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**A PROSPECTIVE STUDY ON THE OUTCOMES OF ADULT CARDIOPULMONARY
RESUSCITATION**

IN

CAPE TOWN

BY

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This study is in partial fulfilment of the degree of MMed Emergency Medicine

DIVISION OF EMERGENCY MEDICINE

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DECLARATION

I, Tiyiselani Elloy Mabasa, hereby declare that this dissertation is my original work and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree to any other university. I also give permission to the university to reproduce contents of this dissertation for the purposes of further research if it so wishes.

Signature:

Date:

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PART A: PROPOSAL AS SUBMITTED FOR ETHICS APPROVAL

RESEARCH PROPOSAL FOR DISSERTATION

**OUTCOMES OF ADULT CARDIOPULMONARY RESUSCITATION PERFORMED IN TWO
HOSPITALS IN THE CAPE METROPOLE, SOUTH AFRICA**

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Introduction and literature review

Cardiopulmonary resuscitation (CPR) is an important aspect of medicine and has been in practice since 1960 when clinical utilization of closed chest massage was first reported.(1) Different electrical rhythms can occur during cardiac arrest, and these can be: ventricular fibrillation, pulseless ventricular tachycardia, pulseless electrical activity, or asystole, all of which require CPR.(2)

Among the causes of mortality, cardiac death is the leading cause of mortality in the industrialized nations.(3) Rates of survival from cardiac arrest to hospital discharge were acknowledged to be low during the 2005 American Heart Association (AHA) conference, averaging $\leq 6\%$ internationally, and survival rates had also been noted to not have increased significantly in recent years.(4) This observation resulted in a change from a ratio of 15:2 to a universal compression-ventilation ratio for all lone rescuers of victims of all ages to an emphasis on the importance of cardiopulmonary resuscitation (CPR) quality. It stipulated quality chest compressions; pushing hard to a depth of at least 5cm at a rate of at least 100 compressions per minute, allowing full chest recoil after each compression, and minimising interruptions in compressions so as to improve forward blood flow to vital organs.(3),(4)

In the 2005 International Consensus Conference for medicine, the recommended sequence of CPR actions was: Airway, Breathing, and Circulation/chest compressions (ABC).(4) In the 2010 guidelines, in an attempt to shorten the delay to first chest compressions for adult victims, experts came to the consensus that rescuers may consider starting CPR with chest compressions rather than ventilation (the sequence has thus changed to be CAB: Compressions, Airway, Breathing).(4) All these changes have been instituted in an attempt to improve the outcomes of resuscitation following cardiac arrest. For the same reasons, physicians in Tucson, Arizona in the year 2003 developed a new approach for resuscitation of patients with cardiac arrest.(3) This new approach is called Cardiocerebral Resuscitation (CCR) and is composed of: a) continuous chest compressions which is chest compression only CPR, b) a new emergency medical service algorithm, and c) aggressive post-resuscitation care.(3)

The new CCR approach showed a dramatic increase of 33% in survival to hospital discharge when instituted in 2004 in Wisconsin by Kellum et al,(3) and this was in comparison with the outcomes in 2003. Significant improvement in survival was also shown by Sunde et al in Norway when they formalized their post-resuscitation care by emphasizing providing therapeutic hypothermia (32 -34°C) to all patients who remained comatose post-resuscitation and performing early percutaneous coronary intervention (PCI) in any patient with possible myocardial ischemia as a contributing factor to the cardiac arrests.(3)

In the 2010 Resuscitation journal, guidelines recommended calling for help and activating the resuscitation team as soon as cardiac arrest got recognised. In these cases cardiac arrest was defined as a state of unresponsiveness, breathlessness or occasional gasping breaths and absence of a pulse.(4) CPR is advised to start immediately following the diagnosis of cardiac

arrest.(4) Trained rescuers should provide ventilations with a compression-ventilation ratio of 30:2 when no definitive airway is in place(4) but with continuous compressions of 100 per minute and ventilations of 12 per minute when definitive airway is achieved.(5)

We still have poor outcomes of CPR in terms of return of neurological function and survival to discharge rate for in-hospital CPR attempts. This may be because the cause of arrest is often associated with advanced chronic illness rather than easily recoverable acute cardiopulmonary event.(6) There has been some minor improvement in outcomes after in-hospital cardiac arrest in recent years.(7) Advances in resuscitation techniques, improved education and training, and more effective organisation of the resuscitation process are thought to be the contributing factors to this slight improvement in survival rates.(7) Survival rate to hospital discharge was reported to be around 15% prior to 1985 but has recently increased to range between 17% and 40% in the past 20 years.(7)

Research still shows in-hospital CPR to bear better outcomes(1) as compared to out-of-hospital CPR.(8) There is data available for outcomes of out-of-hospital CPR for tertiary hospitals in Gauteng, South Africa but no data is available of CPR outcomes in district hospitals in South Africa.

Data collected for in-hospital-CPR outcomes in Pakistan, Shifa International Hospital in 2005 revealed that of the 159 patients included, 55 (35%) were alive at the end of CPR but only 17 (11%) were discharged alive from the hospital.(8) There were 601 patients who received in-hospital CPR in Namazee Hospital, Iran, from October 2008 til March 2008 and 45,1%(271) had return of spontaneous circulation (ROSC) while 54,9%(329) died immediately after resuscitation. Among the ROSC patients mentioned above 6,6%(18) were discharged alive from hospital (3% of the study population).(9) These outcomes show that the rates of ROSC are comparable between the developing and the developed countries (where ROSC in USA was 44% and in the UK 38,6%) but the rates to discharge vary significantly (around 20% in most developed countries). This may be accounted for by the quality of post-resuscitation care.(9)

To date, there is no data detailing the outcome of in-hospital cardiac arrest in the Cape Metropole region in South Africa.

Research question

What are the outcomes after attempting cardio-pulmonary resuscitation in two district hospitals in the Cape Metropole region in terms of :

1. Return of spontaneous circulation (ROSC),
2. Alive at 24hrs,
3. Discharged alive from hospital

Aim

This study endeavours to review CPR outcomes of all adult patients aged 13 years and older following cardiac arrest whilst in GFJooste (GFJ) or New Somerset hospital (NSH).

Objective

The purpose of this study is to examine, over a six month period, at GF Jooste and New Somerset hospitals the outcomes of CPR in terms of:

1. Rates of those patients who had return of spontaneous circulation (ROSC)
2. Rates of those patients who never achieved ROSC
3. 24hour survival rates
4. Survival to discharge rates or
5. Rates of those patients who died after ROSC

Methodology

The study will be based on the modified Utstein style(10) of collecting data.

Study design: this will be a prospective case review study.

Study population: all adults from age 13 and older presenting to GFJ and NSH or admitted in these hospitals who have an event of cardiac arrest in the emergency centres, operating theatre, intensive care units (ICU) or in the wards and are offered CPR. The two hospitals will be convenient to get data from since the primary researcher will have easy access to these hospitals during the time of the study period.

Sampling: there was an estimated 80 deaths per month in 2005 at GF Jooste hospital of which 15 - 20 were from the emergency centre and were probably offered CPR. In 2010 there were 14-22 CPR attempts in the emergency centre at GF Jooste. New Somerset hospital has an estimated 8-14 attempted CPR per month thus making a total estimation of 138-204 CPR attempts in a six month period for the two hospitals combined. A CPR register which has been created will be placed in a file in the two emergency centres, ICU, operating theatres and all the wards of the two hospitals. All heads of departments and treating personnel will be made aware of the study and also be educated on how to fill it in properly. Missing events where cases were not put in the CPR register will be gleaned from the current resuscitation books. The primary researcher will then use the patient stickers to trace the folders from medical records department, and together with the information in the CPR register complete the modified Utstein template.

Time scale: data will be collected for an estimated 6months starting from 1 April 2011 until 30 September 2011 and one month (October) to put the data together and analyse it for reporting.

The results of the study should be ready for distribution and submission to a peer reviewed journal by November 2011.

Data collection: the data will be collected on a weekly basis from the two hospitals by the primary researcher making use of the CPR register which has been created and will be placed in a file in the two emergency centres, ICU, operating theatres and all the wards in NSH and GFJ hospitals. The treating doctor will be expected to fill in the CPR register which will consist of the date, hospital sticker, age, duration of CPR, drugs used, usage of defibrillator, cause of arrest, qualification of the treating doctor, and outcome of CPR. The folder numbers from the CPR register will be used to trace patient folders from medical record department and together with the CPR notes from the doctor's notes information will then be translated onto the modified Utstein template for reporting of in-hospital CPR outcomes.

Data management: epidata software (programmed to limit search using words such as CPR outcomes/ in-hospital CPR/cardiac arrest) will be used to create database which will read with stata. A password will be created, which will need to be punched in before the data can be accessed. Code numbers instead of patient names will be used to allow confidentiality.

Analysis of results: assessment of the distribution of the data will be done using shapiro-wilk from STATA version 11 (data analysis software system) by the primary researcher with some help from a statistician, Henri Carrara (Biostatistician Faculty of Health Sciences, University of Cape Town). If data are normally distributed means and standard deviation will be reported, alternatively median and interquartile ranges will be reported if data will not be normally distributed. Simple percentages will be used to show the outcomes of patients who survived to immediate ROSC, those who were alive at 24hours, those who were discharged alive from hospital and those who died after ROSC. Those patients who were offered CPR but documentation in their folders was not complete to reveal the outcome or their folders were not found will also be reported in a percentage format. Proportions will be described with a 95% confidence interval (C.I) and these may be adjusted for important co-variants using adjprop in STATA 11.

Inclusion criteria: any adult patient aged 13 years and older on whom cardiopulmonary resuscitation is performed who does not fall in the exclusion criteria.

Exclusion Criteria: any patient where resuscitation was:

1. Not initiated due to a 'do not attempt resuscitation' (DNAR) order made prior to arrest or where CPR was terminated after a DNAR was communicated at a later stage.
2. Not attempted because patient was declared dead prior to commencement of CPR.
3. Terminated after the clinician felt the CPR started by nurses was inappropriate in the first place (e.g in terminal cancer patients, medical illnesses with very poor prognosis or patients with injuries incompatible with life such as severe traumatic brain injuries etc).
4. CPR was initiated in the pre-hospital setting.

Distribution of results: the final analysis will be collected and submitted to a peer reviewed journal for publication.

Reporting and implementation of results: the outcomes will reveal how effective our resuscitation efforts are when compared with the outcomes achieved by other developing countries such as Iran and Pakistan. If the study shows good outcomes in terms of ROSC but much lower rates of hospital discharge then recommendations for better post-resuscitation care can be suggested. However, if our ROSC outcomes is to be much less when compared with that of other developing countries then advanced life courses such as Advanced Cardiac Life Support and Advanced Trauma Life Support must be recommended for all physicians likely to be involved in CPR. This will hopefully empower and equip the treating physicians with the necessary skills to be more competent in resuscitation and possibly help improve the outcomes of in-hospital cardiac arrests.

Limitation

Patients who will be excluded from the study who fall into the exclusion criteria will limit the study in terms of numbers as they will not form part of the study. The study will be conducted in only two hospitals as these will be the hospitals that the primary researcher will be working in during the time of conducting the study. This will make it convenient and feasible to collect data on a more frequent basis and avoid losing data.

Folders of those patients who were offered CPR according to the CPR register but were not found from records or outcome was not documented in the folder will still be included in the study but will be calculated as a percentage of outcome unknown. The study will aim for at least 80% of completeness of data to improve the validity of the study. In an effort to avoid losing data the primary researcher will collect the CPR register and patient folders on a weekly basis from the wards, ICU, theatres, emergency centres and medical record department respectively. The primary researcher will follow up on a weekly basis any missing information from the treating clinicians. Any missing information from the folders (e.g. time CPR started, cause of death, outcome of CPR, disposal etc) will result in incomplete filling of the data collection sheet jeopardising the quality of the study. A concerted effort will be made to glean any missing items from doctors' notes by evaluating the nurse's notes.

Another limitation is the challenge that may be created by staff with respect to committing to filling in of the CPR register. To address this we will have to educate and convince the heads of departments and their respective treating staff to buy-in into the study and correctly fill-in the CPR register. The primary researcher will also have to go through the existing resuscitation book (found in the resuscitation room). This will be done to compare entries so as to make sure that all CPR cases that were not included in the CPR register can be traced and folders retrieved from medical record department using patient folder numbers.

Ethical and legal considerations

All the information will be stored in a database created from the epidata software and a password created will need to be entered in into the researcher's personal computer to be able to access the data. This is done so as to ensure confidentiality of the patients involved.

Consent form from the medical CEO of the hospital will need to be signed for permission to conduct the study in the hospitals. No patient or staff names or potential identifiers will be included. Code numbers instead of patient names will be used on the data collection forms to ensure confidentiality and the names of the patients involved will only be known to the researcher.

Budget

Paper	~R60
Printing	~R200
Petrol	~R340
Files	~R200
Total	<u>~R800</u>

All the above expenses will be incurred by the primary researcher thus no external funding will be needed.

Data Collection Sheet

Variable	Total(N)	%
All in-hospital resuscitation attempts		
Any ROSC		
Never achieved ROSC		
Alive at 24hours		
Discharged alive from hospital		
Died in hospital(after ROSC)		
Number of CPR where outcomes are not known		

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CPR Register

1. Date __/__/__

2. Defibrillator used Y N

3. Hospital Sticker _____

4. Cause of arrest _____

5. Drugs

6. Cycles of CPR _____

i) Adrenaline Y N

ii) Amiodarone Y N

iii) Magnesium Y N

iv) Sodium Bicarbonate Y N

v) Insulin Y N

vi) Atropine Y N

vii) Other _____

7. Outcome of CPR

i) Return of Spontaneous Circulation (ROSC)

ii) No ROSC

8. Disposal of patient

i) Ward

ii) ICU/HCU

iii) Theatre

9. Qualification of treating doctor in charge

i) Intern ii) COSMO iii) MO iv) Registrar v) Consultant

10. Name of treating doctor _____

11. Additional notes

--

Modified Utstein template for reporting of in-hospital cardiopulmonary resuscitation

PATIENT VARIABLES

1 Date of event __/__/__

2 Name/ Hospital #

3 Location of CPR

Age

ICU

M F Unknown

EC

Ward

Theatre

Other

EVENT VARIABLES

4 Immediate cause of arrest

Lethal arrhythmia

Traumatic causes

Other medical causes

OUTCOME VARIABLES

5 ROSC

Yes No

7 Survived to discharge

Yes No

6 Alive at 24hours

Yes No

8 Died (after ROSC)

Yes No

Consent form for the hospitals

GFJ/NSH hospital

The CEO

**Re: Request to conduct a study on outcomes of CPR in all cardiorespiratory
arrest adult patients admitted to the emergency units and the wards**

I hereby write this letter to request permission to conduct a study in a prospective case review format on the outcomes of CPR performed on all medical and trauma adult patients aged 13years and older who arrest as in-hospital patients.

I also request permission to access the folders from medical records of all the patients who will have been offered CPR as from 1st April 2011 till 31st September 2011.

Your co-operation in this regard will be highly appreciated.

Regards

Dr TE Mabasa

0735751603

Emergency Medicine Registrar

Consent given: Y/N

Name of Medical CEO _____

Signature of Medical CEO _____

PART B: LITERATURE REVIEW

LITERATURE REVIEW

LITERATURE SEARCH STRATEGY:

The Medline database, pubmed, ovid and google scholar were searched. Search terms included: cpr, cardiopulmonary resuscitation, cardiac arrest, adults, outcome, survival rates, in-hospital, inpatient. 390 articles were retrieved. Relevant websites, grey literature databases and the references of key articles were evaluated. An additional 36 articles were identified of which 3 were of relevance to this study. In total 56 articles were included.

The articles that were excluded were as a result of the time phrame that the study was conducted, or included children in the study, or involved out-of-hospital resuscitation.

University of Cape Town

LITERATURE APPRAISAL

INTRODUCTION:

Cardiopulmonary resuscitation (CPR) is an important aspect of medicine and has been in practice since the 1960's when clinical utilisation of closed chest massage was first reported.(1) CPR consists of providing artificial ventilation and chest compressions. It is performed in an event where cardiac arrest has been declared, in an effort to 'restore life'.(2) Cardiac arrest (CA) occurs when there is cessation of organised cardiac contractility causing circulation to stop, or when there is a clinical condition of unresponsiveness and a lack of palpable pulse in the presence of organised cardiac contractility.(3) Different electrical rhythms can occur during cardiac arrest, including: ventricular fibrillation (VF), pulseless ventricular tachycardia (VT), pulseless electrical activity (PEA), or asystole. All of these may require CPR.(4)

During cardiac arrest there is no blood flow to vital organs and chest compressions restore partial circulation to the heart and brain by building up and maintaining coronary and cerebral perfusion pressure. This is critical for short-term and meaningful long-term survival.(2) CPR is noted as successful if there is return of spontaneous circulation (ROSC) lasting at least 20minutes. This is classified as immediate survival.(5)(6)

Cardiac related deaths are the leading cause of mortality in the industrialised nations, claiming more than 300 000 lives per year in the United States.(7) This makes cardiac arrest and cardiopulmonary resuscitation a very important aspect of medicine, and if efforts are continuously made to decrease cardiac related deaths the economic costs may be lightened.

When reviewing the international literature, factors which are associated with better survival rates (8) are:

- younger age(less than 60yrs)(9)(10)
- absence of multiple comorbidities(11)
- respiratory arrest(11)
- ventricular arrhythmia (be it either ventricular fibrillation or ventricular tachycardia)(12)
- witnessed arrest(13)
- and rapid return of spontaneous circulation (short duration of CPR).(10)(14)

Survival has been found to be poor in the following patients: those whose first documented rhythm is asystole or pulseless electrical activity(10)(13)(15), those with multiple comorbidities(11) or those who suffered an unwitnessed arrest.(13)

Other factors that may affect survival rates from in-hospital cardiac arrest are: location of the CPR(16)(17), and early defibrillation in patients who had a shockable rhythm.(18) There is a 5-10% decrease in successful recovery for each minute delay in defibrillation for ventricular fibrillation or pulseless ventricular tachycardia.(2) Increased interventions, such as putting up multiple intravenous lines and intubation are also associated with increased mortality(19) as these would distract the focus on providing quality CPR.

There is no reported data on the incidence and outcomes of CPR in the general South African population. Statistics South Africa reported on a total of 572 673 deaths that were registered at the Department of Home Affairs for the year 2009.(20) The majority of deaths resulted from certain infectious and parasitic diseases (25%). Tuberculosis (TB) was the most commonly mentioned cause of death. Diseases of the circulatory system were rated as the second most common main group of causes of death (13.7%).(20) Statistics South Africa acknowledges that under-registration or incorrect filling in of the death notification forms may be a limitation to the reliability of these statistics.(20)

CURRENT RESUSCITATION OUTCOMES:

Research still shows in-hospital CPR to have better outcomes as compared to out-of-hospital CPR.(21) Data collected for in-hospital-CPR from a large central hospital in Pakistan in 2005 revealed that of the 159 patients included, 55 (35%) had return of spontaneous circulation (ROSC) at the end of CPR but only 17 (11%) survived to hospital discharge.(21) Of the 290 patients who underwent CPR in a University hospital in Iran from 2007 to 2008, 95 patients (30.4%) had ROSC but only 35 patients (12%) survived to hospital discharge.(1) ROSC in the United States was 44% and in the United Kingdom 38,6%.(22) These outcomes show that the rates of ROSC are comparable between the developing and the developed countries. However, survival rates to hospital discharge following in-hospital cardiac arrest seem to vary significantly. It is currently around 20% in most developed countries compared to the 11-12% in developing countries.(1)(23) This can be accounted for by the varying quality of post-resuscitation care.(22)

At the 2005 American Heart Association (AHA) Conference survival rates to hospital discharge following in-hospital cardiac arrest were acknowledged to have remained persistently low, averaging $\leq 6\%$ internationally in previous years.(24) Despite all the education systems and increasingly evidence-based resuscitation protocols that had been implemented in the recent years, it was noted that survival rates had only increased to an average rate of 20% for in-hospital resuscitation.(24) Survival rates have remained low for out-of-hospital cardiac arrest, averaging 2% to 5% in most studies and occasionally as high as 10%. The United States has a national average survival rate to hospital discharge of 8.4%.(23)(25)

A small study describing the outcomes of out-of-hospital CPR in Gauteng, South Africa, showed a ROSC rate of 18% which is very low when compared to the other developing or

developed countries.(26) The reasons for this are not clear. There is no data currently available for CPR outcomes in district or secondary hospitals in South Africa. To the best of our knowledge, there is also no data detailing the outcome of in-hospital cardiac arrest in the Cape Metropole region in South Africa to date.

Likelihood of survival for in-hospital cardiac arrest seems to be increased when the first rhythm is VF/VT and defibrillation occurs within 3minutes of the arrest.(23) However, a delay in defibrillation predisposes a patient to a decline in chance of survival by 10% for each minute that the patient remains in VF/pulseless VT arrest.(2) Other factors that increases the likelihood of survival are:

- early CPR when started in less than 1 minute after CA
- hospital location: intensive care and haemodialysis units have better survival rates
- time of day of arrest: day shift arrests have better survival rates.(23)

HISTORY OF CPR:

The earliest account of artificial breathing performed as mouth-to-mouth ventilation was first recorded and referenced in the old testament. In the book of Kings the prophet Elisha restored the life of a boy through this technique.(27) Despite the fact that this case remained in the oldest book in the world, it did not get recognition until 1740 when the Paris Academy of Sciences recommended mouth-to-mouth resuscitation for drowning victims, followed by the Dutch Humane Society in 1768. In 1957 the United States military adopted the mouth-to-mouth resuscitation method to revive unresponsive patients. Performance of chest compression in humans was first described in 1891 by Dr Friedrich Maass but it was only in 1903 that Dr George Crile reported the first successful chest compression resuscitation in humans.(27)

The first successful closed human defibrillation was documented in 1955 by Zoll.(27) The key elements of CPR (ABC) were in place and in practice by 1960 but the first CPR guidelines were only published in 1966 by the American Heart Association (AHA).(27) Combining airway, breathing, circulation, and defibrillation (and telephone for out-of-hospital arrests) the American Heart Association in 1992 described the 'chain of survival' model. This model contains four links which are:

- early access
- early CPR
- early defibrillation
- and early advanced cardiac life support (ACLS).(28)

This came about as clinicians, administrators, and researchers recognised the need to improve community systems in order to optimise patient survival for out-of-hospital cardiac arrest.(28)

In 1997 the International Liaison Committee on Resuscitation (ILCOR) also adopted the concept.(28) The chain now has the 5th link - comprehensive and intergrated post arrest care which has the potential to further decrease morbidity and mortality. Survival rates are likely to be poor if one or more of these links in the chain is neglected or delayed.(28) The first link in the chain is early access which poses a challenge on the emergency medical systems (EMS) to respond early to out-of-hospital cardiac arrests calls. EMS response times vary from community to community. The ambulance services in the United Kingdom (UK) are able to arrive at the scene of 90% of their emergency calls within 14 minutes.(29) In 2011/2012, the Western Cape EMS has been averaged to arrive at the scene of 90% of their emergency calls within 12.7 minutes.(personal communication)

As a result of persistently poor outcomes in cardiac arrests, physicians in Tucson, Arizona in the year 2003 developed a new approach for resuscitation of patients with cardiac arrest.(7) This new approach that they used is called Cardiocerebral Resuscitation (CCR) and is composed of:

- continuous chest compressions which is chest compression only CPR
- a new emergency medical service algorithm, and
- aggressive post-resuscitation care.(7)

The new CCR approach showed a dramatic increase of 33% in survival to hospital discharge when instituted in 2004 in Wisconsin by Kellum et al. This is in comparison to the outcomes (15% hospital discharge rate) that they had in the 3 previous years prior to instituting CCR.(7)

At the 2005 International Consensus Conference for medicine, the recommended sequence of CPR actions was: Airway, Breathing, and Circulation/Chest compressions (ABC).(24) In the same year, the AHA observed that survival rates of in-hospital cardiac arrest had not significantly improved. This resulted in changes based on recent evidence.(7) Compression ratio was changed from 15:2 to a universal compression-ventilation ratio of 30:2 for all lone rescuers of victims of all ages (excluding neonates). The emphasis shifted to the importance of providing quality cardiopulmonary resuscitation (CPR) including quality chest compressions defined as:

- pushing hard to a depth of at least 5cm at a rate of at least 100 compressions per minute
- allowing full chest recoil after each compression

- and minimising interruptions in compressions so as to improve forward blood flow to vital organs.(7)(24)

CPR algorithms have always followed the sequence of ABC (Airway, Breathing, Circulation) with the airway and breathing being assessed first, followed by the pulse check which could take up to ten seconds. Rescuers would then give two rescue breaths and only then would chest compressions start (see Appendix 1). These guidelines were adopted by the South African Resuscitation Council. This approach caused a delay in starting compressions. In an attempt to shorten the delay to the first chest compressions the latest AHA guidelines and the Resuscitation Council of South Africa dictates that rescuers must start CPR with chest compressions rather than ventilation (see Appendix 2). The sequence has thus changed to be CAB (Compressions, Airway, Breathing) for all adult victims with a medical cause for cardiac arrest (excluding drowning victims).(2)(24)

CURRENT CPR PRACTICE:

In the 2010 Resuscitation, AHA guidelines recommend the following actions for a suspected adult cardiac arrest. See Table 1 and Appendix 2:

ACTION	EXPLANATION
Call for help	And activate the resuscitation team (and request a defibrillator) as soon as cardiac arrest has been recognised (as defined by a state of unresponsiveness/breathlessness or occasional gasping breaths and absence of a pulse).(24)
Ventilations and compressions	With a compression-ventilation ratio of 30:2 when no definitive airway in place,(24) but with quality continuous compressions of 100/minute and ventilations of 8-10 per minute once definitive airway is achieved.(2)(30)
Rhythm check	As soon as the defibrillator arrives and then after every 2 minutes of CPR.(2)
Defibrillation	After first rhythm check if pulseless VT or V.F. and repeated every 2minutes if refractory.(2)
Adrenalin	Given after the second rhythm check and can be repeated every 3-5 minutes.(2)
Anti-arrhythmic	After third shock and can be repeated every 3-5minutes

Table 1: Actions of CPR

However, if the rhythm check reveals asystole or PEA, CPR will be done in intervals of 2 minutes with only adrenalin being given every 3-5 minutes (see Appendix 2).

In the Western Cape, the current CPR practice follows the guidelines set out by the Resuscitation Council of South Africa (see Appendix 3). These guidelines are adopted from the 2010 AHA guidelines. South Africa has twenty Advanced Cardiac Life Support (ACLS) training centres with 79 ACLS instructors throughout the country. These instructors provide training to the doctors from private and government sector, most of which are 'front-liners' in their hospitals. There are over 2689 ACLS qualified doctors in South Africa.(31) ACLS-like resuscitation training has also been incorporated into the undergraduate medical training programmes in the Western Cape. We can deduce that a large number of doctors in our hospitals are trained to provide high quality CPR as per ACLS guidelines.

POST RESUSCITATION CARE:

Caring for the patients with ROSC after CA can be very challenging and can impact strongly on morbidity and mortality.(25) As the post resuscitation care continues the emergency physician must strive to identify and treat the cause of the cardiac arrest if at all possible. The emergency physician can arguably have the most significant impact on patient morbidity and mortality by providing well co-ordinated and systematic post cardiac arrest care for these critically ill patients while in the emergency centre.(25) However, a multi-disciplinary team approach is needed in post-cardiac arrest care to optimise outcome.

There are five critical components of post cardiac arrest care:

- haemodynamic optimisation
- appropriate ventilation and oxygenation
- management of metabolic derangements (such as glucose and potassium control)
- early cardiac catheterisation when indicated
- induction of therapeutic hypothermia for appropriate candidates

It is imperative that the emergency physician be knowledgeable and skilled in managing these critically ill patients. This is because some of these patients tend to stay in the emergency centre for many hours before accessing the intensive care unit.(32)

Haemodynamic optimisation:

The addition of vasopressin and corticosteroids to the routine epinephrine/adrenaline has shown some improvement in survival following a cardiac arrest event in some studies.(33) This approach was implemented after animal data showed improved long-term survival with

combined vasopressin and epinephrine.(33) Cardiac arrest is associated with lower cortisol levels during and after CPR.(33)(34)(35)(36) This contributes to the postresuscitation shock syndrome.(34)(36) The syndrome is defined as a complex array of pathophysiologic processes such as systemic ischemia, brain injury, myocardial dysfunction and persistence of the precipitation cause of the arrest.(25) Corticosteroid supplementation during and after CPR might confer benefits with respect to haemodynamics,(34)(36) which may result in improved survival.

Mentzelopoulos et al conducted a single-centre, prospective randomized double-blinded trial on the effects of vasopressin, epinephrine, and corticosteroids for in-hospital cardiac arrest patients. They found that the study group had more frequent return of spontaneous circulation (39 out of 48 patients= 81%) when given combined vasopressin-epinephrine and methylprednisone during resuscitation and a stress-dose hydrocortisone in post-resuscitation shock. The control group only had ROSC in 27 out of 52 patients(52%) and survival to hospital discharge rate of 2(4%) as compared to 9(19%) for the study group.(33) The difference between the two groups with respect to outcomes may have been as a result of improved haemodynamics and central venous oxygen saturation in the study group.

Based on the available limited data, vascular autoregulatory mechanisms may be impaired or absent following ROSC after CA. As a result, patients who have ROSC post cardiac arrest may need a higher mean arterial pressure (MAP) of 90-100 mmHg to be able to sustain cerebral perfusion pressure and oxygen delivery.(37) It would therefore be sensible to attempt to maintain haemodynamic stability using vasoactive agents and corticosteroids to prevent brain damage, which these patients are susceptible to if the haemodynamic status is not well controlled. The evidence for vasoactive and steroid use is very limited and at present they do not form part of advanced cardiac life support guidelines.

Appropriate ventilation and oxygenation:

There are currently no optimal settings that have been determined for mechanical ventilation of patients with ROSC following CA.(25) Current guidelines recommend starting with a low tidal volume (6- 8ml/kg) ventilatory mode and a respiratory rate of 16-18 breaths per minute to avoid volutrauma and hyperventilation respectively.(25) Minute ventilation may be adjusted to maintain normal partial pressure of carbon dioxide (PaCO₂) of 40-45mmHg.(25)

An end tidal carbon dioxide concentration (PetCO₂) of 35-40mmHg can also be used to monitor ventilation. Maintaining plateau pressures of equal or less than 30 cm of water is advisable so as to minimise ventilator induced lung injury.(25)

High partial pressures of arterial oxygen (PaO₂) of more than 300mmHg when patients are placed on 100% forced inspiratory oxygen (FiO₂) may be deleterious. A study by Kilgannon and colleagues found significant hyperoxia to be associated with poor outcomes.(38) For

these reasons, the AHA recommends FiO₂ and partial end expiratory pressure (PEEP) to be titrated against target oxygen saturation level of above 94% or a PaO₂ of around 100mmHg.(25)

Management of metabolic derangements:

This entails correction of metabolic derangements such as glucose control and electrolyte imbalances.(25) The emergency physician can either supplement or shift the electrolyte or metabolite depending on the patient's metabolic status. In the Western Cape most district and regional facilities have access to point-of-care blood gas testing, and management of metabolic derangements is standard post-arrest care.

Early cardiac catheterisation:

A diagnosis of acute coronary occlusion should be considered in patients who suffer sudden cardiac arrest (SCA) after complaining of chest pain and have ST segment changes on ECG. It is therefore recommended that urgent cardiac catheterisation be provided as this is the definitive therapy for these patients.(25) Anti-thrombotic therapy should be considered for patients with suspected ischaemic cardiac event if percutaneous coronary intervention (PCI) is not immediately available.(25) In the Western Cape access to Interventional Cardiology is very limited in the state sector. Early cardiac catheterisation is not an option for post-resuscitation care.

Therapeutic Hypothermia:

There are several studies showing benefits of induced mild therapeutic hypothermia (32°C - 34°C) in cardiac arrest patients.(39) The speed and timing of induction have been related to improved outcomes.(39) Despite the benefits that therapeutic hypothermia has shown, many centres (including Western Cape) still have not implemented cooling protocols,(39)(40) citing reasons that inducing mild therapeutic hypothermia would be too technically difficult and expensive.(39) However, Kory and colleagues have proposed cooling techniques that are rapid, safe, and inexpensive. These include:

- cold (4°C) saline infusion at a rate of 40ml/kg,
- evaporative cooling by fanning the wetted, fully exposed patient, and
- iced water gastric tube lavage.(39)

With this technique they found that even minor temperature decreases during or immediately after the time of arrest were associated with benefits in neurological outcome. Therapeutically induced mild hypothermia has been found to decrease in-hospital mortality and improve neurological outcome in comatose cardiac arrest survivors.(41) The time limit of initiation for mild hypothermia to be neuroprotective is approximately 6-8 hours after ROSC.(39)(42)

Significant improvement in survival was also shown by Sunde et al in Norway when they formalised their post-resuscitation care. They emphasised providing therapeutic hypothermia (32 -34°C) to all patients who remained comatose post-resuscitation and performing early percutaneous coronary intervention (PCI) in any patient with possible myocardial ischemia as a contributing factor to the cardiac arrests.(7)

In the AHA guidelines, the use of therapeutic hypothermia is recommended for all comatose survivors of CA(25), but this recommendation has not yet been instituted in the South African setting.

Once the desired target temperature of 32°C-34°C has been reached, then the second phase, the maintenance phase (with cooling blankets and ice packs) should begin. The goal of this phase is to maintain a steady core body temperature for 12-24 hrs post ROSC. After this phase the patient should be rewarmed at a rate of 0,25°C to 0,5°C per hour.(25) The medical personnel should continue to monitor oxygenation, ventilation, and haemodynamic optimisation throughout the induction, maintenance, and rewarming phases of therapeutic hypothermia.(25)

OTHER FACTORS AFFECTING CPR OUTCOMES:

Some of the suggested factors are:

- Time of day when CPR is done
- Gender of the patient
- Monitoring or lack thereof of the critically ill patients
- Quality of CPR

Some studies have shown that survival to discharge following in-hospital cardiac arrest was lower during the nights and weekends compared with day or evening times on weekdays, even after accounting for the many potentially confounding factors relating to patient, arrest event, and hospital.(8)(10)(43)(44) However, Danciu and colleagues found no correlation between survival and time of arrest.(8) This may have been due to the small sample size of their study.

Most authors have found gender not to be a significant independent predictor of survival,(10) whereas others have found that women of child-bearing age were more likely than comparably aged men to survive to discharge after in-hospital cardiac arrest, even after controlling for aetiology of arrest and other important variables.(45)

Several previous studies have identified infection as a poor prognostic factor.(46)(14)

A small study of 531 patients between 2002 and 2005 done by Yap revealed a favourable outcome among patients who had cardiac arrest whilst in monitored areas (9% vs 4% for those not in monitored areas).(43) Herlitz et al found that only 31.1% of patients in non-monitored

wards survived to discharge whereas 43.2% of the patients in the monitored wards were discharged home. Reasons for such a difference in outcomes may have been as a result of expertise that the nurses have with respect to advanced and basic cardiac life support.(13) The fact that non-monitored areas are often peripherally located and the monitored areas more centrally located (making it easier for the resuscitation team to reach) is another possible reason.

A small cohort, non-randomized study of 67 patients revealed that chest compression rates were often less than the recommended 100/minute. The study also showed that compression depth was often more shallow than the minimum 3,8cm, and ventilation rates were higher than 12-16/minute.(47) In a study done by Abella et al, suboptimal compression rates were found to correlate with poor ROSC. Aufderheide found that hyperventilation during CPR causes an increase in intrathoracic pressure which decreases the venous return.(48)(49) A low venous return will in turn result in a low cardiac output. These complications resulted in an increase in mortality.(49) Since various studies have demonstrated the inability of some nursing and medical staff to perform basic life support,(50) regular training and updates on resuscitation skills and management should be advocated for all medical staff, as it may have an effect on the initial outcome.(50)

All these factors mentioned above can potentially impact on survival. Potential practical solutions for helping to improve poor quality CPR would include mechanical devices. These can provide chest compressions reliably at a set rate and depth and generate better haemodynamic characteristics than manual chest compressions.(47)(51) Another possible solution would be to improve monitoring and feedback/debriefing which may serve as a powerful tool to improve rescuer training and care for cardiac arrest patients.(47)(52)(53) The disadvantages thereof would mainly be financial costs and time needed to provide such services.

RAPID RESPONSE SYSTEMS:

Signs of deterioration usually do precede in-hospital cardiac arrest (IHCA) in at least 60%-80% of the cases.(54) Early aggressive interventions may therefore help prevent these very ill patients from going into cardiac arrest.(54) To intervene early on these deteriorating patients, Rapid Response Systems (RRS) can be instituted in an attempt to prevent cardiac arrest and its complications.(54)

A RSS is a system that includes a protocol for monitoring patients and a list of 'call out criteria'. 'Call out' criteria differs from institution to institution but common elements include:

- A change in vital signs (heart rate, blood pressure, respiratory rate, temperature, saturation)
- A change in Glasgow coma scale (GCS) score
- Threatened airway

- Or other signs of cardiovascular deterioration (such as impaired urine output)

In most institutions the system is activated by nurses when they are concerned about the patient's status.(54) In the Western Cape (WC) we do not yet have a formalised RRS policy but the nursing staff may often alert the doctor on duty or the emergency unit doctor via a telephone or emergency bell when the patient deteriorates or requires CPR. Once activated, a team of health care providers (in the WC mainly formed of the emergency unit doctor, doctor on call for the specific speciality, and at times anaesthetic officer) present to the patient's bedside to address the crisis.(54)

Responding teams may be made up of a number of different doctors or nurses as either a Medical Emergency Team (METs), Rapid Response Team (RRTs), Cardiac Arrest Team (CAT), or Critical Care Outreach Team (CCO). METs are teams that are generally led by a physician and have the ability to prescribe therapy, place central lines, provide advanced airway management and initiate ICU level care at bedside(54). RRTs traditionally are those teams that do not have the above four capabilities but can perform a preliminary evaluation of the patient and then summon for additional help if needed.(54)

There are several steps of a typical RRS. The first step involves a patient clinically deteriorating. Secondly the nursing staff will assess and monitor the patient. Third step would involve the nursing staff having to make a decision to activate the team based on the specific call out criteria for the hospital and on the fourth step is activation of the team(54).

Literature shows that physicians frequently document concerns for patient deterioration several hours before the patient requires an (unexpected) intensive care transfer.(55) If these were acted upon, some of the transfers and cardiac arrests would probably have been prevented.

Literature show outcome data for RRSs to vary significantly among institutions. Some studies showed a reduction in IHCA but not mortality while others did not show any significant change in either IHCA or mortality.(54) A few demonstrated a reduction in both IHCA and mortality when RRSs were instituted.(54) Laurens et al showed statistically significant reductions in hospital-wide mortality rates and cardiopulmonary arrests.(56) These differences could be accounted for by the methodological design flaws among the studies and also the different RRS policies from one institution to another.

Given the above varying outcomes of RRSs it will be difficult to extrapolate whether or not RRS would impact positively when applied to institutions in the Western Cape and South Africa. It would therefore be worth developing policies for RRSs suiting our setting with the hope of decreasing the number of cardiac arrests and improving our mortality rates.

CONCLUSION:

To the best of our knowledge, there is no data detailing the outcome of in-hospital cardiac arrest in South Africa to date.

International IHCA survival rates to discharge rates are between 15% and 20%.⁽²³⁾⁽³³⁾ Advances in resuscitation techniques, improved education and training, and more effective organisation of the resuscitation process and implementation are thought to be the contributing factors to the slight improvement in survival rates demonstrated over the last 50 years.⁽⁴³⁾ Even though this is slightly better compared to previous outcomes, it is still very low and efforts should continuously be made to improve outcomes of IHCA. A well co-ordinated and systematic post cardiac arrest care plan and implementation of the RRSs can help to further improve the IHCA mortality rates.

This study endeavours to review CPR outcomes of all adult patients aged 13 years and older following cardiac arrest due to all causes whilst in GfJooste or New Somerset Hospitals. Our objective is to determine the outcomes of CPR in terms of:

- Rate of ROSC
- 24 hour survival rate
- Survival to hospital discharge rate

Studies with regard to RRSs, induced therapeutic hypothermia and outcomes of CPR for IHCA still need to be conducted in the future as there is currently very limited research done in these areas in South Africa.

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University of Cape Town

PART C: JOURNAL ARTICLE

**A PROSPECTIVE STUDY ON THE OUTCOMES OF ADULT
CARDIOPULMONARY RESUSCITATION
IN
CAPE TOWN**

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ABSTRACT

Introduction: Outcomes of cardiac arrest and cardiopulmonary resuscitation (CPR) are poorly monitored or evaluated in our hospitals in South Africa. CPR plays a significant role in emergency medicine, and regardless of poor outcomes internationally, efforts should continuously be made to improve these outcomes. In this study we set out to establish the outcomes of CPR performed on all cardiac arrest patients in two hospitals in the Cape Metropole region.

Methods: Adult patients aged 13 years and older who had a cardiac arrest and on whom CPR was performed as in-hospital patients at GF Jooste and New Somerset Hospitals from 1 May 2011 to 31 October 2011 were enrolled in the prospective case review study. Patient folders were identified using the CPR register. Data was extracted from the CPR register and the patient folder onto the modified Utstein template and then transferred onto the data collection sheet. The CPR register was placed in all the wards, emergency centres, intensive care units, and operating theatres in the two hospitals. Primary outcomes were rated as: return to spontaneous circulation (ROSC), alive at 24hours, survival to hospital discharge or died after ROSC.

Results: Assessment of the distribution of the data was done using shapiro-wilk from STATA version 11. We had a total number of 125 consecutive CPR attempts that met the inclusion criteria and our rates of immediate survival, survival at 24hours, and survival to discharge were 48.8%, 18.4%, and 12% respectively.

Conclusion: The analysis of this data in our setting shows that our survival to hospital discharge rates does not differ much from those in other developing countries, however, it is much lower when compared with that of developed countries. Further studies are needed to help us assess and improve the quality of resuscitation efforts and aid in strategic planning to improve CPR outcomes in our hospitals.

INTRODUCTION

Cardiopulmonary Resuscitation (CPR) is an attempt to restore circulation in a victim suffering a sudden cardiac arrest (CA). This is done by performing cardiac compressions and providing artificial ventilations. Sudden cardiac arrest (SCA) is common, and in the United States (US) someone suffers from SCA every 90 seconds.(1) More than 166 000 victims experience out of hospital cardiac arrest (OHCA) and more than 370 000 suffer in-hospital cardiac arrests every year.(2)(3) CPR has been widely practiced since the 1960s when the American Heart Association (AHA) developed training programs in CPR.(1)

CPR training and scientific research into the practice of CPR has had some influence on the outcomes of those suffering from SCA. The earliest studies reported in-hospital cardiac arrest (IHCA) survival rates of around 10% but more recently survival to hospital discharge rates of up to 37% have been recorded in certain institutions.(4)

The 2010 American Heart Association (AHA) guidelines now recommend CPR to follow the CAB (Compressions-Airway-Breathing) approach instead of the old mantra of 'ABC' in an attempt to start chest compressions earlier.(5) These changes need to be widely adopted, practised, and evaluated to determine if they have impacted positively on the outcomes of CPR following sudden cardiac arrest (CA).

There are several factors that affect outcomes of CPR. Studies have been conducted to assess predictors of survival after CPR in hospitalized patients.(6)(7)(8)

In the pre-arrest phase initial rhythm is the most valuable prognostic factor. Ventricular fibrillation and pulseless ventricular tachycardia show a favourable outcome when compared with non-shockable rhythms.(9)

Among the intra-arrest factors the quality of the CPR and early defibrillation are the most important factors affecting outcome.(10)(11)(12) Recent resuscitation literature has described the quality of CPR as critical if the prospect of return of spontaneous circulation (ROSC) is to be increased.(9)

Quality post resuscitation care as a post-arrest factor can also impact extensively on the outcomes of IHCA and decrease mortality. Other factors such as gender and circadian rhythm have not been proven conclusively to make a difference. (7)(8)

There is currently no data available detailing the outcomes of in-hospital CPR in Cape Town. Protocols for post resuscitation care in comatose survivors of cardiac arrest have not yet been established and implementation of induced therapeutic hypothermia and post arrest percutaneous coronary intervention (PCI) for these critically ill patients are not routine practice.

The aim of this study is to describe patient demographics, the outcomes of cardiopulmonary resuscitation, and assess the factors that could influence survival rates in Cape Town hospitals.

METHODS

We set out to review the CPR outcomes of all adult patients aged 13 years and older following cardiac arrest whilst in the GF Jooste and New Somerset Hospitals, Western Cape, South Africa.

GF Jooste is a district hospital in the Cape Metro region and has 224 beds including 8 high care unit (HCU) beds. It is one of the busiest hospitals in Cape Town, serving an average of 1.1 million people. The New Somerset Hospital is also a teaching hospital in the Cape Metropole region and boasts just over 400 beds including 4 intensive care unit (ICU) beds.

A prospective audit was done of all patients who received CPR whilst admitted in these two hospitals from 1 May 2011 up to and including 31 October 2011. Survival was rated as immediate (as defined by return of spontaneous circulation for more than 20 minutes), 24hour survival rate, and survival to hospital discharge. If a patient experienced several cardiac arrests, only the first CPR was considered. Ethics approval was obtained from the Faculty of Health Sciences Human Research Ethics Committee of the University of Cape Town. The study was also approved by the Department of Health of the Western Cape and permission given by the heads of the institutions. Patient confidentiality was adhered to as per the department's rules.

Inclusion criteria:

Any adult patient aged 13 years and older on whom in-hospital CPR was performed.

Exclusion criteria:

Any patient where resuscitation was terminated after a DNAR (Do Not Attempt Resuscitation) order was communicated, if the patient suffered CA outside the hospital, or if the patient was younger than 13 years old.

Data collection included demographics, cause of arrest, cycles of CPR, medications used during CPR, outcome of CPR, level of experience of the treating doctor and location of arrest. Data collection forms were completed by the senior medical team member supervising the arrest. An effort was made to trace missing cases by reviewing all in-hospital deaths to determine whether resuscitation was attempted during the study period and then retrospectively fill in the CPR form when necessary. Patients who had ROSC were followed up on a regular basis to determine if they later died, survived up to 24 hours post CPR or survived to hospital discharge. Completed forms were collected on a weekly basis and data was entered into a computer database (Microsoft Excel 2007).

Assessment of the distribution of the data was done using Shapiro-wilk from STATA version 12 including Chi-Square and Fischer Exact tests. A P-value of < 0.05 was considered significant. Proportions were described with a 95% confidence interval.

RESULTS

Outcomes

During the 6 month study period there were 148 in-hospital cardiopulmonary resuscitations. 10 folders were either not found or had incomplete data and 13 did not meet the inclusion criteria. The final number included in the study was 125. Of these, 61(48.8%) had return of spontaneous circulation (ROSC) (95% C.I 39%-57%). In the ROSC group 38 died within 24hours and 23 (18.4%) survived to 24 hours post CPR (95% C.I 12%-26%). The overall rate of survival to hospital discharge was 12% (15/125) (95% C.I 6%-19%). See table 1 below.

Hospital	CPR	ROSC	No ROSC	Alive @ 24 hours	Discharge
NSH	45	19	26	11	6 (13.3%)
GFJ	80	42	38	12	9 (11.25%)
Total	125	61 (48.8%)	64 (51.2%)	23 (18.4%)	15 (12%)

Table 1. Outcome variables

The mean age of patients on whom in-hospital CPR was commenced on was 50 years and there were 55 females and 70 male patients. Table 2 shows the demographic variables.

DERMOGRAPHIC VARIABLE	N (%)	MEDIAN AGE (years)
Median Age		50.2
Sex		
Male	70 (56%)	48.5
Female	55 (44%)	52.6

Table 2. Demographic variables

The ROSC rate for women was 50.9% (28/55) and survival to hospital discharge rate was 10.9% (6/55). For men the ROSC rate was 47.1% (33/70) and the survival to hospital discharge rate was 12.5% (9/70). The difference between the sexes was not found to be statistically significant (P> 0.05).

Of the 15 patients who survived to hospital discharge, 8 (53.3%) had arrested secondary to an Acute Coronary Syndrome event (myocardial ischemia/infarction or dysrhythmia). These 8 are part of the 31 patients who had Acute Coronary Syndrome. Most (113) of the patients had a medical cause (respiratory failure, shock, ACS, arrhythmias, metabolic abnormality or other) for their cardiac arrest. None of the 12 trauma patients who had an in-hospital cardiac arrest survived to hospital discharge. All the patients who had septic shock as the primary cause of the cardiac arrest also did not survive to hospital discharge. However the cause of arrest in this study was not of statistical significance ($p > 0.05$). See table 3 below for causes of arrest.

CAUSE OF ARREST	FREQUENCY	PERCENTAGE (%)
Medical	106	84.8
Surgical	8	6.40
Trauma	11	8.80
Total	125	100.00

Table 3: Causes of arrest.

ROSC occurred in 52% of HCU/ICU patients and the survival to hospital discharge rate was 8.7%. Theatre, Emergency Centre and wards (medical and surgical) had ROSC rates of 2 (28.5%), 42 (54.5%) and 5 (29.4%) respectively. The survival to hospital discharge rate was 28.5% for theatre patients, 14.3% for E.C, and 0% for the wards. These results showed a moderate statistical difference in outcome in relation to the location of the CPR ($p 0.054$). See table 4 below.

Location of CPR	Frequency (n)	Percentage (of total)	ROSC (n/%)	Survival to discharge (n/%)
Emergency Centre	77	61.60	42(54.5%)	11 (14.3%)
HCU/ICU	23	18.40	12(52.1%)	2 (8.7%)
Theatre	7	5.60	2(28.5%)	2 (28.5%)
Ward	17	13.60	5(29.4%)	0 (0%)
XRay department	1	0.80	0	0 (0%)
Total	125	100	61	15

Table 4. Outcomes of CPR in different locations.

DISCUSSION

Patient variables

There is contradictory evidence regarding sex and age as predictors of survival following in-hospital cardiac arrests .(7)(13) Some authors report a lower proportion of survival to hospital discharge with increasing age whereas others have found sex nor age not to be a predictive factor of survival. (14)(15) In this study we did not evaluate for any differences in outcomes with respect to age as this was not part of our objectives. The study did however reveal a slightly higher percentage of men surviving to hospital discharge (12.5% vs 10.9%) even though this difference was not statistically significant.

We had one patient with abdominal malignancy of unknown stage. The overall hospital discharge rate of cancer patients following CPR compares favourably to survival rates in unselected inpatients but our lone cancer patient did not have ROSC.(16)

In this study, all patients who had septic shock as the primary cause of the cardiac arrest did not survive to hospital discharge. Several previous studies have shown infection to be a poor prognostic factor for in-hospital CPR.(17)

None of the trauma related cardiac arrests survived to hospital discharge even though none of them had any significant comorbidities.

Despite all the factors mentioned above, the cause of arrest appears not to be of statistical significance. This may be as a result of the small sample study that we had and the study population that was enrolled.

Hospital variables

Both the hospitals where we conducted our study are teaching hospitals with consultants, registrars, medical officers and interns. Due to limited staffing there is no consultant cover on the 'shop floor' afterhours and on weekends. During these times the registrars and the medical officers are the primary responders to a cardiac arrest call in the emergency centre or theatre. Interns are usually the first medical personnel to respond to a ward resuscitation call. From personal communication with the nursing management it was confirmed that some of the nurses have not received formal training in basic life support. Anecdotally, most of the professional nurses were found to be willing to initiate resuscitation (despite not being formally trained) while awaiting the medical doctors to arrive at the bedside of the patient.

Each ward, Emergency Centre, Operating Theatre, and X-Ray departments have at least one resuscitation trolley with drugs, intubation kit etc at their disposal. NSH ICU has only 1 manual defibrillator in their unit while GFJ has 2 in their HCU. The operating theatres and the emergency centres are well stocked with manual defibrillators but the wards only have

1 defibrillator per ward. There are, however, no defibrillators in the X-Ray departments of the two hospitals. The lack of defibrillators in the X-Ray departments is a cause for concern as delays in defibrillation may result in increased mortality and morbidity.(12) Such delays could be avoided if automated electric devices (AED) could be mounted in the X-ray departments as these can easily be used by even lay personnel such as radiographers.

Despite the fact that medical emergency teams have been found to have a positive impact on both cardiac arrest rate and overall hospital mortality we still do not have such teams in our setting.(18)(19)

The location of the resuscitation also seem to show different survival patterns.(20) Smith and colleagues found the lowest survival to hospital discharge rate to be in the medical wards (8.8%).(21) In this study 17 CPR cases were from the surgical and medical wards combined, and none of them survived to hospital discharge. We suspect that this may have been influenced by poor monitoring in the wards with cardiac arrests not being witnessed resulting in delays in initiating CPR. These wards are mainly 'manned' by junior staff. Lack of experience and training in advanced life support of the nursing and medical personnel may also have contributed to such poor outcomes.

Theatre had 7 patients with cardiac arrest and 2 (28.5%) were discharged alive from hospital. This is a similar outcome when compared with the outcome in a study done at a university hospital in Nigeria. (22) The Emergency Centre had 77 resuscitation attempts with a survival to hospital discharge rate of 14.3% (11/77). HCU/ICU had a survival to hospital discharge rate of 8.7% (2/23).

There appears to be a moderate statistical difference (p 0.054) in outcomes depending on the location where CPR occurred. There were no survivors to discharge from the non-monitored areas (wards) but there were 15 from the locations where monitoring occurred. It is clear that monitoring aids in early recognition of CA and in effect promotes rapid initiation of CPR. Poor monitoring may have had an impact on mortality in this study population.

Event variables

Most (113) patients had a medical cause (respiratory, shock, ACS, arrhythmias, metabolic abnormality or other) for their cardiac arrest. This is in keeping with the patient demographics and acuity of the patients admitted to these hospitals.(23)

Location of CPR and monitoring was associated with better survival to hospital discharge rates.

Patients who presented with features of sepsis or had trauma did not survive to hospital discharge.

CONCLUSION

Management protocols of in-hospital cardiac arrests are affected by the resources and healthcare systems of each country. This impact directly on the survival to hospital discharge rates. The international survival to hospital discharge rate following in-hospital cardiac arrest is currently 20%.⁽¹⁵⁾ To the best of our knowledge this study is the first Utstein style report on the outcomes of in-hospital cardiac arrest in South Africa. Our 12% survival to hospital discharge rate is well below that of the developed countries such as Japan and Sweden, which are 27,8% and 34% respectively.⁽¹⁴⁾⁽¹⁵⁾ However, this rate is comparable with that of other developing countries such as Pakistan (11%) and Turkey (13.4%).⁽²⁴⁾⁽²⁵⁾

The quality of our post-resuscitation care may also be a major factor contributing to the outcomes of the in-hospital cardiac arrests. Even though our ROSC rate of 48.8% is equivalent to that of most developed countries our survival to hospital discharge rate is much lower compared to that of countries such as Japan and Sweden. The Western Cape has not yet implemented protocols on therapeutic hypothermia for patients with sudden cardiac arrest despite the growing evidence that suggests there may be neurological benefits and improved outcomes.⁽²⁶⁾⁽²⁷⁾ Implementation of such protocols will be expensive but may positively impact on our survival rates.

There is some evidence that implementation of medical emergency teams are associated with a reduction in hospital mortality.⁽¹⁸⁾ Henderson et al showed that the formation of a structured, formalised hospital resuscitation team was associated with an increase in the number of patients experiencing ROSC and in the percentage of patients who were discharged from hospital following in-hospital cardiopulmonary arrest.⁽¹⁹⁾ Given the limited resources and training in our setting, we would recommend implementation of resuscitation teams and a feasibility study to evaluate the impact such teams would have.

During the study it was apparent that not all medical and nursing staff were familiar with the new 2010 American Heart Association and or the South African Resuscitation Council guidelines. This was evident from the note keeping as they did not comply with the new cardiac arrest algorithms. Regular Advanced Life Support training for all medical and nursing staff may help in improving the initial outcomes of in-hospital cardiac arrest.

If we improve and intensify monitoring of the critically ill patients, we may enhance care and early recognition of cardiac arrests, expedite initiation of CPR and potentially improve outcomes of these patients.⁽²⁸⁾ This is critical in our setting since none of the patients who had sudden cardiac arrest in the non-monitored areas survived to hospital discharge.

Further studies will need to be done to assess the trend of the outcomes of CPR and hopefully help identify areas and strategies to improve cardiac arrest outcomes in the future.

LIMITATIONS

The study was conducted in only two hospitals. While these are typical of district and secondary level hospitals in the Western Cape, they may not represent the outcomes in larger central hospitals.

We had aimed for at least 90% of completeness of data on the data collection sheet to improve the validity of the study. Any missing information from the CPR form was retrieved from the patient's clinical record where possible. A proportion of patients (8.7%) did not meet the inclusion criteria. Furthermore 6.5% of the files either had incomplete documentation or could not be located from the central records of the hospitals under study. These were not included in the study.

ACKNOWLEDGEMENT

We would like to thank Mr Henri Carara, biostatistician, who provided statistical advice. The co-operation of the staff and management of New Somerset and GF Jooste Hospitals is appreciated.

CONFLICT OF INTEREST

None declared.

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PART D: APPENDICES

APPENDIX 1: AHA BLS GUIDELINES 2005

APPENDIX 2: AHA BLS GUIDELINES 2011

APPENDIX 3: SOUTH AFRICAN RESUSCITATION COUNCIL CPR GUIDELINES

APPENDIX 4: CPR FORMS

APPENDIX 5: MODIFIED UTSTEIN DATA COLLECTION SHEET

APPENDIX 6: EMERGENCY MEDICINE JOURNAL INSTRUCTIONS TO AUTHORS

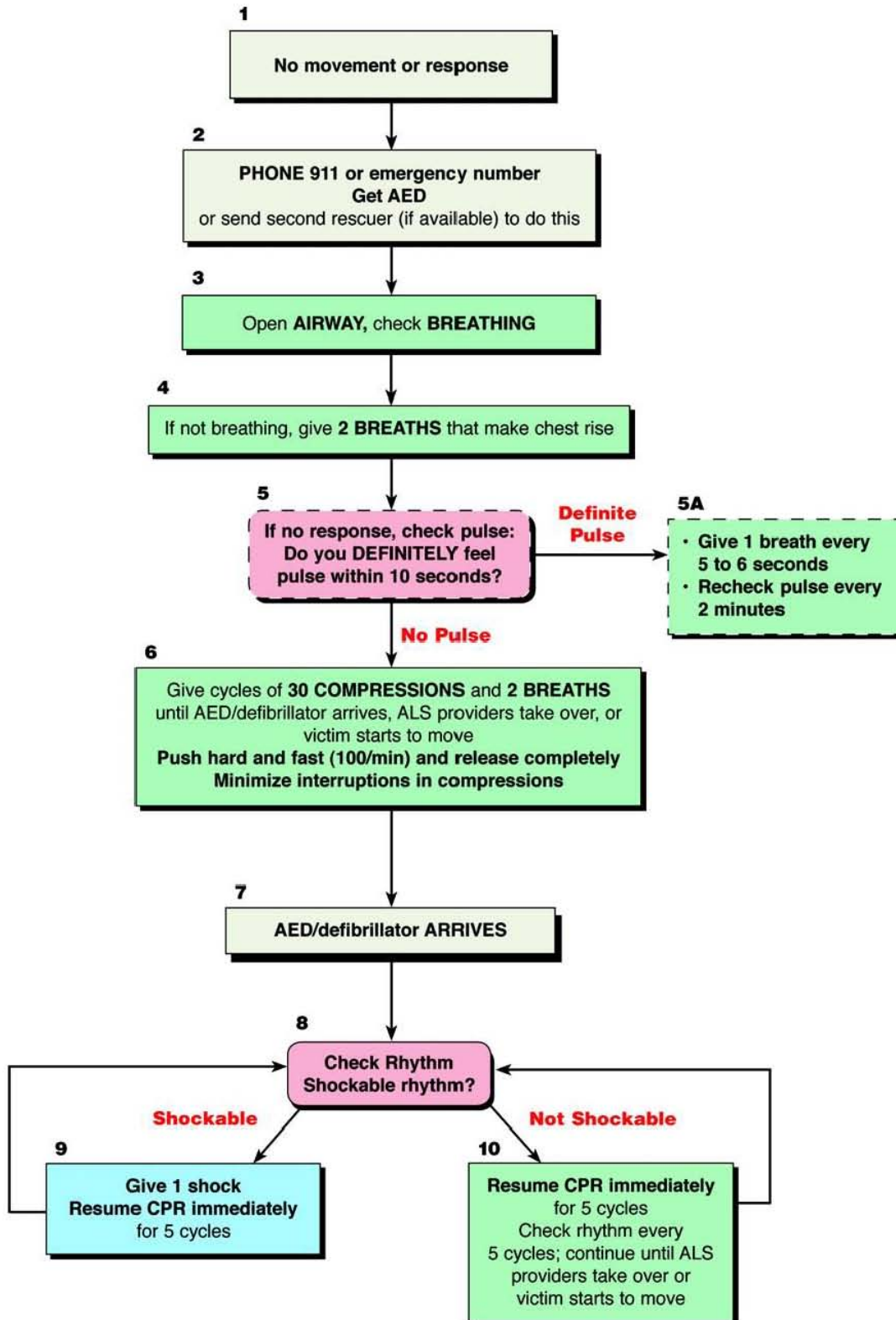
APPENDIX 7: ETHICS APPROVAL LETTER

University of Cape Town

APPENDIX 1

AHA BLS guidelines 2005

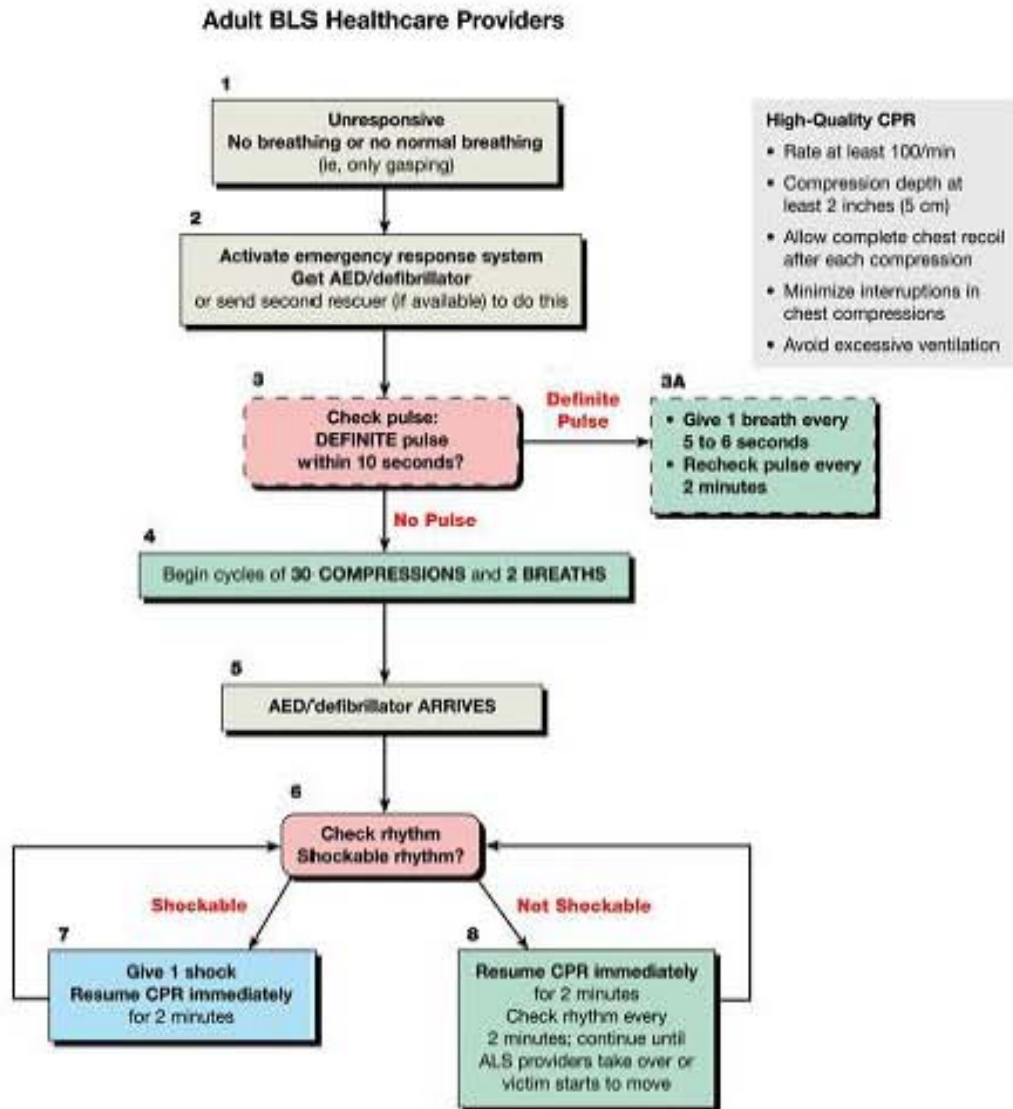
Courtesy American Heart Association



APPENDIX 2

AHA BLS guidelines 2010

Courtesy American Heart Association



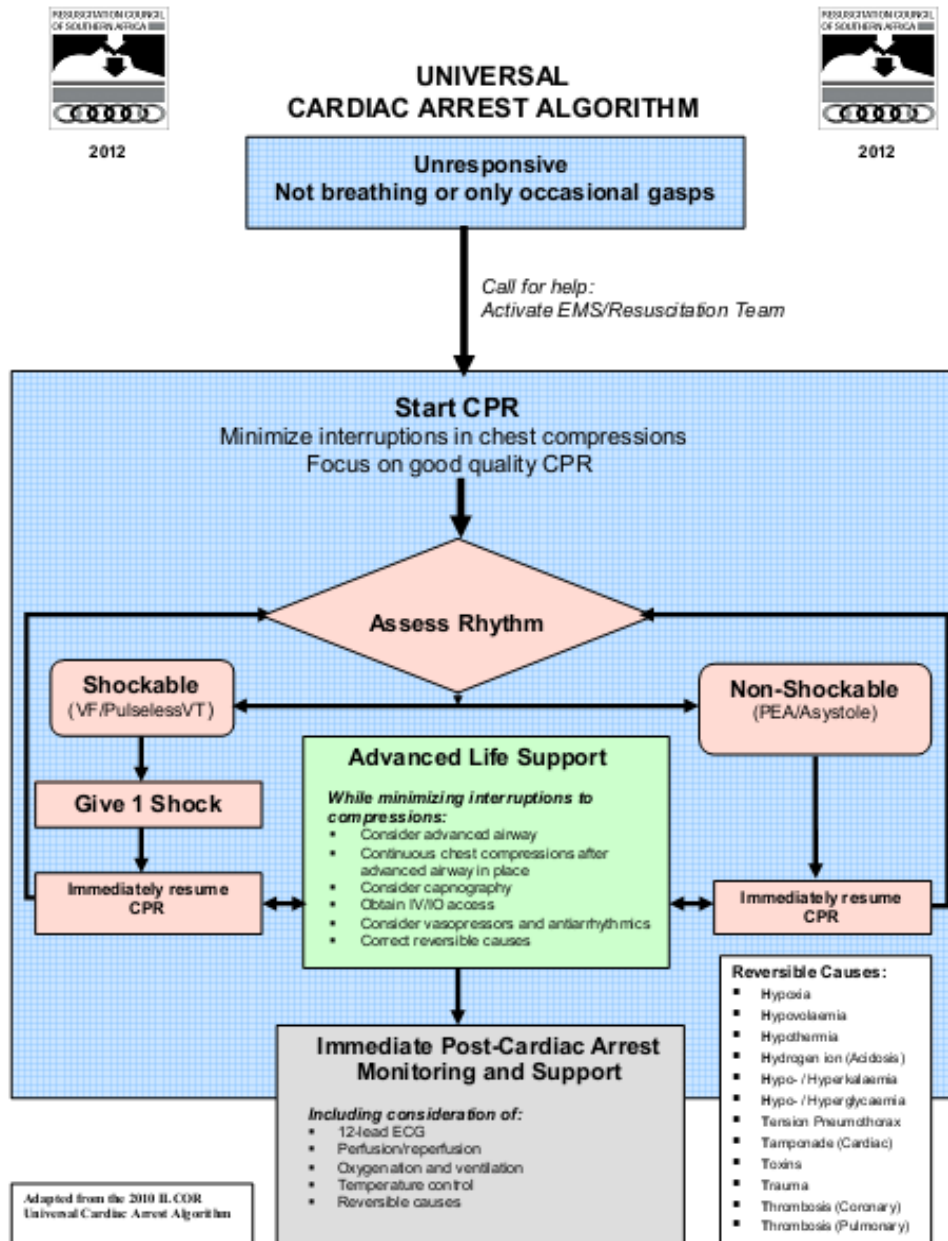
Note: The boxes bordered with dashed lines are performed by healthcare providers and not by lay rescuers.

© 2010 American Heart Association

APPENDIX 3

SARC CPR guidelines 2010

Courtesy Resuscitation Council of South Africa



APPENDIX 4

CPR Register

1.Date ___/___/___

2.Defibrillator used Y N

3.Hospital Sticker_____

4.Cause of arrest_____

5.Drugs

6.Cycles of CPR _____

i) Adrenaline Y N

ii) Amiodarone Y N

iii) Magnesium Y N

iv) Sodium Bicarbonate Y N

v) Insulin Y N

vi) Atropine Y N

vii) Other_____

7.Outcome of CPR

i) Return of Spontaneous Circulation(ROSC)

ii) No ROSC

8.Disposal of patient

i) Ward

ii) ICU/HCU

iii) Theatre

9.Qualification of treating doctor in charge

i) Intern ii) COSMO iii) MO iv) Registrar v) Consultant

10.Name of treating doctor_____

11.Additional notes

APPENDIX 5

Modified Utstein template for reporting of in-hospital cardiopulmonary resuscitation

PATIENT VARIABLES

1 Date of event __/__/__

2 Name/ Hospital #

3 Location of CPR

Age

ICU

M F Unknown

EC

Ward

Theatre

Other

EVENT VARIABLES

4 Immediate cause of arrest

Lethal arrhythmia

Traumatic causes

Other medical causes

OUTCOME VARIABLES

5 ROSC

Yes No

7 Survived to discharge

Yes No

6 Alive at 24hours

Yes No

8 Died (after ROSC)

Yes No

APPENDIX 6

Emergency Medicine Journal Instructions to Authors

Original articles

For full length accounts of original research, often shorter articles are better. Additional information may be placed on the web site as a data supplement.

Abstract: 250 words

Word count: up to 3000 words

Illustrations and tables: up to 6

References: 25

Peer review: all papers are reviewed by at least one reviewer. If there is uncertainty about acceptance after review, papers are reviewed by the editors.

References

Authors are responsible for the accuracy of cited references: these should be checked against the original documents before the paper is submitted. It is vital that the references are styled correctly so that they may be hyperlinked.

Citing in the text

References must be numbered sequentially as they appear in the text. References cited in figures or tables (or in their legends and footnotes) should be numbered according to the place in the text where that table or figure is first cited. Reference numbers in the text must be given in square brackets immediately after punctuation (with no word spacing)—for example, [6] not [6].

Where more than one reference is cited, separate by a comma—for example, [1, 4, 39]. For sequences of consecutive numbers, give the first and last number of the sequence separated by a hyphen—for example, [22-25]. References provided in this format are translated during the production process to superscript type, which act as hyperlinks from the text to the quoted references in electronic forms of the article.

Please note, if your references are not cited in order your article will be returned to you before acceptance for correct ordering.

Preparing the reference list

References must be double spaced (numbered consecutively in the order in which they are mentioned in the text) in the [slightly modified] Vancouver style (see example below). Only papers published or in press should be included in the reference list. (Personal communications or unpublished data must be cited in parentheses in the text with the name(s) of the source(s) and the year. Authors should get permission from the source to cite unpublished data.).

References must follow the [slightly modified] Vancouver style:

12 Surname AB, Surname CD. Article title. Journal abbreviation Year;**Vol**:Start page–End page.

Use one space only between words up to the year and then no spaces. The journal title should be in italic and abbreviated according to the style of Medline. If the journal is not listed in Medline then it should be written out in full.

Check journal abbreviations using PubMed.

List the names and initials of all authors if there are 3 or fewer; otherwise list the first 3 and add et al. (The exception is the Journal of Medical Genetics, which lists all authors.)

Example references:

Journal article

13 Koziol-McLain J, Brand D, Morgan D, et al. Measuring injury risk factors: question reliability in a statewide sample. *Inj Prev* 2000;**6**:148–50.

Cover letter

Your cover letter should inform the Editor of any special considerations regarding your submission, including but not limited to:

1. Details of related papers published or submitted for publication.
 - Copies of related papers should be submitted as “Supplementary files not for review” to help the Editor decide how to handle the matter.

Title page

The title page **must** contain the following information:

1. Title of the article.
2. Full name, postal address, e-mail, telephone and fax numbers of the corresponding author.
3. Full names, departments, institutions, city and country of all co-authors.
4. Up to five keywords or phrases suitable for use in an index (it is recommended to use [MeSH](#) terms).
5. Word count - excluding title page, abstract, references, figures and tables.

The manuscript must be submitted in Word. PDF format is not accepted.

The manuscript must be presented in the following order:

1. **Title page.**
2. **Abstract** (or summary for case reports) (note: references not allowed in abstracts or summaries).

3. **Main text** (provide appropriate headings and subheadings as in the journal. We use the following hierarchy: **BOLD CAPS**, **bold lower case**, Plain text, *Italics*).
4. **Tables** should be in the same format as your article (ie Word) and not another format embedded into the document. They should be placed where the table is cited and they must be cited in the main text in numerical order.
5. **Acknowledgments, Competing interests, Funding.**
6. **Reference list.**

Appendices (these should be Web only files to save space in the print journal; if so, please ensure you upload appendices as Web Only files and ensure they are cited in the main text as such.)

Images must be uploaded as separate files (view further details in Figures/illustrations) All images must be cited within the main text in numerical order.

Do not use the automatic formatting features of your word processor such as endnotes, footnotes, headers, footers, boxes etc. Please remove any hidden text.

Statistics

Statistical analyses must explain the methods used.

Style

Abbreviations and symbols must be standard and SI units used throughout except for blood pressure values which are reported in mm Hg.

Whenever possible, drugs should be given their approved generic name. Where a proprietary (brand) name is used, it should begin with a capital letter.

Acronyms should be used sparingly and fully explained when first used.

APPENDIX 7



UNIVERSITY OF CAPE TOWN

Faculty of Health Sciences
Human Research Ethics Committee
Room E52-24 Groote Schuur Hospital Old Main Building
Observatory 7925
Telephone [021] 406 6626 • Facsimile [021] 406 6411
e-mail: shuretta.thomas@uct.ac.za

01 April 2011

Sent via Internal mail & Email

HREC REF: 144/2011

Dr TE MABASA,
EMERGENCY MEDICINE
J-FLOOR
OMB

Dear Dr MABASA,

PROJECT TITLE: OUTCOMES OF ADULT CARDIOPULMONARY RESUSCITATION PERFORMED IN TWO HOSPITALS IN THE CAPE METROPOLE, SOUTH AFRICA.

Thank you for submitting your new study to the Faculty of Health Sciences Human Research Ethics Committee

It is a pleasure to inform you that the Ethics Committee has formally approved the above-mentioned study.

Approval is granted until 15 April 2012

Please submit an annual progress report (FHS016) if the research continues beyond the expiry date. Please submit a brief summary of findings if you complete the study within the approval period so that we can close our file.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please quote the HREC. REF in all your correspondence.

Yours sincerely

A/PROF MARC BLOCKMAN
CHAIRPERSON, FHS HUMAN ETHICS

Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938

This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Convention on Harmonisation Good Clinical Practice (ICH GCP) and Declaration of Helsinki guidelines.

The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

