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A clinical audit of responses by an emergency department: medical emergency team, within a 469 bed private hospital in Gauteng, South Africa, from 1st January 2010 to 31st December 2010

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A CLINICAL AUDIT OF RESPONSES BY AN EMERGENCY DEPARTMENT: MEDICAL EMERGENCY TEAM, WITHIN A 469 BED PRIVATE HOSPITAL IN GAUTENG, SOUTH AFRICA, FROM 1ST JANUARY 2010 TO 31ST DECEMBER 2010.

By

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584971

A research report presented to the

Faculty of Health Sciences, University of the Witwatersrand

in partial fulfilment for the degree

of

Master in Science in Medicine: Emergency Medicine.

Supervisor: Professor E Kramer

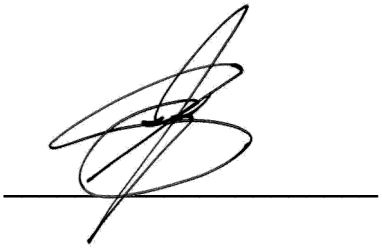
Johannesburg, November 2015.

Declaration

I, Shane Kotzé, declare that this research report is my own work. It is being submitted in partial fulfillment for the degree of Masters in Science in Medicine: Emergency Medicine to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

I further declare that I have not intentionally or unintentionally plagiarised any person's work and that all work used from others or with the assistance of others have been acknowledged or referenced.

I further declare that this research project has been undertaken in accordance with the approval of the Human Research Ethics Committee (Medical), clearance certificate number M111111.



Shane Kotzé

The 9th day of November 2015.

Dedication

I dedicate this research report to:

- My wife, Nicola, for without you I would never have our three precious children Ann, Joshua and Christopher, nor would I have been able to undertake this venture. Your love, support and tolerance mean everything to me.

- My parents: Sarel and Jeanette, for all your selfless sacrifices to educate me and for your wisdom.

- Friends and family who have journeyed to our Creator – you are always with me in spirit; you give me courage to conquer my fears and strength to face the unknown. You are angels who walk with me.

"Salus Aegroti Suprema Lex."

My patient's wellbeing is my highest calling, my life.

Abstract

Introduction

Patients often deteriorate when in hospital, which may result in unscheduled admission to Intensive Care Units, cardiac arrest and possibly death. Medical Emergency Teams (MET) have been instituted in hospitals to mitigate these patient critical events.

Aim

The aim of this clinical audit was to appraise the practices of a MET in a large, private South African hospital.

Method

A retrospective, transverse, observational analysis of 278 MET responses (which occurred in 2010) was undertaken.

Results

Males accounted for 57.2% of MET responses. Males further accounted for 60.9% of cardiac arrests. Females had a higher mortality compared to males.

Age analysis showed a multimodal age distribution. A mean overall age of 56.2 years was observed. A paediatric median of 0.583 years was found whilst a mean of 60.432 years was found in the adult category. An increase in frequency of MET responses was observed with advancing age with associated poor outcome.

The MET functioned hospital-wide. Intensive care unit (ICU) and high care unit (HCU) areas accounted for the majority of MET responses and cardiac arrest prevalence. Similarly, ICU and HCU areas had a high mortality at the end of MET responses – 33% to 80% mortality.

No statistically significant difference in activation frequency occurred between days of the week. No “weekend effect” could be immediately demonstrated. Public holidays proved to be difficult to objectively analyse with regards to prevalence of MET responses.

A peak in MET response frequency was demonstrated between 03h00 to 03h59. A minimal increased night-time prevalence was found but was not statistically significant. An increase in mortality was noted for cardiac arrest occurring at night.

The prevalence of cardiac arrest was 0.324 per 100 admissions. The return of spontaneous circulation (ROSC) rate for the MET was 62.7%. The cardiopulmonary resuscitation (CPR) survival rate at the end of MET responses was 58.2%.

A total of 596 man-hours were expended on MET responses. The average MET response duration was 26 minutes.

Conclusion

The MET in operation at the Hospital in this audit is a combined MET and Heart Arrest Team. The MET operates hospital-wide, 24 hours a day and is internationally comparable.

Acknowledgements

Firstly, I wish to thank Professor Efraim Kramer for your infectious passion for Emergency Medicine. Your guidance and mentorship in my career and academia is greatly appreciated.

Secondly, Doctors Alison Bentley and Isabel Coetzee: your simplistic approach to a mammoth task has made the seemingly impossible, possible.

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Abbreviations

- **ACLS®:** Advanced Cardiac Life Support.
- **ATLS®:** Advanced Trauma Life Support.
- **CCOT:** Critical Care Outreach Team.
- **CPR:** Cardiopulmonary Resuscitation.
- **CICU:** Cardiac Intensive Care Unit.
- **DNAR:** Do Not Attempt Resuscitation.
- **ED:** Emergency Department.
- **GHCU:** General High Care Unit.
- **HCU:** High Care Unit
- **the Hospital:** the hospital at which the study was based.
- **ICU:** Intensive Care Unit.
- **MICU:** Medical and Cardiothoracic Intensive Care Unit.
- **MET:** Medical Emergency Team.
- **NVHCU:** Neurovascular High Care Unit
- **PALS®:** Paediatric Advanced Life Support.
- **PICU:** Paediatric Intensive Care Unit.
- **the Practice**: the Emergency Department Practice at the Hospital.
- **ROSC:** Return of Spontaneous Circulation.
- **RRS:** Rapid Response System.
- **RRT:** Rapid Response Team.
- **TICU:** Trauma Intensive Care Unit.

Chapter 1: Introduction

1.1. Introduction

It is inevitable that some patients may die during their hospital stay. However, in-hospital death may be prevented in up to 37% of cases[1]. Death, together with cardiac arrest and unplanned intensive care unit (ICU) admission are regarded as adverse events[2].

A system has been developed to minimise and prevent these adverse events, namely the Rapid Response System (RRS)[2].

1.2. Rapid Response Systems

RRS are an internationally accepted and promoted concept[3-5] for the improvement of overall quality of patient care and management of patients whose general condition shows deterioration in-hospital[6].

RRS are described by a 4 pillar analogy namely an afferent pillar, efferent pillar, quality assurance pillar and a management and administrative pillar[5,7,8] as presented in Figure 1.1. The latter two pillars focus on non-clinical parameters; whilst their importance is acknowledged, a detailed discussion is beyond the scope of this Clinical Audit. The afferent and efferent pillars, however, are discussed in detail in sections 1.2.1 and 1.2.2.

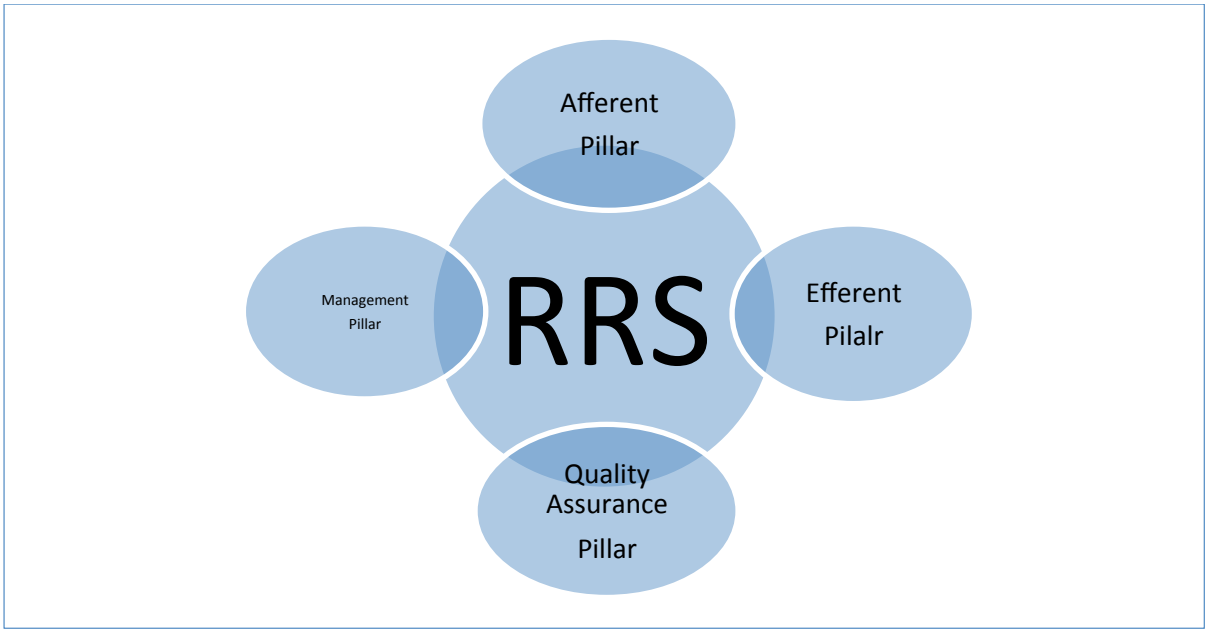


Figure 1.1 - The four pillars of a Rapid Response System (RRS).

1.2.1 Afferent Pillar

The afferent pillar analogy is used to describe the patient monitoring and warning structures in place to alert the RRS to patient deterioration. This pillar relies heavily on observational and subjective functions of the doctors and nurses attending to the patient at a specific time.

For this pillar to function, various RRS objective activation criteria have been proposed[6]. It is accepted that patients who have cardiac arrest show physiological deterioration in the hours prior to arrest[9-11]. Such deterioration is marked by change in the patient's vital data (heart rate, respiratory rate, blood pressure, temperature and level of consciousness)[9-11]. Thus, activation criteria are largely based on vital data changes and propose thresholds beyond which the RRS should be activated[12].

1.2.2 Efferent Pillar

The efferent pillar is a collective name for the response mechanisms of the RRS as demonstrated in Figure 1.2. The efferent pillar is extensively described in literature and numerous modalities of response exist[6,13].

Medical Emergency Team (MET) is one such efferent pillar modality and was proposed and implemented as recently as 1990 in Liverpool Hospital in Sydney, Australia[13]. Subsequently, other response systems have been developed, namely the Rapid Response Team (RRT) and the Critical Care Outreach Team (CCOT).

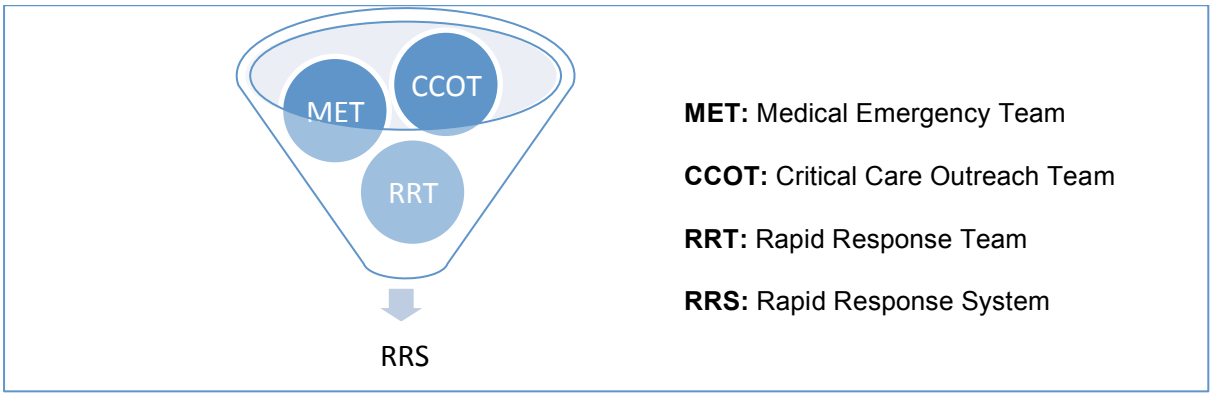


Figure 1.2 - Different Efferent Pillar Formats.

MET is a team comprised of both doctors and nurses[3,7]. RRT is made up of either doctors and nurses or nurses only[3,7], whereas CCOT is comprised of nurses only[13].

These teams ultimately have the same goals: prevent and reduce patient critical (adverse) events (cardiac arrest[8] and unplanned ICU admission)[14] and overall hospital mortality[10,13,15]. It is these goals which translate into monitoring parameters when assessing a RRS success or failure.

In addition to this role of prevention of patient critical events, the RRS have in many hospitals absorbed Code Blue/Heart Arrest teams which historically attended only to patients in cardiac arrest and now function as a single entity[6].

This Clinical Audit, refers to one such RRS and the MET which forms part of it.

1.3. Setting of the Study

1.3.1 The Hospital

This Clinical Audit was based in a large private hospital in Gauteng, South Africa. The Hospital has just under 500, an Emergency Department (ED), 18 operating theatres, 5 specialised ICUs, 2 high care units (HCU), a radiological intervention unit and two cardiac catheterisation laboratories.

The Hospital admits patients of any age, including paediatrics. These patients may be locals to the immediate area. However, a large amount of patients are referred to the Hospital from peripheral areas.

The specialists working in the Hospital are on-site during office hours and after hours on an *ad hoc* basis. As a result of possible specialist unavailability and the need for 24 hour expert resuscitation, the Hospital has implemented a RRS and MET over the past 10 years.

The researcher has an interest in this MET and is involved in the operation and management thereof. As such, the impact of the MET on patient outcome and the interventions performed by the team were questioned. These questions gave rise to this Clinical Audit.

1.3.2 The MET Operations

A monthly duty roster for the MET is compiled by the ward secretary of the ED. The roster is comprised of 2 shifts per day: day shift from 07h00 to 19h00 and night shift from 19h00 to 07h00. The team members are assigned to a shift in advance and recorded on the roster. The triage nurse on duty in the ED during the respective shift confirms the names of the team members for the shift and their presence at the Hospital.

The MET is led by the on-duty medical doctor from the ED who is trained in Advanced Cardiac Life Support (ACLS®), Paediatric Advanced Life Support (PALS®) and Advanced Trauma Life Support (ATLS®). The ED doctor is assisted by 3 professional nurses (ACLS® trained), 1 from the ED, 1 from Neonatal ICU or Paediatric ICU and one from Medical/Cardiothoracic ICU or Trauma ICU. A porter from the ED accompanies the team. The MET functions 24 hours a day and is hospital-wide.

The ED doctor is employed by the private practice managing the ED (the Practice). The Practice is contracted by the Hospital to provide medical services in the ED and to manage the MET.

1.3.3 MET Response Activation

The MET may be activated by any member of the Hospital's staff or through any of the afferent pillars in place at the Hospital such as the CCOT. The MET is activated for all instances of unexpected cardiopulmonary arrest, a sudden change in the patient's condition or for patients needing the advanced resuscitation skills of the MET. The MET is available to patients, visitors and members of staff.

The MET is activated by placing a call to the ED triage nurse on duty at 1 of 2 designated telephone extensions in the ED. The triage nurse verbally dispatches the ED doctor and ED professional nurse to the location requiring assistance. The triage nurse telephonically dispatches the additional 2 team members on duty from the relevant Intensive Care Units per the roster.

1.3.4 MET Response Procedure

With each MET response, the ED doctor takes charge, delegates roles to the team members and evaluates the patient. Where the patient's treating specialist is available, the specialist has the prerogative to take charge or to allow the ED doctor to continue.

The resuscitation process proceeds as is required. At the end of the MET response, the patient can be moved to a location with higher nursing acuity if needed.

The MET is dismissed if the resuscitation is successful and the patient's condition has stabilised, the patient is handed over to the treating specialist or if the patient has died.

The MET response is recorded by the ED professional nurse on a standard form in Utstein format[16] provided by the Hospital Group. A copy of the form is provided to the ED doctor who completes additional clinical notes kept by the Practice. An entry is made into the MET Register in the ED by the clerk on duty, employed by the Practice, for each MET response.

1.4. Summary

A brief overview of RRS, the reason for the study together with the setting and present practice is described in the introductory chapter. Chapter 2 discusses the relevant literature with regard to hospital resuscitation.

Chapter 2: Literature Review

2.1 Introduction

In Chapter 2, a review of the available literature for RRS and Cardiopulmonary Resuscitation (CPR) was undertaken. The focus of the review is to understand key concepts relating to RRS and CPR to better understand and answer the objectives set out in 2.9.2.

2.2 Literature Search Process

A literature study was conducted using PubMed®, MEDLINE®, Cochrane®, SAe-publications, SCOPUS® and MD Consult® databases. Search phrases: “Medical Emergency Team”, “Rapid Response Team”, “Rapid Response System”, “Critical Care Outreach Team”, “Code Blue Team”, “Heart Arrest Team”, “Cardiac Arrest Team” and/or “South Africa” were used. These phrases were combined with a combination of the following “age”, “sex”, “weekend”, “public holiday”, “location” and “outcome”. Results returned were appraised individually and a summary of their findings relevant to this Clinical Audit are presented in sections 2.3 to 2.8.

2.3 South African Context

A paucity of research on resuscitation and RRS exists in South Africa. Using the literature search process described in section 2.2, only pre-hospital CPR statistics could be obtained for South Africa. Stein[17] reported in a pre-hospital retrospective analysis, that 21% patients in cardiac arrest, in the Johannesburg pre-hospital setting, had return of spontaneous circulation (ROSC).

The researcher found no data pertaining to cardiac arrest mortality and CPR statistics in-hospital for South Africa. In addition, no published data on RRS in South Africa could be sourced.

2.4 Cardiopulmonary Resuscitation

CPR statistics are well researched and documented according to a standardised Utstein-style template of reporting[16]. The overall in-hospital survival rate internationally for CPR varies between 10% and 18%[1,7,10].

Despite nearly 50 years which have passed since the conception of modern CPR, survival from CPR has not changed[18,19]. Cardiac arrest has a poor overall patient outcome in-hospital[9,20]. Patients who undergo cardiac arrest appear to cross a physiological precipice after which modern CPR efforts have a limited effect.

An intermediary measure of success of CPR is ROSC. ROSC is a measure of immediate success of CPR whereas “survival” refers long-term survival from cardiac arrest.

2.5 Rapid Response Systems

2.5.1 Promotion of Rapid Response Systems

The United States Institute for Healthcare Improvement’s 100 000 Lives campaign in 2004 was a driving force behind the implementation of RRS[21-23]. This same Institute reiterated the importance of RRS in 2006 with its 5 Million Lives Campaign[22].

Further to this, given the scientific basis of the proven Chain of Survival which RRS facilitate, the use of RRS can be supported[5,20,24]. The Chain of Survival is a concept

galvanised in the ACLS® course which promotes early access, early CPR, early defibrillation and early advanced care[25]. RRS ensures all these links are expediently provided to the patient.

Tibbals and van der Jagt[13] describe non-implementation of RRS as unethical. Sakai[8] suggested RRS be used until proven harmful and describes RRS as “de facto standard” in healthcare. Given the absence of damaging effects of RRS, literature consequently pleads that these systems be implemented[22]. These are contentious statements when research has shown conflicting outcomes as discussed in section 2.6.

In paediatric hospitals, however, data is clear and a statistically significant improvement in critical events and overall hospital mortality is documented[4,5,13]. Unanimity exists that RRS make a difference in the paediatric population and their use strongly supported.

2.5.2 Markers of outcome

Peberdy *et al*[6] suggested that the most important measure of success of a RRS is patient outcome. By the nature of RRS, outcome equates to survival. Standard reporting formats for survival are binary:

- Status of the patient at the end of RRS activation: dead or alive[6].
- Status of the patient at hospital discharge: dead or alive[6].

RRS may additionally be evaluated on performance of their primary goals namely:

- Number of unplanned ICU admissions[6].

- Unplanned ICU admissions result in organisational and administrative issues – for example staffing of the Units. As a result, it is preferable for unplanned admissions to be minimised.

- Incidence of cardiac arrest in the patient population[6].
  - Unexpected cardiac arrest is an unwanted patient event[6]. Ultimately prevention of such an event is desirable.
- Overall hospital mortality[6].
  - By the nature of a hospital, patients should leave in a better state of health than when they arrived. Mortality is therefore a parameter which should be mitigated in hospitals[6].

2.5.3 Presentation of outcome

Different formats for outcome data presentation of RRS and CPR exist. DeVita *et al*[7] presented cardiac arrest prevalence per 1000 discharges. Chan *et al*[21] and Tibbals and van der Jagt[13], however, presented cardiac arrest prevalence per 1000 admissions (0.19 to 2.45/1000 admissions). Skogvoll and Nordseth[26] provided CPR incidence statistics per 1000 beds per year. Overall hospital mortality was presented by Chan *et al*[21] per 100 admissions (3.22 to 3.09/100 admissions).

Different reporting formats pose a problem to research. Data cannot be directly equated between studies and thus comparison between different MET is troublesome.

2.5.4 Effect of RRS on Hospital Mortality

No consensus exists in literature as to effect of RRS on adult cardiac arrest prevention and overall hospital mortality statistics[9,24,27]. The 2010 International

Consensus on CPR and Emergency Cardiovascular Care Science document on Education, Implementation and Teams, appraised numerous studies on RRS available at the time[27]. No evidence-based decision for or against RRS could be made by the investigators due to conflicting data.

The lack of consensus in studies is explained by significant and often poorly explained inter-hospital variables (discussed in section 2.6) and varying response modalities[6]. Moreover, articles often refer to MET, RRT and CCOT interchangeably and are thus difficult to equate[14,20].

A further compounding factor may be the ethical and logistical dilemma of conducting randomised controlled trials (the accepted gold standard in medical research) on patients in need of emergency care[1,26]. Thus data collected and published are mainly from single institutions where pre and post RRS implementation studies were undertaken[21].

Two key documents, however, exist in literature with a common aim: resolve the problem of inconsistent data collection by standardising nomenclature, variable disclosure and outcome measures[6,7]. These guidelines, however, trivialise complex systems for purposes of comparison.

2.6 Outcome and prevalence of RRS and CPR

In addition to non-standardised formats for outcome presentation, outcome and prevalence of RRS is influenced by many inter-dependent factors unique to each patient and hospital. This provides a further comparative challenge. These factors influencing outcome are discussed in sections 2.6.1 and 2.6.2.

2.6.1 Patient dependent factors influencing outcome and prevalence.

2.6.1.1 Age

Better outcomes are reported in the paediatric patient population[9]. This may be explained by a higher incidence of respiratory abnormalities[9] and an increase in comorbidities in an ageing population[9,26]. Additionally, adults have a higher RRS response prevalence: Jaderling *et al*[28] reported a mean age for RRS ICU admission in an adult population of 65 years. Howell *et al*[29] reported a mean age of 56 years +/- 19.8 years in their adult only study. Parr *et al*[30] showed a mean age of 64.5 years in their study with an age range of 3 to 98 years of age. According to Churpek *et al*[31], an increase in age is associated with an increased risk for cardiac arrest, death and adverse outcomes independent of any vital sign changes.

In a paediatric-only RRS study, Anwar-ul-Haque *et al*[32] reported a median age of 27 months with 39% of patients younger than 1 year. In another paediatric RRS study, Krmpotic and Lobos[33] reported a median age of 14 months with 46% of these patients under 1 year of age.

2.6.1.2 Comorbidities

Comorbidities account for a poor outcome as the patient already has a compromised physiology and then suffers an additional incident[26].

2.6.1.3 Presenting rhythm

Ventricular fibrillation, as the presenting rhythm, is associated with good patient outcomeas the abnormal rhythm can be defibrillated and converted to a perfusing rhythm[17,26].

2.6.1.4 Sex

Skogvoll and Nordseth[26] failed to show that patient sex could be consistently linked to favourable or unfavourable outcome in resuscitated cardiac arrest. In a pre-hospital study by Ahn *et al*[34] female patients had higher chances of survival to hospital discharge.

However, males have a modestly higher prevalence in RRS responses: Parr *et al*[30] reported a prevalence of 55.2% male responses. Simmes *et al*[35] found a male prevalence of RRS responses of 52%, while Beitler *et al*[36] reported a male RRS response prevalence of 57%. Peberdy *et al*[37] showed a male prevalence of cardiac arrest of 58% in their study. Kutsogiannis *et al*[19], Rozen *et al*[38] and Wallace *et al*[39] found a male prevalence of cardiac arrest of 62.3%, 58.3% and 54.5% respectively.

2.6.2 Patient independent factors influencing outcome

Over and above the condition of the patient, the following factors influence RRS outcome namely:

2.6.2.1 Activation criteria

The design of the activation criteria used[6]. Certain criteria may be stricter than others. As a result the RRS may be activated at an early stage which may have a positive effect on patient outcome[6].

2.6.2.2 Location in the hospital

The location within a hospital where the patient deteriorates may influence patient outcome[6,26]. Cardiac arrest mortality in wards is approximately 80% whereas cardiac arrest mortality in an ICU setting can vary between 52% to 100%[38]. A primary aim of

RRS is to limit out of ICU cardiac arrests[23]. Peberdy *et al*[40] motivates this reasoning as follows: ICU cardiac arrest is better monitored and immediat CPR can be instituted. Kutsogiannis *et al*[19] found the highest RRS response prevalence in the coronary care unit.

2.6.2.3 Interventions

Interventions required or performed by the team may have an impact on patient outcome[6]. One hospital's team may only be able to provide basic interventions where another may provide more advanced interventions. Each may be beneficial or deleterious to patient outcome.

2.6.2.4 Nursing factors

Nursing factors have an influence on the use and understanding of RRS. High nursing staff workload results in decreased RRS activation as does nursing inexperience[41]. Unrecognised patient deterioration may be attributed to poor situational awareness of the attending staff[42].

2.6.2.5 Promotion of RRS

Promotion of RRS leads to increased utilisation of the RRS[41] and the subsequent heightened awareness of patient deterioration may account for transient improved patient mortality and therefore improved outcome[4].

2.6.2.6 Time of the day

Time of the day has an influence on RRS activation[18,25,27]. Jones and Bellomo[43] describe an increase in RRS activation between 08h00 and 08h30 and in the 30 minutes prior to nursing handover times. Peberdy *et al*[37] showed higher numbers of

cardiac arrests during the day (highest night time prevalence between 03h00 and 04h00) but with increased cardiac arrest mortality at night.

Furthermore, Peberdy *et al*[37] reports the lowest survival to discharge rate for cardiac arrests occurring between 04h00 and 05h00. Peberdy *et al*[37] ascribe the higher night time mortality to an increase in medication errors, poor psychomotor functioning, decrease in supervision, lack of sleep, lower nurse to patient ratios and less responding professionals in a hospital at night. Postnova *et al*[44] comment that the worst timing for a shift corresponds with the time of natural sleep; this means that a professional will experience the most sleepiness on shift at a time when they would usually be sleeping.

2.6.2.7 Day of the week

Day of the week may influence outcome. Peberdy *et al*[37] found lower cardiac arrest survival rates on weekends and could not provide sound reason for this. Voltz *et al*[45] showed an 18% increase in mortality on weekends and public holidays. Voltz *et al*[45] attribute this to the possibility of a reduced number of trained professionals on site in their institution.

2.7 Limitation of care

Between 2% and 4% of patients admitted to a hospital may die[2]. Patients who are in the process of dying a natural death may trigger the RRS afferent arm[2]. As such, the efferent arm of the RRS may be faced with patients for whom DNAR would be more appropriate than active resuscitation.

Sundararajan *et al*[46] found that in 5% of RRS activations, DNAR would have been appropriate. While Barret[47] found that 30% of patients to whom the RRT responded, should have had a DNAR in place. The RRT then played a role in reclassifying the death of such a patient from unexpected to expected[47]. Chen *et al*[48] warn that this practice may result in a false statistical improvement in outcome.

However, Sundararajan *et al*[46] reiterate the importance of the discussion of treatment limitations and DNAR during RRS responses. Jones *et al*[2] refer to this process as diagnosing dying. Jones *et al*[49] describe the use of RRS for DNAR decisions a possible mismatch of resources as patients who should be receiving palliative care are resuscitated.

Reasons for RRS activation for patients for whom DNAR orders were already in place include failure by the regular treating staff to recognise natural dying, failure to undertake DNAR order discussions prior to deterioration and an unwillingness of the patient, family or physician to accept that limitation of care may be more appropriate than resuscitation[2,46].

2.8 Time spent on RRS responses

DeVita *et al*[7] found that the average time spent on RRS responses was approximately 30 minutes. Similarly, Jacques *et al*[50] reported 74% of RRS responses exceeded 20 minutes with 45% of these lasting between 21 and 30 minutes.

2.9 Aims, Significance and Objectives

2.9.1 Aims

The aim of this Clinical Audit is to quantify the activities of the MET in place at the hospital and attempt to compare the MET to international data.

2.9.2 Objectives

The objectives of this Clinical Audit were to:

- Ascertain the prevalence of MET responses according to sex.
- Ascertain the age distribution of patients to whom the MET responds and compare age to outcome.
- Determine the prevalence of MET responses in specific locations within the Hospital.
- Determine the time of day when MET responses occur.
- Establish the prevalence of MET responses according to day of the week.
- Determine the immediate outcome of MET responses and compare this to the location within the Hospital.
- Investigate the prevalence of CPR for unexpected cardiac arrest within the Hospital.
- Determine the prevalence of CPR for unexpected cardiac arrest according to sex.
- Establish the prevalence of patients for whom the MET was activated where DNAR would have been appropriate.
- Determine the immediate outcome of CPR for unexpected cardiac arrest in the Hospital.

- Determine the immediate outcome of CPR for unexpected cardiac arrest according to sex.
- Determine the day/night distribution of CPR for unexpected cardiac arrest and compare this to outcome.
- Establish the total amount of time spent on MET responses and the mean time per MET response.

2.10 Summary

In chapter 2, the available literature was critically appraised and a set of objectives devised for this Clinical Audit. In Chapter 3, an in-depth discussion of the methods utilised in this Clinical Audit will be presented.

Chapter 3: Methods

3.1 Introduction

Chapter 3 is devoted to the discussion of the Clinical Audit design, methodology, data collection, data analysis as well as the ethical considerations needed for the Clinical Audit.

3.2 Study Design

3.2.1 Clinical Audit

The study was a retrospective, observational, transverse quantitative study using both descriptive and comparative techniques.

3.2.2 Study Population

The study population was defined as all in-patients, staff and visitors of the Hospital to whom the MET responded. As no discrimination was made between these groups during activation of the MET, all responses were recorded in a single MET Register kept in the ED.

3.2.3 Inclusion Criteria

The study included all MET responses during the period of 1 January 2010 to 31 December 2010, entered into the MET Register kept in the ED. This time period was chosen as it would provide the most recent data available with reliable reporting at the time of Research Protocol conception.

The study included duplication of individual patients if the same patient had been attended to more than once by the MET. Thus, the sample included all activations, and was not limited to individual patients.

All entries, irrespective of activation criteria, in the MET Register during the given time period were included in the initial sample. The initial sample included all emergency and non-emergency ward visits by the MET as suggested by Peberdy *et al*[6].

3.2.4 Exclusion Criteria

Where data from a MET response was not comprehensive and impeded data collection, all efforts to obtain the data from alternate sources were made. Failure to obtain comprehensive data resulted in exclusion of the response from the total number of MET responses.

The MET does not respond to the ED. Thus, the ED was automatically excluded from the study.

In instances where the MET was activated for non-emergency reasons (namely insertion of an intravenous cannula, central line and urinary catheter) these responses were finally excluded from the sample.

Where the MET was activated to patients not admitted in the Hospital, these MET responses were excluded from the data in order to conclude the CPR prevalence statistics for this Clinical Audit.

3.3 Data Collection

Data collection was undertaken within the confines of the ED to prevent confidential records leaving the premises. Data collection was conducted between 1 December 2011 and 31 December 2011.

The first step of data collection was to obtain the MET register. All activations during the given time period were identified by the researcher and a comprehensive list of all MET responses was generated as a master list. The second step involved utilising the master list as a reference, patient files of all patients meeting the inclusion criteria were requested from the Practice filing system. The identified files were placed in a lockable storeroom until all files were available. Files were checked against the Register and master list once obtained to ensure no files were omitted.

The third step in the data collection process, involved setting up a Microsoft® Excel® spread-sheet to generate the master list of MET responses. A serial number was subsequently assigned to each MET response in the master list. The patient files were re-numbered with their allocated serial numbers and collated.

The fourth step was to file the master list electronically. Only the serial numbers were used to identify files. The serial numbers became the basis of the data sheet (Appendix D) used in data capturing. All electronic documents were password protected and stored on a personal computer with fingerprint recognition security. A duplicate copy of the documents was stored off-site in a password protected electronic database.

In the data sheet, serial numbers represented the row names, against which the data was entered corresponding with the column names / variables.

Systematically (following the serial number allocation in the data sheet), individual patient files were reviewed and data collected, according to the predetermined variables (Section 3.4). Data obtained was manually entered into a data sheet.

Hereafter, the data were subjected to statistical analysis described in section 3.5.

On completion of data collection, serial numbers were removed from the files. Files were then returned to storage as required by the Practice.

The electronic data collected was finally stored in digital hardcopy with password encryption.

In addition to the data collected by the Researcher, the Hospital manager supplied a set of confidential figures which were used to calculate the CPR prevalence ratios.

3.4 Variables

Variables formed the key data collection points needed for the generation of an audit tool. Variables represented the column names in the data sheet and were chosen to answer the set objectives of the audit. The following variables were measured:

3.4.1 Sex

Sex was recorded as a nominal variable recorded as male or female.

3.4.2 Age

Age was a measurement variable which was recorded as a decimal fraction up to one year of age.

3.4.3 Location

Location within the Hospital was allocated as nominal variables and are defined below. Patients had to be within the confines of the unit at the time of the MET response. Where an in-patient was in-transit or within another location, that location was recorded as the location for the MET response. Each of the locations within the Hospital will be briefly discussed in sections 3.4.3.1 to 3.4.3.6.

3.4.3.1 Operating Theatres and Recovery Area

The Hospital has three separate operating complexes. A main theatre complex, a second gastroenterology and neurovascular complex and lastly an obstetrics and gynaecology theatre complex.

Where a MET response occurred in the recovery area, this was indicated on the data sheet as a subordinate location.

3.4.3.2 Intensive Care Units

The Hospital has 5 ICUs namely:

- Cardiac ICU (CICU)
- Medical and Cardiothoracic ICU (MICU)
- Trauma and Surgical ICU (TICU)
- Paediatric ICU (PICU)
- Neonatal ICU (NICU)

3.4.3.3 High Care Units

The Hospital has 2 HCUs namely:

- General HCU (GHCU)
- Neurovascular HCU (NVHCU)

3.4.3.4 General and Speciality Wards

Discrete ward areas existed in the Hospital with specific specialties admitting patients in respective wards.

- Surgical short stay ward
- Obstetrics and gynaecology ward
- Paediatric ward
- Gastroenterology ward
- Surgical ward A
- Surgical ward B
- Orthopaedic ward
- Medical ward
- Oncology and Neurology ward

3.4.3.5 Procedure or Intervention Areas - 3 areas were identified.

- Dialysis suite
- Radiology Suites
- Radiation oncology suites.

3.4.3.6 Other

Including general public areas, consulting rooms, waiting areas and the pharmacy.

3.4.4 Time of Activation

Time of activation was recorded as exact time in 24 hour format. Exact time was chosen over time periods or working shifts to ensure maximum data could be collected for interpretation.

3.4.5 Duration of Activation

The duration of the MET response was recorded in minutes. The activation duration was recorded from the time the MET was activated until the MET withdrew from the callout.

3.4.6 Day of week

The day of the week that the MET callout took place was recorded as a nominal variable described by the name of the day of the week in the data sheet.

The Hospital performs minimal elective surgeries and functions with reduced staff numbers on public holidays and weekends. As such public holidays, Saturdays and Sundays were of particular interest. The number of public holidays and the corresponding days of the week were ascertained and the MET responses on those days were counted separately. This would allow for a ratio of responses per day to be calculated to allow comparison of a normal working day with public holidays.

3.4.7 Patient category

Patient categories were based on international consensus[6]. Paediatric populations often exist in isolation within paediatric hospitals. As such a paediatric category is not mentioned by Peberdy *et al*[6]. A paediatric group with medical and surgical sub-

groups was added for this Clinical Audit. The specific patient categories are discussed in sections 3.4.7.1 and 3.4.7.2.

3.4.7.1 Adult

All patients 13 years and older primarily admitted for a condition falling under medical and surgical specialities and subspecialties.

3.4.7.2 Paediatric

The Hospital does not admit any patient 13 years or older in the Paediatric Ward or Paediatric ICU. As such, Paediatric refers to all patients less than 13 years primarily admitted for a condition falling under the medical and surgical specialities and subspecialties of paediatrics.

3.4.8 Outcome

The immediate outcome of a MET response was recorded in the data sheet as “Alive” or “Dead”.

3.4.9 CPR

Where CPR was performed this was recorded in the data sheet as CPR “Yes” or “No”. CPR is performed for unexpected cardiac arrest and thus data for unexpected cardiac arrest could be extrapolated from this.

3.4.10 ROSC

The presence of a sustained perfusing cardiac rhythm for 5 minutes and longer was termed ROSC. This was indicated as a “Yes” or “No” on the data sheet.

3.4.11 DNAR

The MET may be erroneously activated where a DNAR decision is made prior to the arrival of the MET or where the treating physician decides at the time of MET activation that resuscitation efforts will be futile. In such cases, this was noted in the data sheet as DNAR “Yes” or “No”.

3.5 Data Analysis

The data sheet was set up in Microsoft® Excel® version 14.0.4760.1000. Data were collected in the data sheet. Data were interpreted using Microsoft® Excel® and GraphPad Instat®.

The researcher conducted the statistical analysis and the services of a statistician were not utilised.

The data analysis needed to answer the questions derived from the Study Objectives set out in section 2.9.2.

3.6 Permission and Ethical Approval

Permission to perform the study was obtained from the Practice (Appendix A), the Hospital and the Hospital Group. The Hospital Group requested anonymity and as such the relevant documentation is confidential.

Ethical approval to perform the study was subsequently obtained from the Human Research Ethics Committee of the University of the Witwatersrand clearance certificate number M111111 (Appendix B) and the Research Committee of the Hospital Group (Appendix C).

3.7 Summary

The research methodology and permissions were discussed in this chapter. From this process, data was obtained and is presented as results in Chapter 4.

Chapter 4: Results

4.1 Introduction

The results of the Clinical Audit are presented in this Chapter. The results have been grouped under the original research objectives to ensure that each objective is answered.

4.2 Summary of sample and excluded responses.

The initial sample found 284 responses.

Responses were excluded according to the exclusion criteria discussed in 3.2.4:

Two responses for insufficient data.

Four responses for non-emergency situations.

This resulted in a final sample of n=278.

4.3 Ascertain the prevalence of MET responses according to sex.

Males accounted for 159 (57.2%) of responses whilst females accounted for the remaining 119 (42.8%).

4.4 Ascertain the age distribution of patients to whom the MET responds and compare age to outcome.

The age distribution and prevalence of responses is shown in Figure 4.1. A mean age of 56.2 years was observed. Fourteen responses were undertaken for children under 1 year of age.

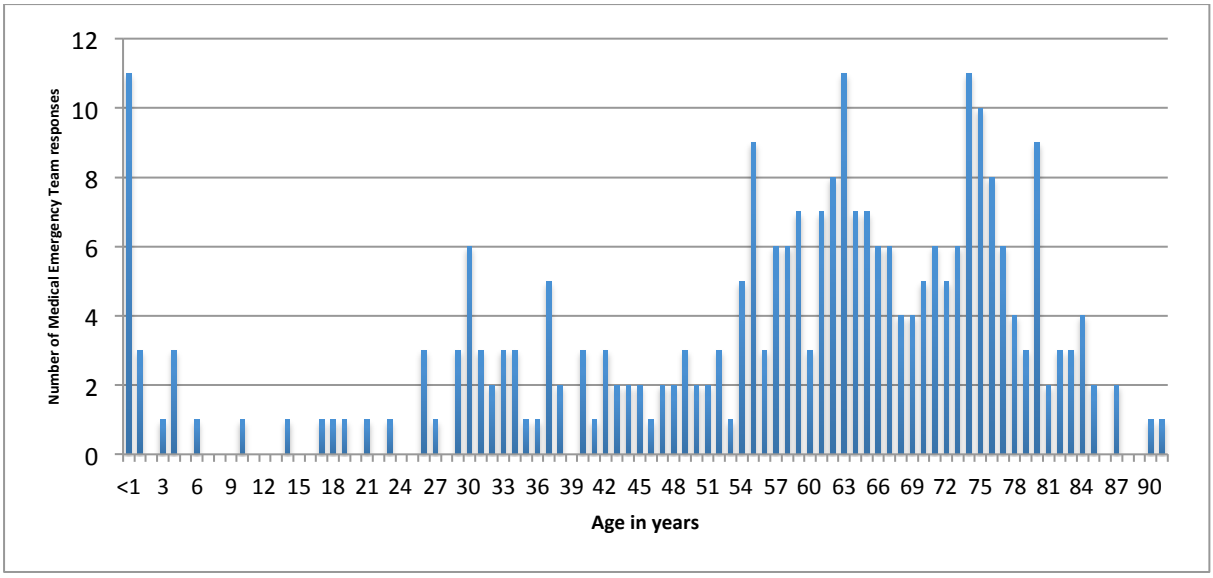


Figure 4.1: Age distribution of Medical Emergency Team responses.

In Figure 4.2, the paediatric (age <13 years) prevalence of MET responses is shown. A median of 0.583 years was obtained for the paediatric sub-category.

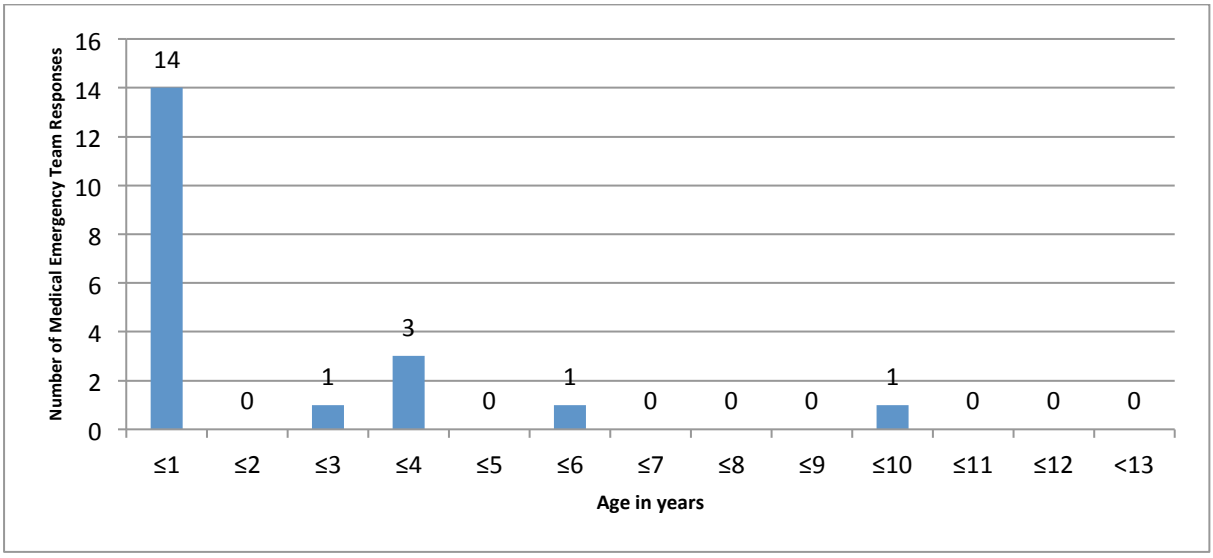


Figure 4.2: Prevalence of MET responses <13 years of age.

Further itemisation of prevalence in children under 1 year of age is presented in Figure 4.3.

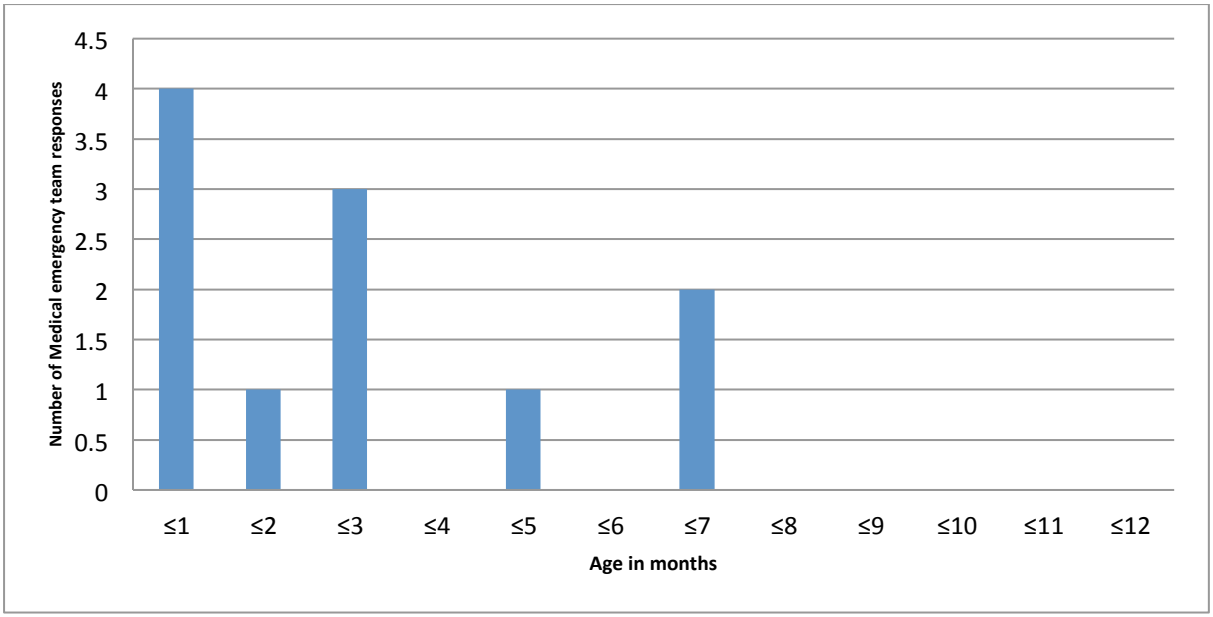


Figure 4.3: Prevalence of MET responses in children <1 year of age.

The adult MET response prevalence is shown in Figure 4.4. A mean adult age of 60.432 years was found.

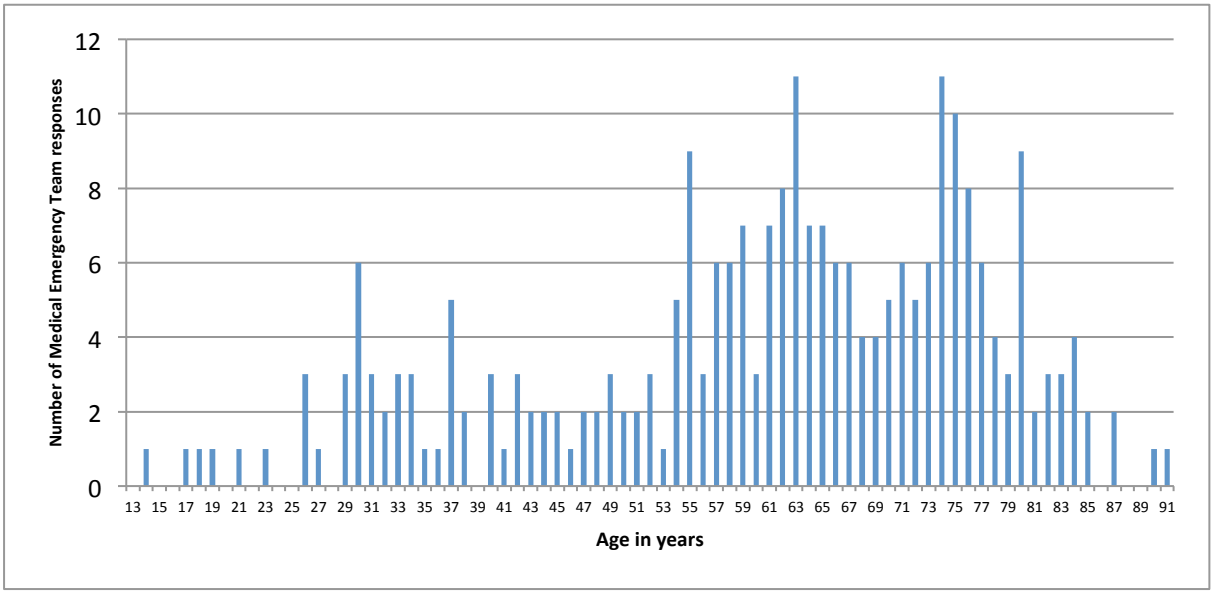


Figure 4.4: Prevalence of MET response in adults (13 years and older).

The number of MET responses ending with patient deaths is shown in Figure 4.5.

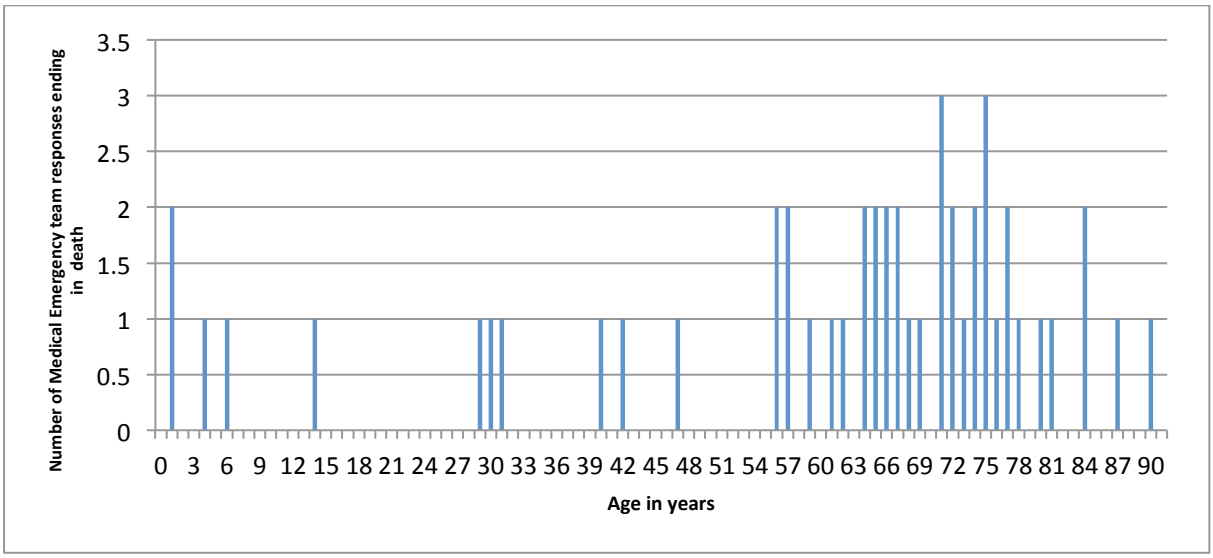


Figure 4.5: Deaths according to age.

4.5 Determine the prevalence of MET responses in specific locations within the Hospital.

In Table 4.1, the prevalence of MET responses in specific locations is demonstrated.

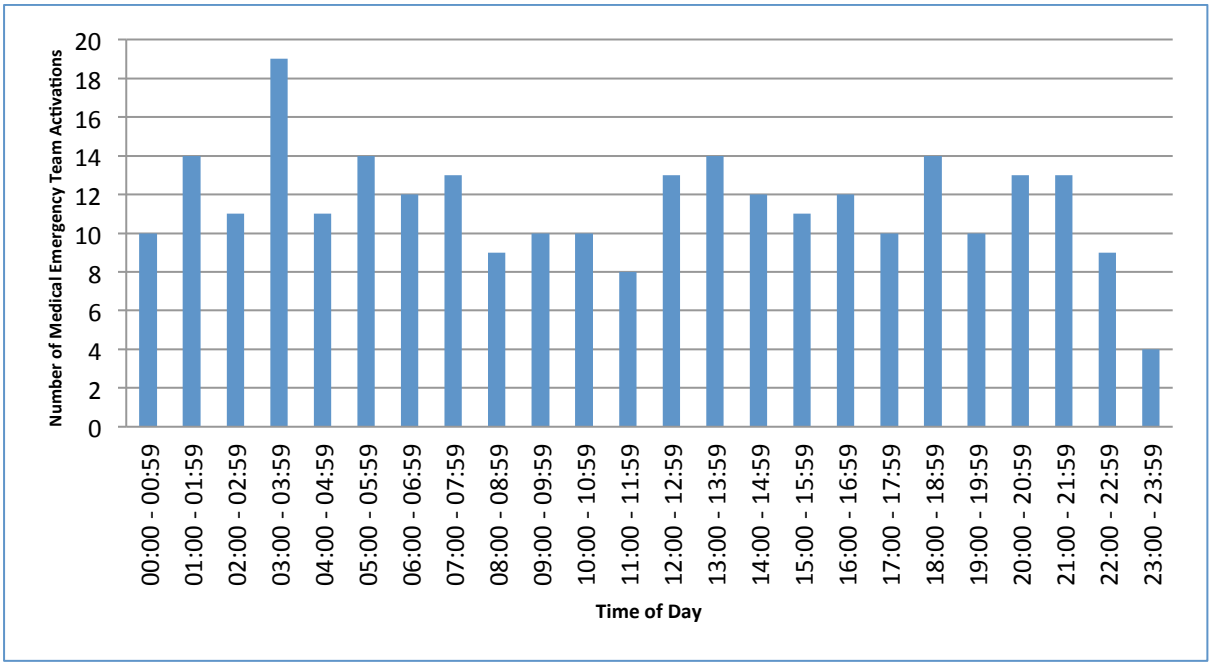
Specific Location	Number of Activations	%
Operating Theatres	4	1.44
Medical and Cardiothoracic ICU	57	20.50
Trauma ICU	46	16.55
Paediatric ICU	11	3.96
Cardiac ICU	37	13.31
Neonatal ICU	5	1.80
General High Care	40	14.39
Neurovascular High Care	14	5.04
Surgical Short Stay Ward	5	1.80
Obstetrics and Gynaecology Ward	3	1.08
Paediatric Ward	0	0
Gastroenterology Ward	11	3.96
General Surgical Ward A	2	0,72
General Surgical Ward B	15	5.19
Orthopaedic Ward	4	1.44
Medical Ward	4	1.44
Oncology and Neurology Ward	9	3.24
Radiology	2	0.72
General Areas	6	2.16
Consulting Rooms	1	0.34
Dialysis Suite	2	0.72

ICU: Intensive Care Unit
MET: Medical Emergency Team

Table 4.1: Prevalence of MET responses according to specific locations.

4.6 Determine the time of day when MET responses occur.

Figure 4.6 shows the prevalence of MET responses according to the time of day.



MET: Medical Emergency Team

Figure 4.6: Time distribution of MET activations.

4.7 Establish the prevalence of MET responses according to day of the week.

Table 4.2 shows the prevalence of MET responses according to days of the week.

Day of week	Number of days (excluding public holidays)	Number of responses (on days not public holidays)	Responses per day (excluding public holidays)	Number of public holidays	Number of responses on public holidays	Responses per day on public holidays
Monday	49	42	0.86	3	6	2
Tuesday	51	40	0.78	1	2	2
Wednesday	51	41	0.80	1	4	4
Thursday	51	36	0.71	1	0	0
Friday	50	38	0.76	3	1	0.33
Saturday	50	36	0.72	2	2	1
Sunday	51	39	0.81	1	3	3

MET: Medical Emergency Team

Table 4.2: Prevalence of MET responses According to Day of the Week.

4.8 Determine the immediate outcome of MET responses and compare this to the location within the Hospital.

Forty nine (17.6%) MET responses ended with a patient who had died.

Table 4.3 shows the immediate outcome of MET responses in specific locations.

Location	Number of responses alive	% Responses alive	Number of responses dead	% Responses Dead
Operating Theatres	2	50	2	50
Medical and Cardiothoracic ICU	48	84	9	16
Trauma ICU	38	81	9	19
Paediatric ICU	9	82	2	18
Cardiac ICU	26	70	11	30
Neonatal ICU	5	100	0	0
General High Care	36	90	4	10
Neurovascular High Care	10	77	3	23
Surgical Short Stay Ward	4	100	0	0
Obstetrics and Gynaecology Ward	3	100	0	0
Paediatric Ward	0	0	0	0
Gastroenterology Ward	9	82	2	18
General Surgical Ward A	1	50	1	50
General Surgical Ward B	12	80	3	20
Orthopaedic Ward	4	100	0	0
Medical Ward	3	75	1	25
Oncology and Neurology Ward	7	78	2	22
Radiology	2	100	0	0
General Areas	7	100	0	0
Consulting Rooms	1	100	0	0
Dialysis Suite	2	100	0	0

ICU: Intensive Care Unit
MET: Medical Emergency Team

Table 4.3: Immediate MET response outcome according to location.

4.9 Investigate the prevalence of CPR for unexpected cardiac arrest within the Hospital.

Of the 278 MET responses, the team performed CPR for unexpected cardiac arrest on 110 occasions (40% of MET responses). This resulted in a prevalence ratio of 0.324 per 100 admissions.

4.10 Determine the prevalence of CPR for unexpected cardiac arrest according to sex.

CPR for unexpected cardiac arrest was performed on 67 males and 43 females to whom the MET responded.

4.11 Establish the prevalence of patients for whom the MET was activated where DNAR would have been appropriate.

Of the 278 MET responses, DNAR order was established for 14 (5%) activations. In 2 instances where DNAR was established, CPR had been commenced.

4.12 Determine the immediate outcome of CPR in unexpected cardiac arrest in the Hospital.

ROSC was achieved in 69 (63%) MET responses where the patient had unexpected cardiac arrest. At the end of MET responses where CPR was performed, the remaining 64 patients (58%) were alive and 46 patients(42%) had died. ROSC and CPR mortality are presented in Tables 4.4 and 4.5 respectively.

Location	ROSC	% ROSC	No ROSC	% No ROSC
Operating Theatres	2	67	1	33
Medical and Cardiothoracic ICU	20	71	8	29
Trauma ICU	9	60	6	40
Paediatric ICU	4	67	2	33
Cardiac ICU	11	55	9	45
Neonatal ICU	4	100	0	0
General High Care	8	67	4	33
Neurovascular High Care	1	20	4	80
Surgical Short Stay Ward	1	100	0	0
Obstetrics and Gynaecology Ward	0	0	0	0
Paediatric Ward	0	0	0	0
Gastroenterology Ward	3	75	1	25
General Surgical Ward A	1	50	1	50
General Surgical Ward B	1	25	3	75
Orthopaedic Ward	1	100	0	0
Medical Ward	1	50	1	50
Oncology and Neurology Ward	2	67	1	33
Radiology	0	0	0	0
General Areas	0	0		0
Consulting Rooms	0	0	0	0
Dialysis Suite	0	0	0	0

ICU: Intensive Care Unit
ROSC: Return of Spontaneous Circulation
CPR: Cardiopulmonary Resuscitation

Table 4.4: ROSC during CPR According to specific locations.

Location	Number Alive	% Alive	Number Dead	% Dead
Operating Theatres	1	33	2	67
Medical and Cardiothoracic ICU	20	71	8	29
Trauma ICU	8	53	7	47
Paediatric ICU	4	67	2	33
Cardiac ICU	10	50	10	50
Neonatal ICU	4	100	0	0
General High Care	8	67	4	33
Neurovascular High Care	1	20	1	80
Surgical Short Stay Ward	1	100	0	0
Obstetrics and Gynaecology Ward	0	0	0	0
Paediatric Ward	0	0	0	0
Gastroenterology Ward	2	50	2	50
General Surgical Ward A	1	50	1	50
General Surgical Ward B	1	25	3	75
Orthopaedic Ward	1	100	0	0
Medical Ward	1	50	1	50
Oncology and Neurology Ward	1	33	2	67
Radiology	0	0	0	0
General Areas	0	0	0	0
Consulting Rooms	0	0	0	0
Dialysis Suite	0	0	0	0

ICU: Intensive Care Unit
CPR: Cardiopulmonary Resuscitation

Table 4.5: Outcome of CPR According to Specific Locations.

4.13 Determine the immediate outcome of CPR in unexpected cardiac arrest according to sex.

At the end of MET responses, 41 (61%) males were alive and the remaining 26 (39%) males were dead who had CPR performed for unexpected cardiac arrest during the MET response.

At the end of MET responses, 23 (53%) females were alive and the remaining 20 (47%) females were dead who had CPR performed on them for unexpected cardiac arrest during the MET response.

4.14 Determine the day/night distribution of CPR for unexpected cardiac arrest and compare this to outcome.

During the day (07h00 to 18h59), CPR for unexpected cardiac arrest was performed during 54 MET responses.

During the night (19h00 to 06h59), CPR for unexpected cardiac arrest was performed during 56 MET responses.

The respective outcome of CPR during day-time and night-time are tabulated in Table 4.6.

	Number Alive	% Alive	Number Dead	% Dead
Day	33	61	21	39
Night	31	55	25	45

CPR: Cardiopulmonary resuscitation

Table 4.6: Diurnal CPR Outcome.

4.15 Establish the total amount of time spent on MET responses and the mean time per MET response.

A total of 118 hours and 13 minutes was spent on MET responses during 2010. The average time spent on 278 MET responses was 25 minutes and 48 seconds.

4.16 Summary

The results of the study were presented in this chapter and will be critically appraised and compared with literature in Chapter 5.

Chapter 5: Discussion

5.1 Introduction

In Chapter 5, the results will be critically appraised and compared with international literature, where possible.

5.2 Ascertain the prevalence of MET responses according to sex.

This Clinical Audit found a male prevalence of 57.2%. This is consistent with literature: Parr *et al*[30] demonstrated a male prevalence in RRS responses of 55.2%. Beitler *et al*[37] and Simmes *et al*[36] found a male predominance of 57% and 52% respectively.

A definite reason for this phenomenon could not be found in this Clinical Audit nor in the available literature.

5.3 Ascertain the age distribution of patients to whom the MET responds and compare age to outcome.

5.3.1 Overall age

A mean age of 56.2 years was found in this Clinical Audit on MET, which was hospital-wide with no age limitations. This Clinical Audit therefore showed that an overall increase in age is associated with an increase in MET activation prevalence. This Clinical Audit is congruent with the literature of Parr *et al*[30] who demonstrated a mean age of 64.5 years in a study with a population ranging from 3 years to 98 years of age.

5.3.2 Paediatric population

A median age of 0.58 years was found in this Clinical Audit. This corresponds with a 70% majority of MET responses under 1 year of age.

Anwar-ul-Haque *et al*[32] found a median age of 27 months with 39% of RRS responses to children under 1 year of age. Krmpotic and Lobos[33] demonstrated a median age of 14 months and 46% of patients were under 1 year of age.

The paediatric age group in this Clinical Audit is congruent with literature. The slightly higher median age in literature can be explained by a wider paediatric population which includes patients up to 18 years of age.

Children under 4 years are burdened by communicable, perinatal and nutritional diseases which decrease with advancing age in the paediatric population[51]. This accounts for the low median in this population.

5.3.3 Adult population

The adult population in this Clinical Audit had a mean age 60.4 years.

This is consistent with literature, which demonstrates an increasing prevalence in RRS responses with advancing age. Jaderling *et al*[28] and Howell *et al*[29] who found mean ages of 65 years and 56 years respectively in adult population RRS studies.

5.3.4 Outcome

In this Clinical Audit, advancing age was related to an increase in mortality. The majority of deaths occurred after 55 years of age. Furthermore advancing age was related to an increase in the prevalence of MET activations. Thus, an increase in age was related to an increase in the prevalence of MET activations and an increase in mortality.

This is consistent with the literature of Chan *et al*[12] and Skogvoll and Nordseth[31] who found similar results and proposed an increase in comorbidities as the cause. Chan *et al*[12] noted an increase in respiratory disorders in the elderly as a contributing factor to mortality.

5.4 Determine the prevalence of MET responses in specific locations within the Hospital.

5.4.1 ICU and high acuity areas

The highest MET response prevalence, in this Clinical Audit, was in the MICU, TICU, GHCU, CICU and NVHCU. This indicates a functional MET – patients should rather undergo deterioration and cardiac arrest in the monitored high acuity areas of ICU and HCU as the outcome is better[23].

Kutsogiannis *et al*[19] found the highest RRS response prevalence to be in the coronary care unit (CICU equivalent). This was not the case in this Clinical Audit. The discrepancy between the findings of this Clinical Audit and the findings of Kutsogiannis *et al*[19] can be explained by patient independent factors i.e. activation

criteria which differs between hospitals[6], nursing factors (such as increased workload) and the promotion of the RRS in a hospital[41].

An interesting finding in this Clinical Audit, is the prevalence of MET activations in NVHU (a 5-bed unit). The high prevalence in a small bed unit could result in a relative falsely low prevalence. As such, the prevalence in the NVHCU could be relatively higher than the other high acuity areas.

5.4.2 Wards

Surgical Ward B had the highest prevalence of MET responses of the wards. This is an adult medium-term ward admitting and managing complicated surgical patients; as such the high prevalence may be acceptable.

5.5 Determine the time of day when MET responses occur.

The highest overall MET response prevalence was during the night. A peak in prevalence could be observed between 03h00 and 03h59.

Postnova *et al*[44] suggest that a professional is most drowsy at a time period which corresponds to the time of their normal sleep. This may be a reason for the increased night-time prevalence of MET activations in this Clinical Audit. Additionally, the Hospital has a decreased nursing staff contingency at night. Doctors are only on the premises during office hours and *ad hoc* after hours.

5.6 Establish the prevalence of MET responses according to day of the week.

No statistical difference could be demonstrated between days of the week (excluding public holidays) and MET prevalence. Similarly no difference could be demonstrated between days of the week and weekend days (with public holidays excluded). However, this finding could be examined with caution: minimal elective surgeries occur on the weekends at the Hospital. Additionally, short-stay patients are discharged prior to the weekend. As such, the weekend MET prevalence may in fact be relatively higher than weekdays. The "weekend effect" of Voltz *et al*[45] may therefore be hidden.

The prevalence of MET responses on public holidays could not be accurately examined. The number of responses per day on public holidays is falsely high as the denominator (number of public holidays falling on the day of the week) is small.

5.7 Determine the immediate outcome of MET responses and compare this to the location within the Hospital.

The locations in the Hospital with the highest mortality percentage after MET response were: Operating Theatres, Surgical Ward A, CICU, Medical Ward, NVHCU, Oncology and Neurology Ward and Surgical Ward B. The relative number of MET responses skews some of these figures. If corrected for prevalence, CICU, NVHCU, Surgical ward B and Oncology and Neurology have the highest mortality.

5.8 Investigate the prevalence of unexpected cardiac arrest within the Hospital.

The prevalence of unexpected cardiac arrest in this Clinical Audit was 0.324 per 100 admissions (3.24 per 1000 admissions).

This figure is higher than that of the paediatric-only study of Tibbals and van der Jagt who reported a prevalence of 0.19 to 2.45 per 1000 admissions[13].

5.9 Determine the prevalence of cardiac arrest according to sex.

Males had a higher prevalence (64.18%) of unexpected cardiac arrest compared to females in this Clinical Audit. This is in-keeping with the findings of Kutsogiannis *et al*[19], Rozen *et al*[38], Wallace *et al*[39] and Peberdy *et al*[37] who found a male predominance of 62.3%, 58.3%, 54.5% and 58% respectively. As such, this Clinical Audit correlates with literature.

5.10 Establish the prevalence of patients for whom the MET was activated where DNAR would have been appropriate.

DNAR was deemed appropriate for 5% of MET responses in this Clinical Audit. Sundararajan *et al*[46] reported an equal figure whilst Barret[47] reported a figure of 30%. This Clinical Audit corresponds with the data of Sundararajan *et al*[46].

The apparent mismatch of resources of a MET (aiming to resuscitate a patient) deciding that DNAR is more appropriate for a patient, is questionable for some[49]. Sundararajan *et al*[46], however, reiterate the importance of DNAR being an appropriate treatment decision during RRS response and encourage this action.

5.11 Determine the immediate outcome of unexpected cardiac arrest in the Hospital.

In this Clinical Audit, ROSC was achieved in 63% of MET responses where CPR was performed for unexpected cardiac arrest. One outcome for CPR in this Audit was mortality at the end of MET response. In this Clinical Audit the mortality at the end of MET activations for CPR was 58%. It is clear that not all patients on whom CPR was performed survived the MET response.

The highest ROSC rate was achieved by NICU, Surgical Short Stay Ward and Orthopaedic Ward. The prevalence of MET activations in the Surgical Short Stay Ward and Orthopaedic Wards was relatively low compared with other locations and as such may be an inaccurate representation of success.

The mortality for CPR in this Clinical Audit was 29% to 50% for the ICU group and 0% to 75% for the wards. Rozen *et al*[38] found the mortality for CPR in ICU to be between 52% and 100% whilst ward mortality was 80%. This Clinical Audit is therefore incongruent with literature. This Clinical Audit looked at immediate outcome and mortality and did not follow patients to discharge – this may explain the seemingly lower mortality figures than the literature.

5.12 Determine the immediate outcome of unexpected cardiac arrest according to sex.

Female mortality (47%) for unexpected cardiac arrest exceeded males in this Clinical Audit. In contrast, Ahn *et al*[34] found the reverse to be true in a pre-hospital study.

This discrepancy in male and female cardiac arrest mortality corresponds to the findings of Skogvoll and Nordseth[26].

5.13 Determine the day/night distribution of unexpected cardiac arrest and compare this to outcome.

In this Clinical Audit, night-time prevalence exceeded daytime prevalence. Similarly night-time outcome was worse than daytime outcome. Night-time mortality was 45% for unexpected cardiac arrests.

This corresponds to the findings of Peberdy *et al*[37]. Peberdy *et al*[37] propose that medication errors, poor psychomotor functioning, decrease in supervision, lack of sleep, lower nurse to patient ratios and less responding professionals at night could account for this. All these factors are plausible in this Clinical Audit.

5.14 Establish the total amount of time spent on MET responses and the mean time per MET responses.

A total of 596 hours and 5 minutes were spent during 2010 when the cumulative man-hours for each team member are calculated. This equates to a significant amount of time for nursing staff and doctors away from their daily duties.

The average individual time per MET response was 25 minutes and 45 seconds. This corresponds to literature. DeVita *et al*[7] estimate the average RRS response to be 30 minutes. Jacques *et al*[50] reported a similar finding – 74% of RRS responses took more than 20 minutes, while 45% of these were between 21 and 30 minutes.

5.15 Summary

In chapter 5, the results of this Clinical Audit were discussed and compared with available literature. Chapter 6 will complete this Clinical Audit with the conclusion, limitations and recommendations.

Chapter 6: Conclusion, Limitations, and Recommendations

6.1 Introduction

The conclusion, limitations to the study and recommendations are presented in this chapter.

6.2 Concluding Statements

This Clinical Audit on the MET responses at the Hospital appraised 278 responses by means of a Clinical Audit.

Males accounted for 57.2% of MET responses. Males further accounted for 60.9% of cardiac arrests. Females had a higher mortality compared to males.

Age analysis showed a multimodal age distribution. A mean overall age of 56.2 years was observed. A paediatric median of 0.583 years was found whilst a mean of 60.432 years was found in the adult category. An increase in frequency of MET responses was observed with advancing age with associated poor outcome.

The MET functioned hospital-wide. ICU and HCU areas accounted for the majority of MET responses and cardiac arrest prevalence. Similarly, ICU and HCU areas had a high mortality at the end of MET responses – 33% to 80% mortality.

No statistically significant difference in activation frequency occurred between days of the week. No “weekend effect” could be immediately demonstrated. Public

holidays proved to be difficult to objectively analyse with regards to prevalence of MET responses.

A peak in MET response frequency was demonstrated between 03h00 to 03h59. A minimal increased night-time prevalence was found but was not statistically significant. An increase in mortality was noted for cardiac arrest occurring at night.

The prevalence of cardiac arrest was 0.324 per 100 admissions. The ROSC rate for the MET was 62.7%. The CPR survival rate at the end of MET responses was 58.2%.

A total of 596 man-hours were expended on MET responses. The average MET response duration was 26 minutes.

In summary, the MET in operation at the Hospital is a combination of a Medical Emergency and Heart Arrest teams. It operates hospital-wide, 24 hours a day. The MET is internationally comparable and has ROSC exceeding that of available literature.

6.3 Limitations

The researcher encountered several limitations during the Clinical Audit. These included poor record keeping, absence of hospital information and time-inappropriate DNAR decisions.

6.3.1 Incomplete Record Keeping

The clinical notes for two files could not be found during data collection. As a result, these responses were excluded from the data sheet and reduced the total audited responses. Absence of data proved to be a challenge. Multiple personnel members completed the clinical records and inconsistencies were found in style of record keeping.

The researcher hoped to explore the presenting electrocardiogram (ECG) rhythm in detail. Incomplete record keeping of the ECG rhythm at activation of the MET and the rhythm at MET arrival invalidated this data. Record keeping may have been difficult as some activations were for patients in unmonitored beds or automated external defibrillators (AEDs) had been used by first responders. This data had significant relevance as a predictor of outcome of CPR. Skogvoll and Nordseth[26] found a higher success rate if the initial rhythm was ventricular fibrillation and was successfully defibrillated. Stein[17] found a shockable rhythm to be a positive predictor of ROSC.

The time of activation for 2 (0.007%) MET responses was not recorded. Thus, they were excluded from the data analysis for time of activation. This was not a statistically significant correction. The records for 1 (0.004%) activation did not note the day of the week. This record was excluded from the relevant data analysis for days of the week and did not make a significant difference to the results.

The duration of 5 (1.7%) MET responses were not recorded. These activations were excluded from relevant calculations during the data analysis for MET response duration.

6.3.2 Hospital Information

The number of discharges and beds occupied per year for 2010 could not be obtained from the Hospital. As a result, a detailed comparison of cardiac arrest prevalence with international data could not be undertaken. Additionally, MET response prevalence according to the overall hospital population and admission days could not be achieved.

The outcome of patients managed by the MET, 24 hours after a MET response and 28 days after a MET response was not available to the researcher. As a result, long-term outcome for the MET and CPR could not be determined.

6.3.3 Time-Inappropriate DNAR Decisions

Fourteen responses (5%) occurred for patients who were suffering a terminal illness or where the patient could not benefit from further medical care. Decisions not to resuscitate these patients were either made prior to arrival of the MET (but were not disclosed to the ward personnel) or the specialist had not specified this prior to MET response and decided this telephonically during a MET response. Had the DNAR orders been specified, these activations would not have occurred.

6.4 Recommendations

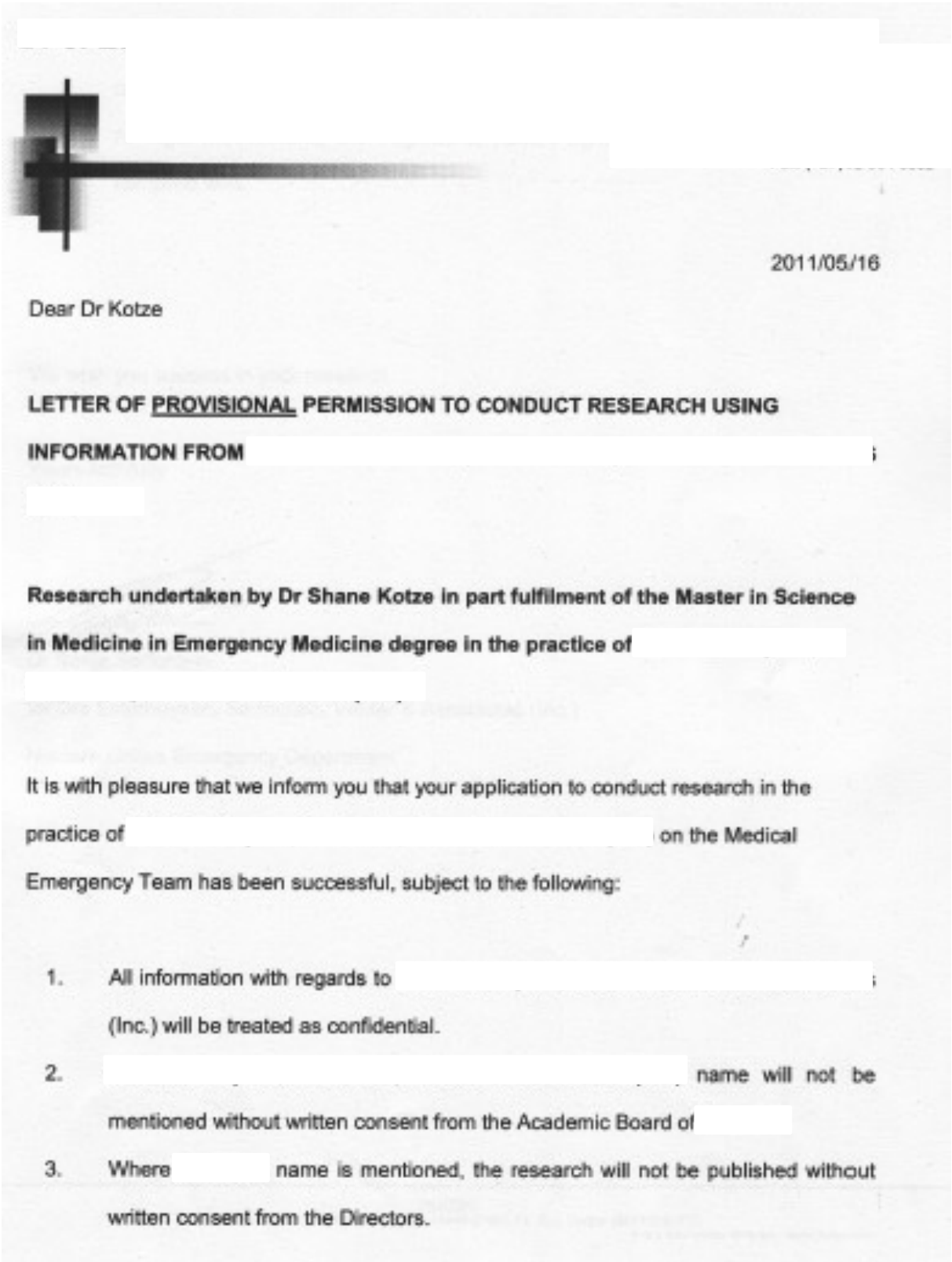
The researcher makes the following recommendations with respect to the MET in this Clinical Audit:

- Improved record keeping and meticulous completion of each variable in the MET record form must be encouraged and audited regularly.
- Operating theatres, Cardiac ICU, NVHCU and Surgical Ward B have a high cardiac arrest mortality which should be further investigated.
- Heightened awareness of patient deterioration by the Hospital staff during the early morning hours especially prior to 03h00.
- Further research should be undertaken to evaluate the scientific causes for patient deterioration in the early morning hours.
- DNAR orders should be discussed prior to patient deterioration and MET response by the attending physician. Ward staff should perhaps make these suggestions where appropriate to prompt a timeous DNAR order.
- Patient critical events are a concerning issue which should be appraised by the Hospital Resuscitation Committee and measures must be put into place to actively reduce them.
- MET responses should be kept as brief as possible without being hasty as costs can be excessive.
- A re-audit of MET responses after implementation of the recommendations is suggested.

Appendices

Appendix A

Approval from the Practice



2011/05/16

Dear Dr Kotze

LETTER OF PROVISIONAL PERMISSION TO CONDUCT RESEARCH USING INFORMATION FROM

Research undertaken by Dr Shane Kotze in part fulfilment of the Master in Science in Medicine in Emergency Medicine degree in the practice of

It is with pleasure that we inform you that your application to conduct research in the practice of on the Medical Emergency Team has been successful, subject to the following:

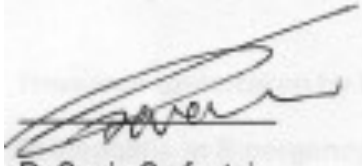
1. All information with regards to (Inc.) will be treated as confidential.
2. name will not be mentioned without written consent from the Academic Board of
3. Where name is mentioned, the research will not be published without written consent from the Directors.

4. A copy of the research will be provided to [redacted] once it is finally approved by the tertiary institution, or once complete.

5. All legal requirements with regards to patient rights and confidentiality will be complied with.

We wish you success in your research.

Yours faithfully



Dr Sonja Serfontein

for [redacted]

Emergency Department

Appendix B

Ethics Approval

.UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Dr Shane Kotze

CLEARANCE CERTIFICATE	M111111
PROJECT	A Clinical Audit of Responses by an Emergency Department: Medical Emergency Team, Within a 469 Bed Private Hospital in Gauteng, SA, from 1st January 2010 to 31st December 2010
INVESTIGATORS	Dr Shane Kotze
DEPARTMENT	Dept of Family Medicine/Emergency Medicine
DATE CONSIDERED	25/11/2011
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 25/11/2011 **CHAIRPERSON** .....
(Professor P E Cleaton Jones)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Prof Efraim Kramer

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix C

Approval from the Hospital Group

RESEARCH COMMITTEE FINAL APPROVAL OF RESEARCH

Approval number: MED-2012-0002

Dr Shane Kotze

E mail: shanekotze@live.co.za

Dear Dr Kotze

RE: A CLINICAL AUDIT OF RESPONSES BY EMERGENCY DEPARTMENT: MEDICAL EMERGENCY TEAM, WITHIN A 469 BED PRIVATE HOSPITAL IN GAUTENG, SOUTH AFRICA, FROM 1ST JANUARY 2010 TO 31 DECEMBER 2010

The above-mentioned research was reviewed by the Research Committee's delegated members and it is with pleasure that we inform you that your application to conduct this research at Hospital, has been approved, subject to the following:

i) Research may now commence with this FINAL APPROVAL from the Academic Board of (Research Committee).

ii) All information with regards to will be treated as confidential.

iii) name will not be mentioned without written consent from the Academic Board of (Research Committee).

iv) All legal requirements with regards to patient rights and confidentiality will be complied with.

v) Insurance will be provided and maintained for the duration of the research. This cover provided to the researcher must also protect both the staff and the hospital facility from potential liability

vi) In accordance with MCC approval, that medicine will be administered by or under direction of the authorised Trialist

vii) The research will be conducted in compliance with the GUIDELINES FOR GOOD PRACTICE IN THE CONDUCT OF CLINICAL TRIALS IN HUMAN PARTICIPANTS IN SOUTH AFRICA (2000)

viii) must be furnished with a STATUS REPORT on the progress of the study at least annually on 30th September irrespective of the date of approval from Academic Board o (Research Committee) as well as a FINAL REPORT with reference

to intention to publish and probable journals for publication, on completion of the study.

ix) A copy of the research report will be provided to once it is finally approved by the tertiary institution, or once complete.

x) e has the right to implement any Best Practice recommendations from the research.

xi) e reserves the right to withdraw the approval for research at any time during the process, should the research prove to be detrimental to the subjects/ or should the researcher not comply with the conditions of approval.

We wish you success in your research.

Yours faithfully

Full member: Research Committee & Medical Practitioner evaluating research applications as per Management and Governance Policy
Date: 12/9/2012

Shannon Nell
Chairperson: Research Committee

Appendix D

Data sheet

Total Number	Serial #	Age	Sex	Day of Week	Time	Duration	Location	Sub-Location	Category	CPR	ROSC	Outcome	DNAR	Notes

Appendix E

Turnitin® Report

Turnitin Originality Report
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