of hypotheses using chi-square tests for nominal data
- Testing of hypotheses using ANOVA (factorial or mixed factorial)
- Additional methods may be used as the need arises.

The total cost for the project will be three thousand five hundred rand only (R3500).

If you have any queries, please feel free to contact me.

Sincerely

[redacted]

Deepak Singh

Appendix 7.5: Durban University of Technology Institutional Research Ethics Committee certificate of ethical clearance

DURBAN UNIVERSITY of TECHNOLOGY

Faculty of Health Sciences

ETHICS CLEARANCE CERTIFICATE

Student Name	Paul Richard Newton	**Student No**	19301652
Ethics Reference Number	**FHSEC 009/11**	**Date of FRC Approval**	Monday 9th May, 2011
Qualification	**Master of Technology in Emergency Medical Care**		
Research Title:	**An evaluation of the appropriateness of Emergency Medical Service (EMS) responses in the eThekwini Health District of KwaZulu-Natal**		

In terms of the ethical considerations for the conduct of research in the Faculty of Health Sciences, Durban University of Technology, this proposal meets with Institutional requirements and confirms the following ethical obligations:

1. The researcher has read and understood the research ethics policy and procedures as endorsed by the Durban University of Technology, has sufficiently answered all questions pertaining to ethics in the PG4a and agrees to comply with them.
2. The researcher will report any serious adverse events pertaining to the research to the Faculty of Health Sciences Research Ethics Committee.
3. The researcher will submit any major additions or changes to the research proposal after approval has been granted to the Faculty of Health Sciences Research Committee for consideration.
4. The researcher, with the supervisor and co-researchers will take full responsibility in ensuring that the protocol is adhered to.
5. ***The following section must be completed if the research involves human participants:***

	YES	NO	N/A
❖ Provision has been made to obtain informed consent of the participants	√		
❖ Potential psychological and physical risks have been considered and minimised	√		
❖ Provision has been made to avoid undue intrusion with regard to participants and community	√		
❖ Rights of participants will be safe-guarded in relation to: - Measures for the protection of anonymity and the maintenance of Confidentiality.	√		
- Access to research information and findings.	√		
- Termination of involvement without compromise	√		
- Misleading promises regarding benefits of the research	√		

[redacted]

SIGNATURE OF STUDENT/RESEARCHER — 30/05/11 DATE

[redacted]

SIGNATURE OF SUPERVISOR — 30/05/11 DATE

[redacted]

SIGNATURE OF HEAD OF DEPARTMENT — 30/05/2011 DATE

[redacted]

SIGNATURE: CHAIRPERSON OF RESEARCH ETHICS COMMITTEE — 01/06/11 DATE

25

Appendix 7.6: Letter of permission to conduct research in the eThekwini district EMRS

12th September, 2011

Attention Mr Nkateko W Sithole - CM(SA)
General Manager: Emergency Medical Services
KwaZulu-Natal Department of Health
121 Chief Albert Luthuli Street
Trizon Towers
Pietermaritzburg.

Dear Mr Sithole

Subject: Request to access records of the Emergency Medical and Rescue Services of the eThekwini health district of KwaZulu-Natal.

I am conducting a research project in order to complete a Master of Technology degree in Emergency Medical Care through the Department of Emergency Medical Care and Rescue, Durban University of Technology. The study has received approval from the University's research ethics committee and a copy of the research proposal and ethics clearance certificate is attached.

Title of research: An Evaluation of the appropriateness of Emergency Medical Service responses in the eThekwini Health District of KwaZulu-Natal.

- Name of research student: Mr. P.R. Newton (Student number: 19301652)
  Contact telephone no: 031 373 5269
  E-mail: pauln@dut.ac.za

- Name of Supervisor: Mr. R. Naidoo
  Contact telephone no: 031 373 5611
  E-mail: raveenn@dut.ac.za

- Name of Co – Supervisor: Prof. P. Brysiewicz
  Contact telephone no: 031 260 1281
  E-mail: brysiewiczp@ukzn.ac.za

Purpose of the study: The purpose of the study is to evaluate the appropriateness of Emergency Medical Service (EMS) responses in comparison to patient needs in a South African urban EMS system.

The study has as its objectives:

Department of Emergency Medical Care & Rescue
P O Box 1334, DURBAN, 4000, Tel: (031) 373 5203, Fax: (031) 373 5201
e-mail:leighm@dut.ac.za www.dut.ac.za

- To analyse the EMS dispatch in terms of the level of prioritisation and the resources allocated to the response;
- To evaluate the clinical needs of the patient once the EMS responding unit arrives on scene; and
- To compare the EMS response with the clinical needs of the patient.

The study proposes to collect data from the eThekwini district Emergency Medical and Rescue Service (EMRS). Data will be collected at two different points over a single 72 hour period:

- Reliable dispatch data can be accessed through computer generated logs at the EMRS control centre; and
- Detailed epidemiological and clinical data can be obtained from the corresponding paramedic patient report forms.

I am therefore writing to you in order to request access to the dispatch logs and the corresponding patient report forms generated by the eThekwini EMRS over a typical 72 hour period.

Informed consent
Informed consent is not required for the purpose of the study. The data to be used for the study will be taken from organisational records where personally identifiable information will not be recorded. All subjects will remain anonymous.

Risks
There are no risks to study participants. All personally identifiable information will be omitted during data collection thereby ensuring anonymity. Only chronological, demographical and clinical information will be collected for research purposes.

Benefits
There are no financial benefits to individuals participating in this study. However, it is hoped that the results of the study will inform the development of improved resource management strategies among emergency medical service systems.

The results of the study will be made available to you. This will be done in the form of a report which will be copied into a locked PDF on completion of the project and forwarded to you on your request.

If you are unable to provide me with access to the data because you are not satisfied with certain areas of the study, please feel free to forward any concerns to me or my supervisors.

Thank You

[redacted]

Mr PR Newton
Research Student

Department of Emergency Medical Care & Rescue
P O Box 1334, DURBAN, 4000, Tel: (031) 373 5203, Fax: (031) 373 5201
e-mail:leighm@dut.ac.za www.dut.ac.za

Appendix 7.7: Letter of permission to conduct research in the KwaZulu-Natal Department of Health

DURBAN UNIVERSITY of TECHNOLOGY

12th September, 2011

Principal Technical Advisor
Health Research and Knowledge Management
Department of Health
Natalia Building
330 Langalibalele Street
Pietermaritzburg
3200

Research Project: The appropriateness of Emergency Medical Service dispatch in the eThekwini Health District of KwaZulu-Natal.

Attention: Mrs. N. Snyman

I hereby request permission to undertake the above mentioned research project in fulfillment of a Masters Degree within the eThekwini Health District of KwaZulu-Natal.

The Research Ethics Committee of the Durban University of Technology has approved my research proposal.

The following are attached for your perusal in support of my request:

1. Copy of research proposal.
2. Ethical approval certificate from the Durban University of Technology.
3. Letter of permission to access EMRS records.

Please feel free to contact me should you have any queries.

Thank you for your consideration.

Regards

[redacted]

PAUL NEWTON
Research student

Department of Emergency Medical Care & Rescue
P O Box 1334, DURBAN, 4000, Tel: (031) 373 5203, Fax: (031) 373 5201
e-mail:pauln@dut.ac.za www.dut.ac.za

Appendix 7.8: Letter of approval to conduct research with the KwaZulu-Natal Department of Health

health

Department:
Health
PROVINCE OF KWAZULU-NATAL

Health Research & Knowledge Management sub-component
10 – 103 Natalia Building, 330 Langalibalele Street
Private Bag x9051
Pietermaritzburg
3200
Tel.: 033 – 3953189
Fax.: 033 – 394 3782
Email.: hrkm@kznhealth.gov.za
www.kznhealth.gov.za

Reference : **HRKM159/11**
Enquiries : **Mrs G Khumalo**
Telephone : 033 – 3953189

18 November 2011

Dear Mr P R Newton

Subject: Approval of a Research Proposal

1. The research proposal titled **'The appropriateness of Emergency Medical Service dispatch in the eThekwini Health District of KwaZulu-Natal'** was reviewed by the KwaZulu-Natal Department of Health.

The proposal is hereby **approved** for research to be undertaken at eThekwini EMRS.

2. You are requested to take note of the following:
   a. Make the necessary arrangement with the identified facility before commencing with your research project.
   b. Provide an interim progress report and final report (electronic and hard copies) when your research is complete.

3. Your final report must be posted to **HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200** and e-mail an electronic copy to hrkm@kznhealth.gov.za

For any additional information please contact Mrs G Khumalo on 033-3953189.

Yours Sincerely

[redacted]

Dr E Lutge
Chairperson, Health Research Committee
KwaZulu-Natal Department of Health
Date: 21/11/2011.

uMnyango Wezempilo . Departement van Gesondheid

Fighting Disease, Fighting Poverty, Giving Hope

Appendix 7.9: Ratification of research by the Higher Degree Committee of the Durban University of Technology

DURBAN UNIVERSITY of TECHNOLOGY

26 August 2011

Reference: Proposal Ratification: PR NEWTON, Student number 19301652

Dear Mr. Newton

MASTERS DEGREE OF TECHNOLOGY: EMERGENCY MEDICAL CARE AND RESCUE

This serves to confirm the ratification of your research proposal by the Higher Degrees Committee, at its meeting on 18 August 2011, as follows:

1. Research proposal and provisional dissertation title:

   AN EVALUATION OF THE APPROPRIATENESS OF EMERGENCY MEDICAL SERVICE (EMS) RESPONSES IN THE ETHEKWINI HEALTH DISTRICT OF KWAZULU-NATAL

   Supervisor: Mr. R Naidoo

   Co-supervisor: Prof P Brysiewicz

   Please note that any proposed changes in the dissertation title require the approval of your supervisor/s, the Faculty Research Committee, as well as ratification thereof by the Higher Degrees Committee.

2. Research budget to the amount of **R8 663.00**

   Please note that this funding is not a scholarship or bursary and is therefore not paid directly to you, but is controlled by your supervisor. Any proposed changes to use of this funding allocation require the approval of your supervisor and the Faculty Research Committee.

The Institutional Research Committee has stipulated that:

(a) The funding for the Research budget allocated to you is subject to compliance with the Intellectual Property Rights from Publicly Financed Research and Development Act No. 51, 2008 (including the Regulations) in force from time to time;

(b) This University retains the ownership of any Intellectual Property (patent, design, etc.) registered in respect of the results of your Masters/Doctors Degree in Technology studies as a result of the award and the provisions of the above Act;

(c) Should any amounts accrue to you in respect of the disposal of any tangible assets developed or created during the course and scope of your Masters/Doctors Degree in Technology, such amount will first be directed towards repaying the University the funding investment which the University has made in approving your request for funding, with the balance being retained by you;

(d) If the University provided the equipment/materials for the creation of artefacts, this cost must be refunded to the University if such artefacts are sold;

(e) Should you find any of the terms above not acceptable then you are given the option to decline the Research budget award to your project in writing.

May we remind you that in terms of Rule G25(2)(b), if you fail to obtain the Masters/Doctors degree within the maximum time period allowed after first registering for the qualification, Senate may refuse to renew your registration or may impose any conditions it deems fit. You may apply to the Faculty Research Committee for an extension.

Please note that you are required to re-register each year.

Should you experience any problems relating to your research, your supervisor must be informed of the matter as soon as possible. If the difficulties persist, you should then approach your Head of Department and thereafter the Executive Dean of the Faculty.

Please refer to the 2011 General Rule Book concerning the rules relating to postgraduate studies, which include *inter alia* acceptable minimum and maximum timeframes, submission of thesis/dissertations, etc. You are also advised to read the Postgraduate Students' Guide which is available on the DUT website.

Please do not hesitate to contact this office for any assistance. We wish you success in your studies.

Kind regards,

[redacted]

Prof S Moyo

Interim Director: Postgraduate Development and Support

Cc Faculty officer: Mr V Singh

TIP Research Finance: Ms R Govender

Head of Department: Mr S Naguran

Supervisor: Mr R Naidoo

Appendix 7.10: Safety monitoring and annual recertification letter of approval from the Durban University of Technology Institutional Research Ethics Committee

DURBAN UNIVERSITY *of* TECHNOLOGY

INSTITUTIONAL RESEARCH ETHICS COMMITTEE (IREC)

20 June 2012

Mr P R Newton
C/o Department of Emergency Medical Care
Faculty of Health Sciences
DUT

Dear Mr Newton

Title: An evaluation of the appropriateness of Emergency Medical Services (EMS) responses in the eThekwini Health District of Kwa-Zulu Natal
FHSEC 009/11

The Institutional Research Ethics Committee acknowledges receipt of your Safety Monitoring and Annual Recertification report.

I am pleased to inform you that the study has been approved to continue.

Please note that ethical approval has been extended till **9 May 2013**, if the research is not complete within this time, you will be required to apply for recertification three months before the expiry date.

Yours Sincerely

[redacted]

Dr D. F. Naude
Chairperson: IREC

Appendix 7.11: Description of dispatch within the incident type category

Incident description	Incident type at dispatch: Accident	Assault	Disaster / Major Incident	Inter-hospital Transfer	Maternity	Medical	Motor Vehicle Accident	Obstetric	Total
abdominal pain	0	0	0	0	0	23	0	0	23
abscess/skin infection	0	0	0	0	0	1	0	0	1
dog bite	1	0	0	0	0	0	0	0	1
ante-partum haemorrhage	0	0	0	0	0	0	0	1	1
asthma	0	0	0	0	0	70	0	0	70
blunt object	0	28	0	0	0	0	0	0	28
burns	5	0	0	0	0	0	0	0	5
cancer related	0	0	0	0	0	7	0	0	7
cardiac failure	0	0	0	0	0	11	0	0	11
chest pain	0	0	0	0	0	36	0	0	36
chronic obstructive airway disease	0	0	0	0	0	3	0	0	3
collapse-concious	0	0	0	0	0	14	0	0	14
collapse-unconcious	0	0	0	0	0	55	0	0	55
complicated	0	0	0	0	7	0	0	0	7
cerebro-vascular accident	0	0	0	0	0	20	0	0	20
domestic	18	12	0	0	0	0	0	0	30
diarrhoea & vomitting	0	0	0	0	0	71	0	0	71
diabetes	0	0	0	0	0	25	0	0	25
disaster management	0	0	10	0	0	0	0	0	10
drowning	2	0	0	0	0	0	0	0	2
eclampsia	0	0	0	0	0	0	0	1	1
epileptic	0	0	0	0	0	13	0	0	13
fitting/convulsions	0	0	0	0	0	16	0	0	16
fracture	27	0	0	0	0	0	0	0	27
gunshot wound	0	9	0	0	0	0	0	0	9
head injury	22	0	0	0	0	0	0	0	22
headache	0	0	0	0	0	6	0	0	6
heavy motor vehicle	0	0	0	0	0	0	3	0	3
hypertension	0	0	0	0	0	6	0	0	6
hypotension	0	0	0	0	0	3	0	0	3
hypothermia	0	0	0	0	0	1	0	0	1
inter district hospital transfer	0	0	0	10	0	0	0	0	10
intra-district hospital transfer	0	0	0	368	0	0	0	0	368
Industrial/IOD/WCA	1	0	0	0	0	0	0	0	1
kidney disorder	0	0	0	0	0	5	0	0	5
in labour	0	0	0	0	1	0	0	55	56
light motor vehicle	0	0	0	0	0	0	25	0	25
lower respiratory tract infection	0	0	0	0	0	1	0	0	1
malaise	0	0	0	0	0	40	0	0	40
miscarriage/abortion	0	0	0	0	0	0	0	7	7
motor cyclist	0	0	0	0	0	0	3	0	3
multiple pregnancy	0	0	0	0	0	0	0	1	1
multiple vehicles	0	0	0	0	0	0	22	0	22

rape/sexual assault	0	2	0	0	0	0	0	0	2
normal	0	0	0	0	12	0	0	0	12
normal vaginal delivery	0	0	0	0	0	0	0	1	1
overdose	0	0	0	0	0	13	0	0	13
other	0	0	0	0	0	33	0	1	34
pedestrian	0	0	0	0	0	0	33	0	33
pregnancy induced hypertension	0	0	0	0	0	0	0	1	1
pneumonia	0	0	0	0	0	6	0	0	6
poisoning	0	0	0	0	0	3	0	0	3
post MVA	0	0	0	0	0	0	3	0	3
post assault	0	3	0	0	0	0	0	0	3
pyrexia	0	0	0	0	0	16	0	0	16
psychiatric/psychological	0	0	0	0	0	1	0	0	1
pulmonary tuberculosis	0	0	0	0	0	18	0	0	18
per vagina bleeding	0	0	0	0	0	8	0	7	15
respiratory distress	0	0	0	0	0	35	0	0	35
repatriation	0	0	0	7	0	0	0	0	7
retained placenta	0	0	0	0	0	1	0	0	1
HIV/AIDS	0	0	0	0	0	2	0	0	2
snake bite	1	0	0	0	0	0	0	0	1
sport	1	0	0	0	0	0	0	0	1
stabbing	0	79	0	0	0	0	0	0	79
suicide	0	5	0	0	0	0	0	0	5
train	0	0	0	0	0	0	3	0	3
unknown	0	0	0	0	0	5	0	0	5
unrest	0	18	0	0	0	0	0	0	18
upper respiratory tract infection	0	0	0	0	0	1	0	0	1
Total	78	156	10	385	20	569	92	75	1385

8 REFERENCES

Aldous, C., Rheeder, P. and Esterhuizen, T. 2011. *Writing Your First Clinical Research Proposal*. Cape Town: Juta.

Aldrich, C. A., Hisserich, J. C. and Lave, L. B. 1971. An Analysis of the Demand for Emergency Ambulance Service in an Urban Area. *American Journal of Public Health*, 61 (6): 1156-1169.

American College of Surgeons. 1986. *Hospital and Prehospital Resources for the Optimal Care of the Injured Patient*, Chicago, IL: American College of Surgeons.

American Health Information Management Association. 2007. *Statement on Consistency of Healthcare Diagnostic and Procedural Coding*, 2013. Chicago, IL: American Health Information Management Association.

Anderson, J. 2008. Lights, Siren to Become Optional: Fire Department Rating Its Responses. *The Sun*. B.1. Available: http://dut.summon.serialssolutions.com/link/0/eLvHCXMwY2BQME9LtjBMTDRKMTW2NE40SATmxSTjZEuTNJMkyyRjc_CV16Em4T6WkV5G7kiluZsQA1NqniiDnJtriLOHLqxojE_JyYk3BE23mZoaWRgaizHwJoJWf-eVgHeJpYgzsKYBoypVHFR8igONEmfgiLB09on0D4JyhWBcvWLwVia9whJxYGkNjmldQz0DABwgLAQ (Accessed 17/04/2013).

Andersson, T. and Varbrand, P. 2007. Decision Support Tools for Ambulance Dispatch and Relocation. *The Journal of the Operational Research Society*, 58 (2, Special Issue): 195 - 201.

Bahrami, M. A., Maleki, A., Ezzatabadi, M. R., Askari, R. and Tehrani, G. H. A. 2011. Pre-Hospital Emergency Medical Services in Developing Countries: A Case Study About EMS Response Time in Yazd, Iran. *Iranian Red Crescent Medical Journal*, 13 (10): 735.

Baum, R. S., Alvarez Iii, H. and Cobb, L. A. 1974. Survival after Resuscitation from out-of-Hospital Ventricular Fibrillation. *Circulation*, 50 (6): 1231-1235.

Bausell, R. B. 2006. Translation Research: Introduction to the Special Issue. *Evaluation & the Health Professions*, 29 (1): 3-6.

Berry, M., Blocker, J., Bryant, K., Goodloe, J., Leland, G., Sacra, J., Synovitz, C., Williamson, S. and Woodard, M. 2009. *A Strategic-Based Emergency Medical Services Bluepring for Oklahoma City.* Oklahoma City: City Council of the City of Oklahoma City.

Billittier, A., Moscati, R. and Janicke, D. 1996. A Multisite Survey of Factors Contributing to Medically Uneccesary Ambulance Transports. *Academic Emergency Medicine*, 3: 1046 - 1052.

Black, J. J. M. and Davies, G. D. 2005. International EMS Systems: United Kingdom. *Resuscitation*, 64 (1): 21-29.

Brazier, H., Murphy, A. W., Lynch, C. and Bury, G. 1999. Searching for the Evidence in Pre-Hospital Care: A Review of Randomised Controlled Trials. On Behalf of the Ambulance Response Time Sub-Group of the National Ambulance Advisory Committee. *Journal of Accident & Emergency Medicine*, 16 (1): 18-23.

Brink, H. 2010. *Fundamentals of Research Methodology for Health Care Professionals*. 2 ed. Cape Town: Juta.

British Columbia Ambulance Service. 2012. *British Columbia Ambulance Service*. Available: http://www.bcas.ca/EN/main/about/statistics.html (Accessed 08/06/2013).

Brotcorne, L., Laporte, G. and Semet, F. 2003. Ambulance Location and Relocation Models. *European Journal of Operational Research*, 147 (3): 451-463.

Brown, E. and Sindelar, J. 1993. The Emergent Problem of Ambulance Misuse. *Annals of Emergency Medicine*, 22: 646 - 650.

Brown, L. H., Lerner, E. B., Larmon, B., Legassick, T. and Taigman, M. 2007. Are EMS Call Volume Predictions Based on Demand Pattern Analysis Accurate? *Prehospital Emergency Care*, 11 (2): 199-203.

Butman, A. M., Martin, S. W. and Vomacka, R. W. 1995. *Comprehensive Guide to Pre-Hospital Skills: A Skills Manual for EMT-Basic, EMT-Intermediate, EMT-Paramedic*. Mosby.

Camasso-Richardson, K., Wilde, J. A. and Petrack, E. M. 1997. Medically Unnecessary Pediatric Ambulance Transports: A Medical Taxi Service? *Academic Emergency Medicine*, 4 (12): 1137 - 1141.

Carrol, V. 2006. The Impact of EMS System over-Utilization on a Large Urban EMS Service. *Prehospital Emergency Care*, 10 (1): 122 - 127.

Castren, M., Karisten, R., Lippert, F., Christensen, E. F., Bovim, E., Kvam, A. M., Robertson-Steel, I., Overton, J., Kraft, T., Engerstrom, L. and Garcia-Castril-Riego, L. 2008. Recommended Guidelines for Reporting on Emergency Medical Dispatch When Conducting Research in Emergency Medicine: The Utstein Style. *Resuscitation*, 79: 193 - 197.

Centers for Disease Control and Prevention. 2008. *Guidelines for Field Triage of Injured Patients: Recommendations of the National Expert Panel of Field Triage*, MMWR 2008;57

Chen, J. C., Bullard, M. J. and Liaw, S. J. 1996. Ambulance Use, Misuse, and Unmet Needs in a Developing Emergency Medical Services System. *European Journal of Emergency Medicine*, 3: 73 - 78.

Clawson, J. 1981. Dispatch Priority Training: Strengthening the Weak Link. *Journal of Emergency Medical Services*, 6: 32 - 36.

Clawson, J. 2002. Unnecessary Lights-and-Siren Use: A Public Health Hazard. *Public Management*, 84 (9): 12.

Clawson, J., Cady, G., Martin, R. and Sinclair, R. 1998. Effect of a Comprehensive Quality Management Process on Complience with Protocol in an Emergency Medical Dispatch Centre. *Annals of Emergency Medicine*, 32 (5): 578 - 584.

Clawson, J., Olola, C., Heward, A. and Patterson, B. 2007a. Cardiac Arrest Predictability in Seizure Patients Based on Emergency Medical Dispatcher Identification of Previous Seizure or Epilepsy History. *Resuscitation*, 75 (2): 298-304.

Clawson, J., Olola, C., Heward, A., Patterson, B. and Scott, G. 2008a. Ability of the Medical Priority Dispatch System Protocol to Predict the Acuity of "Unknown Problem" Dispatch Response Levels. *Prehospital emergency care : official journal of the National Association of EMS Physicians and the National Association of State EMS Directors*, 12 (3): 290-296.

Clawson, J., Olola, C., Heward, A., Patterson, B. and Scott, G. 2008b. The Medical Priority Dispatch System's Ability to Predict Cardiac Arrest Outcomes and High Acuity Pre-Hospital Alerts in Chest Pain Patients Presenting to 9-9-9. *Resuscitation*, 78 (3): 298-306.

Clawson, J., Olola, C., Scott, G., Heward, A. and Patterson, B. 2008. Effect of a Medical Priority Dispatch System Key Question Addition in the Seizure/Convulsion/Fitting Protocol to Improve Recognition of Ineffective (Agonal) Breathing. *Resuscitation*, 79 (2): 257-264.

Clawson, J., Olola, C. H., Heward, A., Scott, G. and Patterson, B. 2007b. Accuracy of Emergency Medical Dispatchers' Subjective Ability to Identify When Higher Dispatch Levels Are Warranted over a Medical Priority Dispatch System Automated Protocol's Recommended Coding Based on Paramedic Outcome Data. *Emergency Medicine Journal :* 24 (8): 560-563.

Cobb, L. A., Baum, R. S., Alvarez Iii, H. and Schaffer, W. 1975. Resuscitation from out-of-Hospital Ventricular Fibrillation: 4 Years Follow-Up. *Circulation*, 52 (6 Suppl III): 223 - 235.

College of Physicians and Surgeons of Ontario. 2000. *Medical Records*, Policy Statement #4.12. Toronto: College of Physicians and Surgeons of Ontario.

Cone, D. C., Galante, N. and Macmillan, D. S. 2008. Can Emergency Medical Dispatch Systems Safely Reduce First-Responder Call Volume? *Prehospital Emergency Care : official journal of the National Association of EMS Physicians and the National Association of State EMS Directors*, 12 (4): 479-485.

Craig Lefebvre, R. and Flora, J. A. 1988. Social Marketing and Public Health Intervention. *Health Education & Behavior*, 15 (3): 299-315.

Cummins, R. O., Chamberlain, D. A., Abramson, N. S., Allen, M., Baskett, P. J., Becker, L., Bossaert, L., Delooz, H. H., Dick, W. F. and Eisenberg, M. S. 1991. Recommended Guidelines for Uniform Reporting of Data from out-of-Hospital Cardiac Arrest: The Utstein Style. A Statement for Health Professionals from a Task Force of the American Heart Association, the European Resuscitation Council, the Heart and Stroke Foundation of Canada, and the Australian Resuscitation Council, . *Circulation*, 84: 960 - 975.

Curka, P. A., Pepe, P. E., Ginger, V. F., Sherrard, R. S., Ivy, M. V. and Zacharia, B. S. 1993. Emergency Medical Services Priorty Dispatch. *Annals of Emergency Medicine*, 22 (11): 1688-1695.

Dale, J., Higgins, J., Williams, S., Foster, T., Snooks, H., Crouch, R., Hartley-Sharpe, C., Glucksman, E., Hooper, R. and George, S. 2003. Computer Assisted Assessment and Advice for “Non-Serious” 999 Ambulance Service Callers: The Potential Impact on Ambulance Despatch. *Emergency Medicine Journal*, 20 (2): 178-183.

Dale, J., Williams, S., Foster, T., Higgins, J., Snooks, H., Crouch, R., Hartley-Sharpe, C., Glucksman, E. and George, S. 2004. Safety of Telephone Consultation for "Non-Serious" Emergency Ambulance Service Patients. *Quality and Safety in Health Care*, 13 (5): 363-373.

Delbridge, T. R., Chew Jr, J. L., Conn, A. K., Krakeel, J. J., O'malley, P. J., Ryan, S. D., Spaite, D. W., Stewart, R. D., Suter, R. E. and Wilson, E. M. 1998. EMS Agenda for the Future: Where We Are… Where We Want to Be. *Annals of Emergency Medicine*, 31 (2): 251-263.

Department of Health. 2000. *NHS Plan. A Plan for Investment. A Plan for Reform.* London: Stationary Office.

Department of Health. 2001. *Reforming Emergency Care. First Steps to a New Approach. Winter and Emergency Services Capacity Planning Team.* London: Stationary Office.

Department of Health: Kwazulu-Natal. 2010. *Strategic Plan 2010 - 2014.* Pietermaritzburg: Department of Health: KwaZulu-Natal.

Dickoff, J., James, P. and Wiedenbach, E. 1968. Theory in a Practice Discipline: Part I. Practice Oriented Theory. *Nursing Research*, 17 (5): 415-434.

Dugger, C. W. 2009. South Africa Is Seen to Lag in H.I.V. Fight. *The New York Times*. 19 July 2009

Dunne, R. B., Compton, S., Welch, R. D., Zalenski, R. J. and Bock, B. F. 2003. Prehospital on-Site Triaging. *Prehospital Emergency Care*, 7 (1): 85 - 88.

Edelman, L. S. 2007. Using Geographic Information Systems in Injury Research. *Journal of Nursing Scholarship*, 39 (4): 306-311.

Editors of the American Heritage Dictionary. 2009. *The American Heritage Dictionary of the English Language*. Fourth ed. Boston, MA: Houghton Mifflin Harcourt.

Eisenberg, M. S., Bergner, L. and Hallstrom, A. 1979. Cardiac Resuscitation in the Community. Importance of Rapid Provision and Implications for Program Planning. *Journal of the American Medical Association*, 241: 1905 - 1907.

Ek, B., Edström, P., Toutin, A. and Svedlund, M. 2011. Reliability of a Swedish Pre-Hospital Dispatch System in Prioritizing Patients. *International Emergency Nursing*, In press (0).

Ellis, D. Y. and Sorene, E. 2008. Magen David Adom—the EMS in Israel. *Resuscitation*, 76 (1): 5-10.

Emergency Medical Rescue Service. 2012. February 2012 Report. Emergency Medical Rescue Service, EThekwini.

Emergency Medical Rescue Services: Province of Kwazulu-Natal. nd. *Norms and Standards*. Province of KwaZulu-Natal.

Emergency Medical Society of South Africa. 2012. *The South African Triage Scale (SATS)*. Available: http://emssa.org.za/sats/ (Accessed 17/04/2013).

Estochen, B. M., Souleyrette, R. R. and Strauss, T. 1998. *An Assessment of Emergency Response Vehicle Pre-Deployment Using GIS Identification of High-Accident Density Locations*. Center for Transportation Research and Education, Iowa State University.

Fitch, J. 2007. Response Times: Myths, Measurement and Management. *Journal of Emergency Medical Services*: Available: http://www.jems.com/article/communications-dispatch/response-times-myths44-measure (Accessed 22/07/2012).

Flynn, J., Archer, F. and Morgans, A. 2006. Sensitivity and Specificity of the Medical Priority Dispatch System in Detecting Cardiac Arrest Emergency Calls in Melbourne. *Prehospital and Disaster Medicine*, 21 (2): 72 - 76.

Frank, S. A. and Devilliers, P. J. T. 1995. An Analysis of the Appropriate Use of the Caledon Amblance Servince in the Overburg: A Short Report. *South African Medical Journal*, 85: 1185-1186.

Gardner, G. 1990. The Use and Abuse of the Emergency Ambulance Service: Some of the Factors Affecting the Decision Whether to Call an Emergency Ambulance. *Archives of Emergency Medicine*, 7: 81 - 89.

Geographic Information Systems Unit. 2010. *Kwazulu-Natal Health District and EMRS Bases*. Pretoria: Government Printer.

Gibson, G. 1977. Measures of Emergency Ambulance Effectiveness: Unmet Need and Inappropriate Use. *Journal of the American College of Emergency Physicians*, 6 (9): 389-392.

Global Forum for Health Research. 2002. *10/90 Report on Health Research 2002.* Geneva: Global forum for health research.

Goldberg, R., Zautke, J., Koenigsberg, M., Lee, R., Nagorka, F. and Kling, M. 1990. A Review of Prehospital Care Litigarion in a Larger Metropolitan EMS System. *Annals of Emergency Medicine*, 19: 557 - 561.

Gratton, M. C., Ellison, S. R., Hunt, J. and Ma, O. J. 2003a. Prospective Determination of Medical Necessity for ambulance Transport by Paramedics. *Prehospital Emergency Care*, 7 (4): 466-469.

Gratton, M. C., Ellison, S. R., Hunt, J. and Ma, O. J. 2003b. Prospective Determination of Medical Necessity for Ambulance Transport by Paramedics. *Prehospital Emergency Care*, 7 (4): 466 - 469.

Griggs, T. R., Barringer, M., Klauk, B. and Slome, C. 1977. Impact of Medical Training of Ambulance Service Dispatch. *Journal of American College of Emergency Physicians*, 6 (2): 47-49.

Haddy, R. I., Schmaler, M. E. and Epting, R. J. 1987. Non-Emergency Emergency Room Use in Patients with and without Primary Care Physicians. *Journal of Family Practice*, 24 (4): 389 - 392.

Health Professions Council of South Africa. 2008. National Patients' Rights Charter. In: *Guidelines for Good Practice in the Health Care Professions.* Pretoria: HPCSA.

Health Professions Council of South Africa. 2012. *Protecting the Public and Guiding the Professions*. Available: http://www.hpcsa.co.za/ (Accessed 27 December).

Heward, A., Damiani, M. and Hartley-Sharpe, C. 2004. Does the Use of the Advanced Medical Priority Dispatch System Affect Cardiac Arrest Detection? *Emergency Medicine Journal*, 21: 115 - 118.

Hipskind, J. E., Gren, J. M. and Barr, D. J. 1997. Patients Who Refuse Transportation by Ambulance: A Case Series. *Prehospital and Disaster Medicine*, 12: 278 - 283.

Hung, K. K. C., Cheung, C. S. K., Rainer, T. H. and Graham, C. A. 2009. EMS Systems in China. *Resuscitation*, 80 (7): 732-735.

Jaslow, D., Barbera, J., Johnson, E. and Moore, W. 1998. EMS-Initiated Refusal and Alternative Methods of Transport. *Prehospital Emergency Care*, 2: 18 - 22.

Johnston, C. and King, W. D. 1988. Pediatric Prehospital Care in a Southern Regional Emergency Medical Service System. *Southern Medical Journal*, 12: 1473 - 1476.

Kamper, M., Mahoney, B. D., Nelson, S. and Petterson, J. 2001. Feasability of Paramedic Treatment and Referral of Minor Illness and Injuries. *Prehospital Emergency Care*, 5 (4): 371 - 378.

Karch, S. B., Graff, J., Young, S. and Ho, C.-H. 1998. Response Times and Outcomes for Cardiac Arrests in Las Vegas Casinos. *The American Journal of Emergency Medicine*, 16 (3): 249-253.

Kawakami, C., Ohshige, K., Kubota, K. and Tochikubo, O. 2007. Influence of Socioeconomic Factors on Medically Unnecessary Ambulance Calls. *BMC health services research*, 7: 120.

Keele, R. 2010. *Nursing Research and Evidence-Based Practice*. Jones & Bartlett Learning.

Khorram-Manesh, A., Lennquist Montán, K., Hedelin, A., Kihlgren, M. and Örtenwall, P. 2010. Prehospital Triage, Discrepancy in Priority-Setting between Emergency Medical Dispatch Centre and Ambulance Crews. *European Journal of Trauma and Emergency Surgery*, 37 (1): 73-78.

King, B. G. and Sox, E. D. 1967. An Emergency Medical Service System--Analysis of Workload. *Public health reports*, 82 (11): 995.

Knapp, B. J., Kerns, B. L., Riley, I. and Powers, J. 2009a. EMS-Initiated Refusal of Transport: The Current State of Affairs. *Journal of Emergency Medicine*, 36 (2): 157-161.

Knapp, B. J., Kerns, B. L., Riley, I. and Powers, J. 2009b. EMS-Initiated Refusal of Transport: The Current State of Affairs. *The Journal of emergency medicine*, 36 (2): 157-161.

Knight, S., Olson, L. M., Cook, L. J., Mann, N. C., Corneli, H. M. and Dean, J. M. 2003. Against All Advice: An Analysis of out-of-Hospital Refusals of Care. *Annals of Emergency Medicine*, 42 (5): 689-696.

Kobusingye, O. C., Hyder, A. A., Bishai, D., Hicks, E. R., Mock, C. and Joshipura, M. 2005. Emergency Medical Systems in Low- and Middle-Income Countries: Recommendations for Action. *Bulletin of the World Health Organization*, 83: 626-631.

Krafft, T., Castrillo-Riesgo, L. G., Edwards, S., Fischer, M., Overton, J., Robertson-Steel, I. and Konig, A. 2003. European Emergency Data Project (EED Project): EMS Data-Based Health Surveillance System. *European Journal of Public Health*, 13 (3 Supplement): 85 - 90.

Kwazulu-Natal Department of Health. 2001. *Ethekwini Health District*. Available: http://www.kznhealth.gov.za/ethekwini.htm (Accessed 14 December).

Lammers, R. L., Roth, B. A. and Utecht, T. 1995. Comparison of Ambulance Dispatch Protocols for Nontraumatic Abdominal Pain. *Annals of Emergency Medicine*, 26 (5): 579-589.

Langhelle, A., Lossius, H. M., Silfvast, T., Björnsson, H. M., Lippert, F. K., Ersson, A. and Søreide, E. 2004. International EMS Systems: The Nordic Countries. *Resuscitation*, 61 (1): 9-21.

Levine, S. D., Colwell, C. B., Pons, P. D., Gravitz, C., Haukoos, J. S. and Mcvaney, K. E. 2006. How Well Do Paramedics Predict Admission to the Hospital? A Prospective Study. *The Journal of emergency medicine*, 31 (1): 1 - 5.

Liu, R. 2007. Wuxi Shi Yuan Wai Ji Jiu Yi Liao Fu Wu Ti Xi Zhi Jin Zhan [in Chinese]. *Chinese Journal of Emergency Resuscitation Disaster Medicine*, 2: 225 - 227.

London Ambulance Service NHS Trust. 2013. *What We Do*. Available: http://www.londonambulance.nhs.uk/about_us/what_we_do.aspx (Accessed 26/04/2013).

London Department of Health. 1999. *Department of Health Statistical Bulletin. Ambulance Services 1998-9. Bulletin 1999/16.* London: London Department of Health.

Lu, T. C., Chen, Y. T., Ko, P. C., Lin, C. H., Shih, F. Y., Yen, Z. S., Ma, M. H., Chen, S. C., Chen, W. J. and Lin, F. Y. 2006. The Demand for Prehospital Advanced Life Support and the Appropriateness of Dispatch in Taipei. *Resuscitation*, 71 (2): 171-179.

Macfarlane, C., Van Loggerenberg, C. and Kloeck, W. 2005. International EMS Systems in South Africa--Past, Present, and Future. *Resuscitation*, 64 (2): 145-148.

Mackie, R. M. and Hole, D. 1992. Audit of Public Education Campaign to Encourage Earlier Detection of Malignant Melanoma. *BMJ: British Medical Journal*, 304 (6833): 1012.

Mann, N., Schmidt, T. A. and Cone, D. C. 2004. Defining Research Criteria to Characterize Medical Necessity in Emergency Medical Services: A Consensus among Experts at the Neely Conference. *Prehospital Emergency Care*, 8 (2): 138-153.

Marks, P. J., Daniel, T. D., Afolabi, O., Spiers, G. and Nguyen-Van-Tam, J. S. 2002. Emergency (999) Calls to the Ambulance Service That Do Not Result in the Patient Being Transported to Hospital: An Epidemiological Study. *Emergency Medicine Journal*, 19 (5): 449-452.

Maxwell, M. S., Restrepo, M., Henderson, S. G. and Topaloglu, H. 2010. Approximate Dynamic Programming for Ambulance Redeployment. *INFORMS Journal on Computing*, 22 (2): 266-281.

Mccaig, L. F. and Burt, C. W. 2004. *National Hospital Ambulatory Medical Care Survey: 2002 Emergency Department Summary (Report No 340).* Hyattsville, Maryland: U.S. Department of Health and Human Services, Centres for Disease Control and Prevention, National Centre for Health Statistics, Division of Health Care Statistics.

Mccleay, G., Hamilton, D. and Bowie, P. 1995. Emergency Ambulance Service: An Accident and Emergency Audit. *Medical Audit News*, 5: 137 - 138.

Meents, E. and Boyles, T. 2010. Emergency Medical Services--Poor Response Time in the Rural Eastern Cape. *South African Medical Journal - Suid-Afrikaanse tydskrif vir geneeskunde*, 100 (12): 790.

Miles, M. B. and Huberman, A. M. 1994. *Qualitative Data Analysis: An Expanded Sourcebook*. Thousand Oaks, CA: Sage.

Morris, D. L. and Cross, A. B. 1980. Is the Emergency Ambulance Service Abused. *The British Medical Journal*, 281: 121-123.

Mosby. 2009. *Mosby's Medical Dictionary*. 8th ed.: Elsevier.

National Association of Emergency Medical Service Physicians. 2008. *Emergency Medical Dispatch: Approved by the National Association of Emergency Medical Service Physicians Board of Directors November 20, 2007*. Available: http://dut.summon.serialssolutions.com/link/0/eLvHCXMwQ7QySSwPTI1NzUEn4oEne0NNwn0sI72M3JkYYLfMQWMeVmCCS_GU_GTQALq-EbAbY2ZsAt7FbgZsBAPTtXmEE3w2AVjFg3cZGViCyhwjc4xyF1yZuAnAN_illJZARhLAa0iqElGOt0Wc00iUkwQZ-KFtSwVHSGIQYmBKzRNm4PCFzp6LMISDrvV0d_VzjlSAnuqoAFo84hji7GGl4BgQEOQf5uqi4BSpEOLhquDn6OobHKDg5O8Y5KLg7wZUGeTqHOIfFKzgB1Tm6-QapGBkoKMAGoTkyzA9dN_wgPurFU_qNh34p6UIAP7JeYA (Accessed 26/04/2013)

National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research. 1979. Ethical Principles and Guidelines for the Protection of Human Subjects of Research. Available: http://www.hhs.gov/ohrp/humansubjects/guidance/belmont.html (Accessed 19/07/2013).

National Emergency Medical Service Information System. 2005. Available: http://www.nemsis.org/index.html (Accessed 30/04/2013).

National Fire Protection Association. 2010a. *Nfpa 1710: Standard for the Organisation and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*. Massachusetts: NFPA.

National Fire Protection Association. 2010b. *Nfpa 1720: Standard for the Organisation and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Volunteer Fire Departments*. Massechusetts: NFPA.

National Health Service. 2013. *NHS Direct*. Available: http://www.nhsdirect.nhs.uk/ (Accessed 24/04/2013).

Neely, K. W., Drake, M. E. R., Moorhead, J. C., Schmidt, T. A., Skeen, D. T. and Wilson, E. A. 1997. Multiple Options and Unique Pathways: A New Direction for EMS. *Annals of Emergency Medicine*, 30 (6): 797-799.

Neely, K. W., Eldurkar, J. A. and Drake, M. E. R. 2000a. Can Current EMS Dispatch Protocols Identify Layperson-Reported Sentinel Conditions. *Prehospital Emergency Care*, 4 (3): 238 - 244.

Neely, K. W., Eldurkar, J. A. and Drake, M. E. R. 2000b. Do Emergency Medical Services Dispatch Nature and Severity Codes Agree with Paramedic Field Findings? *Academic Emergency Medicine*, 7: 174 - 180.

Neely, K. W., Norton, R. and Schmidt, T. A. 2000c. The Strenght of Specific EMS Dispatcher Questions for Identifying Patients with Important Clinical Field Findings. *Prehospital Emergency Care*, 4 (4): 322 - 326.

NHS Executive Steering Group. 1996. *Review of Ambulance Performance Standards*. London: Stationary Office.

O' Leary, C., Bury, G., Mccabe, M., Kelly, C., Mcgoldrick, F. and Ward, F. 1987. Ambulance-User Analysis in an Accident and Emergency Department. *Irish Medical Journal*, 80: 422 - 423.

O'cathain, A., Turner, J. and Nicholl, J. P. 2002. The Acceptability of an Emergency Medical Dispatch System to People Who Call 999 to Request an Ambulance. *Emergency Medicine Journal*, 19 (2): 160-163.

Ong, M. E. H., Ho, K. K., Tan, T. P., Koh, S. K., Almuthar, Z., Overton, J. and Lim, S. H. 2009. Using Demand Analysis and System Status Management for Predicting Ed Attendances and Rostering. *The American Journal of Emergency Medicine*, 27 (1): 16-22.

Ong, M. E. H., Tan, E. H., Yan, X., Anushia, P., Lim, S. H., Leong, B. S.-H., Ong, V. Y. K., Tiah, L., Yap, S., Overton, J. and Anantharaman, V. 2008. An Observational Study Describing the Geographic-Time Distribution of Cardiac Arrests in Singapore: What Is the Utility of Geographic Information Systems for Planning Public Access Defibrillation? (Pads Phase I). *Resuscitation*, 76 (3): 388-396.

Osterwalder, J. J. 2004. Insufficient Quality of Research on Prehospital Medical Emergency Care - Where Are the Major Problems. *Swiss Medical Weekly*, 134 (27-28): 389 - 394.

Palazzo, F. F., Warner, O. J., Harron, M. and Sadana, A. 1998. Misuse of the London Ambulance Service: How Much and Why? *Journal of accident and emergency medicine*, 15: 368 - 370.

Palumbo, L., Kubincanek, J., Emerman, C., Jouriles, N., Cydulka, R. and Shade, B. 1996. Performance of a System to Determine EMS Dispatch Priorities. *American Journal of Emergency Medicine*, 14 (4).

Patterson, P. D., Baxley, E. G., Probst, J. C., Hussey, J. R. and Moore, C. G. 2006. Medically Unnecessary Emergency Medical Services (EMS) Transports among Children Ages 0 to 17 Years. *Maternal and child health journal*, 10 (6): 527-536.

Patterson, P. D. and Moore, C. G. 2006. Inter-Rater Agreement Using One Component of the Neely Confernce Creteria for Determining Medical Necessity of EMS Transports. *Prehospital Emergency Care*, 10 (1): 121 - 122.

Payne, G. H., Fang, J., Fogle, C. C., Oser, C. S., Wigand, D. A., Theisen, V. and Farris, R. P. 2010. Stroke Awareness: Surveillance, Educational Campaigns, and Public Health Practice. *Journal of Public Health Management and Practice*, 16 (4): 345-358.

Peleg, K. and Pliskin, J. S. 2004. A Geographic Information System Simulation Model of Ems: Reducing Ambulance Response Time. *The American Journal of Emergency Medicine*, 22 (3): 164-170.

Pennycook, A., Makower, R. and Morrison, W. 1991. Use of the Emergency Ambulance Service to an Inner City a&E Department - a Comparison of GP and 999 Calls. *Journal of the Royal Society of Medicine*, 84: 726 - 727.

Peters, J. and Hall, G. B. 1999. Assessment of Ambulance Response Performance Using a Geographic Information System. *Social Science and Medicine*, 49 (11): 1551-1566.

Pillay, S. ed. 2003. *Emergency Medical Dispatcher Manual.* Durban: College of Emergency Care.

Pointer, J. E., Levitt, M. A., Young, J. C., Promes, S. B., Messana, B. J. and Ader, M. 2001. Can Paramedics Using Guidelines Accurately Triage Patients. *Annals of Emergency Medicine*, 38 (3): 268 - 277.

Polit, D. F. and Beck, C. T. 2010. *Essentials of Nursing Research: Appraising Evidence for Nursing Practice*. 7th ed. Philadelphia: Wolters Kluwer Health / Lippincott Williams & Wilkens.

Pons, P. T., Haukoos, J. S., Bludworth, W., Cribley, T., Pons, K. A. and Markovchick, V. J. 2005. Paramedic Response Time: Does It Affect Patient Survival? *Academic Emergency Medicine*, 12 (7): 594-600.

Pons, P. T. and Markovchick, V. J. 2002. Eight Minutes or Less: Does the Ambulance Response Time Guideline Impact Trauma Patient Outcome? *The Journal of emergency medicine*, 23 (1): 43-48.

Pozner, C. N., Zane, R., Nelson, S. J. and Levine, M. 2004. International EMS Systems: The United States: Past, Present, and Future. *Resuscitation*, 60 (3): 239-244.

Priority Dispatch Corporation. 2005. Pro Q.A. 3.4 Priority Dispatch User Guide (computer software and manual).

Rademaker, A. W., Powell, D. G. and Read, J. H. 1987. Innapropiate Use and Unmet Need in Paramedic and Non-Paramedic Ambulance Systems. *Annals of Emergency Medicine*, 16: 553-556.

Rajagopalan, H. K., Saydam, C. and Xiao, J. 2008. A Multiperiod Set Covering Location Model for Dynamic Redeployment of Ambulances. *Computers & Operations Research*, 35 (3): 814-826.

Republic of South Africa. 1974. *Health Professions Act 56 of 1974*. Pretoria: Government Printer.

Robinson, V. 1981. Call Screening Targets False Emergencies. *The International Fire Chief*, 47: 16-18.

Rucker, D. W., Edwards, R. A., Burstin, H. R., O'niel, A. C. and Brennan, T. A. 1997. Patient-Specific Predictors of Ambulance Use. *Annals of Emergency Medicine*, 29 (4): 484 - 490.

Scalice, B. 1978. Abuse of EMS: Is There a Remedy. *Emergency*, 10: 51-56.

Schaefer, R., Rea, T., Plorde, M., Peiguss, K., Goldberg, P. and Murray, J. 2002. An Emergency Medical Services Program of Alternate Destination of Patient Care. *Prehospital Emergency Care*, 6 (3): 309 - 314.

Schmidt, T. A., Cone, D. C. and Mann, N. C. 2004. Criteria Currently Used to Evaluate Dispatch Triage Systems: Where Do They Leave Us? *Prehospital Emergency Care*, 8 (2): 126 - 129.

Schmidt, T. A., Neely, K. W., Adams, A. L., Newgard, C. D., Wittwer, L., Muhr, M. and Norton, R. 2003. Is It Possible to Safely Triage Callers to EMS Dispatch Centers to Alternative Resources? *Prehospital Emergency Care*, 7 (3): 368 - 374.

Selden, B., Schnitzer, M., Nolan, F. and Veronesi, R. 1991. The "No-Patient" Run: 2698 Patients Evaluated but Not Transported by Paramedics. *Prehospital and Disaster Medicine*, 6: 135 - 142.

Setzler, H., Saydam, C. and Park, S. 2009. EMS Call Volume Predictions: A Comparative Study. *Computers & Operations Research*, 36 (6): 1843-1851.

Shah, C. H. M. S., Ismail, I. M. and Mohsin, S. S. J. S. 2008. Ambulance Response Time and Emergency Medical Dispatcher Program: A Study in Kelantan, Malaysia. *The Southeast Asian Journal of Tropical Medicine and Public Health*, 39 (6): 1150.

Siler, K. F. 1975. Predicting Demand for Publicly Dispatched Ambulances in a Metropolitan Area. *Health services research*, 10 (3): 254-263.

Slovis, C. M., Carruth, T. B., Seitz, W. J., Thomas, C. M. and Elsea, W. R. 1985. A Priority Dispatch System for Emergency Medical Services. *Annals of Emergency Medicine*, 14: 1055-1060.

Snooks, H., Foster, T. and Nicholl, J. 2004a. Results of an Evaluation of the Effectiveness of Triage and Direct Transportation to Minor Injuries Units by Ambulance Crews. *Emergency Medicine Journal*, 21: 105 - 111.

Snooks, H., Kearsley, N., Dale, J., Halter, M., Redhead, J. and Cheung, W. 2004b. Towards Primary Care for Non-Serious 999 Callers: Results of a Controlled Study of "Treat and Refer" Protocols for Ambulance Crews. *Quality and Safety in Health Care*, 13 (6): 435-443.

Snooks, H., Williams, S., Crouch, R., Foster, T., Hartley-Sharpe, C. and Dale, J. 2002. Nhs Emergency Response to 999 Calls: Alternatives for Cases That Are Neither Life Threatening nor Serious. *British Medical Journal*, 325: 330 - 333.

Snooks, H., Wrigley, H., George, S., Thomas, E., Smith, H. and Glasper, A. 1998. Appropriateness of Use of Emergency Ambulances. *Journal of accident and emergency medicine*, 15: 212-218.

Snooks, H. A., Dale, J., Hartley-Sharpe, C. and Halter, M. 2004c. On-Scene Alternatives for Emergency Ambulance Crews Attending Patients Who Do Not Need to Travel to the Accident and Emergency Department: A Review of the Literature. *Emergency Medicine Journal*, 21 (2): 212-215.

Sporer, K. A., Craig, A. M., Johnson, N. J. and Yeh, C. C. 2010. Does Emergency Medical Dispatch Priority Predict Delphi Process-Derived Levels of Prehospital Intervention? *Prehospital and Disaster Medicine*, 25 (4): 309 - 317.

Sporer, K. A., Johnson, N. J., Yeh, C. C. and Youngblood, G. M. 2008. Can Emergency Medical Dispatch Codes Predict Prehospital Interventions for Common 9-1-1 Call Types? *Prehospital emergency care : official journal of the National Association of EMS Physicians and the National Association of State EMS Directors*, 12 (4): 470-478.

Sporer, K. A., Youngblood, G. M. and Rodriguez, R. M. 2007. The Ability of Emergency Medical Dispatch Codes of Medical Complaints to Predict Als Prehospital Interventions. *Prehospital emergency care : official journal of the National Association of EMS Physicians and the National Association of State EMS Directors*, 11 (2): 192-198.

Statistics South Africa. 2008. *Community Survey 2007: Statistical Release Basic Results Municipalities.* Pretoria: Statistics South Africa.

Statistics South Africa. 2011. *Mid-Year Population Estimates 2011*. (Notice P0302) Pretoria: Statistics South Africa. Available: http://www.statssa.gov.za/publications/P0302/P03022011.pdf (Accessed 30/04/2013)

Stedman, T. L. 2005. *Stedman's Medical Dictionary*. 28th ed. Baltimore: Lippencot Williams and Wilkens.

Stout, J., Pepe, P. E. and Mosesso, V. N. 2000. All-Advanced Life Support vs Tiered-Response Ambulance Systems. *Prehospital Emergency Care*, 4 (1): 1-6.

Svenson, J. E. 2000. Patterns of Use of Emergency Medical Transport: A Population Based Study. *American Journal of Emergency Medicine*, 18 (2): 130 - 134.

Takei, Y., Inaba, H., Yachida, T., Enami, M., Goto, Y. and Ohta, K. 2010. Analysis of Reasons for Emergency Call Delays in Japan in Relation to Location: High Incidence of Correctable Causes and the Impact of Delays on Patient Outcomes. *Resuscitation*, 81 (11): 1492-1498.

Teamsun. 2012. *News Centre*. Available: http://www.teamsun.com.cn/en/News/1023.shtml (Accessed 30/04/2013).

Thakore, S., Mcgugan, E. and Morrison, W. 2002. Emergency Ambulance Dispatch: Is There a Case for Triage? *Journal of the Royal Society of Medicine*, 95 (3): 126 - 129.

The Council of Ambulance Authorities Inc. 2009. *Response to the Ahmac Discussion Paper on Proposals for Legislative Support for Healthcare Identifiers and Privacy.* Flinders Park SA: The Council of Ambulance Authorities.

The Nuremberg Code. 1949. *Trials of War Criminals before the Nuremberg Military Tribunals under Control Council Law*. The Nuremburg Trials.

The Provincial Decision-Making Enabling (Provide) Project. 2005. *A Profile of Kwazulu-Natal: Demographics, Poverty, Inequality and Unemployment.* Elsenburg: Department of Agriculture.

The State of Florida. 2008. *Bureau of Emergency Medical Services.* Florida Department of Health. Available: http://www.doh.state.fl.us/demo/ems/Providers/commhome.html (Accessed 29 September 2011).

Tsai, A. and Kallsen, G. 1987. Epidemiology of Pediatric Prehospital Care. *Annals of Emergency Medicine*, 16 (3): 284 - 292.

United States Department of Labour. 2013. *Occupational Employment Statistics*. Available: http://www.bls.gov/oes/current/oes292041.htm#ind (Accessed 08/06/2013).

Vardy, J., Mansbridge, C. and Ireland, A. 2009. Are Emergency Department Staffs' Perceptions About the Inappropriate Use of Ambulances, Alcohol Intoxication, Verbal Abuse and Violence Accurate? *Emergency Medicine Journal*, 26: 164 - 168.

Victor, C. R., Peacock, J. L., Chazot, C., Walsh, S. and Holmes, D. 1999. Who Calls 999 and Why? A Survey of the Emergency Workload of the London Ambulance Service. *Journal of accident and emergency medicine*, 16: 174 - 178.

Vukmir, R. B. 2006. Survival from Prehospital Cardiac Arrest Is Critically Dependent Upon Response Time. *Resuscitation*, 69 (2): 229-234.

Wilson, S., Cooke, M., Morrel, R., Bridge, P. and Allen, T. 2002. A Systematic Review of the Evidence Supporting the Use of Priority Dispatch of Emergency Ambulances. *Prehospital Emergency Care*, 6 (1): 42-49.

Zacharia, B. S., Bryan, D., Pepe, P. E. and Griffin, M. 1992. Follow-up and Outcome of Patients Who Decline or Are Denied Transport by EMS. *Prehospital and Disaster Medicine*, 7: 359 - 363.

Zetron International. 2008. A State of the Art Communication System for Kwazulu-Natal Province: Dcs-5020 Improves South African Emergency Readiness. *International Advantage Newsletter* magazine. Available: http://www.zetron.com/Portals/0/PDFs/case_studies/other/005-7536.pdf (Accessed 17/04/2013)