Resuscitation Outcomes for Adult Patients with In-hospital cardiac arrest - Are we successful?

An Audit of Resuscitation Outcomes for the period January 2015 to December 2017 at Universitas Academic Hospital, Bloemfontein, using the Utstein Model.

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Declaration: This publishable manuscript is submitted in fulfillment of the requirements in respect of the master's degree MMed in the Department of Anaesthesiology in the Faculty of Health Sciences at the University of the Free State.

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1. Title:

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2. Declaration of own work:

I, Catharina Maria Strydom, declare that the coursework Master's degree MMed mini-dissertation that I herewith submit in publishable manuscript format for the Master's Degree qualification MMed(Anaesthesiology) in the Department of Anaesthesiology at the University of the Free State with the title:

Resuscitation Outcomes for Adult Patients with In-hospital cardiac arrest - Are we successful?

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is my independent work, and that I have not previously submitted it for a qualification at another institution of higher education. All sections of this publishable manuscript that use quotes or describe an argument or concept developed other authors have been referenced and due citation has been given.

(signed 8 December 2020)

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I, Catharina Maria Strydom, declare that I have no financial or personal relationship(s) which may have inappropriately influenced this research, conducted by myself, or my writing this publishable manuscript. I declare that I have no possible conflicts of interests.

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Spanish-American philosopher George Santayana famously said: *"Those who cannot remember the past are condemned to repeat it"*. May this resuscitation audit enable the heroes of Universitas Academic Hospital to learn from our past efforts, prevent us from repeating our errors, and encourage us to continuously strive to improve resuscitative measures.

This publishable manuscript is dedicated, in loving memory, to my mother Isabella Elizabetha Strydom.

5. Abstract

Title

Resuscitation Outcomes for Adult Patients with In-hospital cardiac arrest - Are we successful? *An Audit of Resuscitation Outcomes for the period January 2015 to December 2017 at Universitas Academic Hospital, Bloemfontein, using the Utstein Model.*

Abstract

Background

The Utstein Model consensus definitions and template allows for the reliable and reproducible recording of data during cardiopulmonary resuscitation (CPR). Enabling inter-institutional comparison of resuscitation outcomes to ensure comparable standards of care.

Objectives

To assess resuscitation outcomes for adult patients with in-hospital cardiac arrest at Universitas Academic Hospital (UAH), Bloemfontein, using the Utstein Model and compare them to similar institutional outcomes in South Africa as well as internationally.

Methods

This study is a retrospective audit of resuscitation reports of adult in-patients for the period January 2015 to December 2017.

Results

194 institutional resuscitation reports were collected for adult in-patients for this study period with 189 reports meeting inclusion criteria. 28,0% of patients survived the cardiac arrest event, 32,8% of patients displayed return of spontaneous circulation (ROSC) with a survival to hospital discharge rate of 12,3%. Of the shockable first rhythms, 2,9% were not defibrillated. Median time to defibrillation was 10 minutes (2-38min range), a large deviation from the acceptable norm at comparable institutions. Advanced airway management strategies made no impact on ROSC (p-value 0.77) or survival to hospital discharge (p-value 0.53). Mechanical ventilation was superior to a bag-mask ventilation strategy for ROSC (p-value <0,001) and survival to hospital discharge (p-value 0.0012). Adherence to ACLS protocols for inotropic support was associated with ROSC (p-value < 0.001) and survival to hospital discharge (p-value < 0.001).

Conclusion

Resuscitation outcomes at UAH are comparable to similar institutions. UAH should focus on improving defibrillation practice. Adherence to ACLS principles of adrenaline administration is paramount in the survival of cardiac arrest.

Keywords

Utstein, resuscitation reporting template, resuscitation, resuscitation outcomes, In-hospital resuscitation, adult resuscitation outcomes, CPR outcomes, South Africa

6. List of abbreviations

ACLS:	Advanced Cardiovascular Life Support
AHA:	American Heart Association
ANTS:	anaesthetists' non-technical skills
BLS:	Basic Life Support
BMV:	Bag-mask ventilation
CanMEDS:	Canadian Medical Educational Directives for Specialists
CPR:	cardiopulmonary resuscitation
$ETCO_2$:	end-tidal CO_2
ETT:	endotracheal tube
ILCOR:	International Liaison Committee on Resuscitation
NRCPR:	National Registry of Cardiopulmonary Resuscitation
PEA:	pulseless electrical activity
ROSC:	return of spontaneous circulation
SGA:	supraglottic airway
VF:	ventricular fibrillation
VT:	ventricular tachycardia
UAH:	Universitas Academic Hospital

7. Chapter One

I. Cardiac arrest and cardiopulmonary resuscitation

Cardiac arrest occurs when cardiac mechanical activity ceases and/or becomes disassociated with electrical activity of the heart. This clinical entity is diagnosed by signs of loss of cardiac output and systemic circulatory collapse. With hypoperfusion of body tissues apoptosis will be initiated leading to vital organ death and subsequently death of the individual person. Resuscitative measures by means of cardiopulmonary resuscitation (CPR) aims to maintain perfusion to vital organs, whilst other resuscitative measures are employed to resynchronize the electro-mechanical function of the myocardium. CPR is thus a lifesaving skill requirement for any health care professional that might witness or be called to assist in in-hospital cardiac arrest scenarios.[1,2]

II. The Anaesthesiologist and cardiopulmonary resuscitation

Anaesthesiologists possess certain speciality dependent competencies which are often called upon to be applied to resuscitative scenarios in in-hospital cardiac arrests. Advanced airway management techniques, a broad knowledge of cardiopulmonary physiology and pharmacology, as well as the manipulation of physics in medicine, all form an integral part of the subject matter necessary for competence in anaesthesiology. Furthermore, anaesthesiologist training imparts anaesthetists' non-technical skills (ANTS), which comprises of task planning and management; coordination of teamwork; situational awareness and critical decision-making prerogatives[3, 4]; which are a major advantage in the management of cardiac arrest events. These competencies establish a clear professional duty for the anaesthetist to be an advocate in the arena of in-hospital cardiopulmonary resuscitation.

The Royal College of Physicians and Surgeons of Canada designed the Canadian Medical Educational Directives for Specialists (CanMEDS) competency framework guideline which serves the dual purpose of directing teaching and training of specialist in order to attain competency in their field of speciality as well as ensuring that societal accountability is maintained.[3,4] This competency framework defines the medical expert as a professional, communicator, collaborator, leader, health advocate and scholar.[3] *Kalafatis et al* defined fitness for purpose in the context of the South African anaesthesiologist, integrating contextual awareness and humaneness into this Modified CanMEDS for South African Anaesthesiology model.[4] When considering the fitness for purpose of anaesthesiologists in our context it must be noted that to be *experts without any deficiencies in either their technical or non-technical skills*[4] it becomes clear that it is both our professional duty and ethical imperative to be proponents for the advancement of current evidence based cardiopulmonary resuscitation practices in our spheres of influence.

Medical experts are burdened with stewarding aspects of clinical governance. This is a framework through which organisations are held accountable for continually improving the quality of their services rendered and protecting high standards of care by creating an environment of excellence; the goal being the delivery of quality care.[5] Where quality refers to the degree to which health services for patients increase the likelihood of a desired health outcome which remains consistent with current professional knowledge.[6] This is achieved by a culture of openness and transparency with a focus on clinical effectiveness, risk management, education and training endorsements, continual research and development initiatives, as well as clinical audit implementation.[5] During the cyclical clinical audit process the goal is to refine and improve on the current clinical practice by improving patient care and outcomes. This is achieved by measuring performance through a systematic review of care against an agreed to criteria of standard of care with the aim of implementing change.[5]

III. Cardiopulmonary resuscitation at Universitas Academic Hospital

When considering the question of success of the resuscitation outcomes for adult patients with in-hospital cardiac arrest at Universitas Academic Hospital (UAH), conducting a standard-based clinical audit is prudent. One must consider the set criteria and outcome standards for adult patients suffering from in-hospital cardiac arrest in comparable centres, specifically in South Africa as well as internationally. The outcomes must be observed, measured, and compared to the current identified performance standard of care. Once the quality of outcomes has been comparatively assessed, factors that may improve or hinder efficacy of the clinical interventions may be identified.[5]

At UAH a resuscitation report is generated for each cardiac arrest. This is reviewed by a Resuscitation Committee, which is made up of representatives from the department of Anaesthesiology, department of Paediatrics, Bioengineering, assistant manager of nursing, and nursing personnel from theatre, the nursing college, and the nursing audit committee. Auditing is needed to ascertain if the institution's resuscitation success rate is comparable with other tertiary level institutions.

IV. The Utstein Model

Universal Consensus definitions regarding the nomenclature of cardiac arrest scenarios are necessary to ensure that data is reliably and reproducibly recorded.[7] The Utstein Reporting Template (Appendix E) provides such a consensus definition, as recommended by the task force of the International Liaison Committee on Resuscitation (ILCOR).[7,8] Templates like these enable comparison of outcomes in different institutions[7]; and the better understanding and identification of elements of resuscitation practice that may enhance outcomes.[7,8,9] Since *Kouwenhoven and colleagues* demonstrated in 1960 that closed chest compressions were an effective means of CPR,[8] it has become one of the most

frequently performed medical interventions in the world.[8] Despite large investments of healthcare resources towards the research of resuscitation as well as formalized training of personnel, prior to the development of the Utstein style model in 1997, no universally accepted guideline of uniform definitions and nomenclature was available. Thus, the true effectiveness of in-hospital resuscitative efforts was unknown.[8]

The original Utstein style guideline was amended in 2004 and is now commonly accepted as the *gold standard* for outcome comparisons when researching CPR.[7] Originally, due to validation in terms of outcome-based comparisons, the task force recommended for comparisons to be process based. The three inter-institutional comparators recommended being; *interval from collapse to first shock for patient in ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT), interval from collapse to achievement of advanced airway management, and interval from collapse to first intravenous administration of epinephrine*.[8] Formerly the ILCOR recognized *collapse to first CPR attempt* and *collapse to first defibrillation attempt* as the two most important time intervals affecting patient survival.[7] The National Registry of Cardiopulmonary Resuscitation (NRCPR) is an American Heart Association sponsored in-hospital event registry which has identified four *gold-standard* intervention intervals that affect cardiac arrest outcomes. These intervals following recognition of pulselessness are starting CPR within one minute, delivering the first defibrillation within three minutes when VF/ pulseless VT is the initial first rhythm, successful endotracheal intubation within five minutes, and administering the first dose of intravenous or intraosseous adrenaline within five minutes.[10,11]

Additional evaluation of in-hospital *chain of survival* contributors of *early recognition, call for help, and arrival of the cardiac arrest team*, were emphasized.[8] Resuscitation nomenclature has also been reviewed by the ILCOR task force to ensure consensus definitions to prevent inconsistencies in data reporting.[7] The 2019 Consensus Report from the ILCOR on in-hospital Utstein guidelines have foregone this former gold standard time-interval documentation in order to measure performance. The only time intervals currently emphasised are the time of arrest and the time of ROSC or termination of CPR.[12,13]

V. Ratified Utstein Model for Universitas Academic Hospital

Lamacraft and colleagues revised these Utstein definitions for the purposes of their pilot study and *Audit of Resuscitation Reports from January 2012 to June 2013 at Universitas Hospital, Bloemfontein using the Utstein model in 2014* (unpublished report),[14] authors' permission was obtained to utilize this revised template (Appendix F) for the purposes of this original research work. Ratifications made by *Lamacraft and colleagues* enabled the data capturing of the different in-hospital locations specific to UAH and excluded out of hospital cardiac arrests.

VI. Factors impacting CPR outcomes in literature

Sparce evidence exists regarding which pre- and post-arrest factors might be employed for outcome prognostication. Patient factors such as premorbid conditions, the location of the in-hospital arrest, arrest factors such as who witnessed the arrest, initial rhythm, time to interventions, time of day of arrest, system factors such as teaching status of the institution and the availability of a rapid response team, may all impact on resuscitation outcomes.[15] Furthermore, the outcome of CPR is dependent on the efficacy of multiple interventions. Early defibrillation, effective chest compressions, assisted ventilation strategies and adherence to advanced life support strategies, have been identified as interventions that may improve outcomes.[7]

The *2015 AHA Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care* is a consensus summary guiding health care professionals as to how resuscitative measures for adult patients should be conducted to ensure the best possible patient mortality and morbidity outcomes.[1] These guidelines are based on the initial 2010 publication of treatment recommendations by ILCOR. Having undergone a rigorous review process where the available scientific body of evidence is evaluated and then categorized using the standardized methodological approach proposed by the Grading of Recommendations Assessment, Development and Evaluation (GRADE) Working Group, this publication has become the gold standard guideline for performing adult CPR in the United States[1] and has been adopted in many countries worldwide, including South Africa.

Basic life support (BLS), advanced life support (ACLS) and post-cardiac arrest care represent care bundles that encompass specific skill sets, as well as applied knowledge in cardiac arrest scenarios reflecting the principles of *2015 AHA Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care*.[1] The fundamentals of cardiopulmonary resuscitation namely high-quality chest compressions, basic airway management and the delivery of appropriate ventilation and providing rapid defibrillation via an AED are addressed by BLS. Whereas ACLS encompasses team dynamics and communication training, the recognition of and intervention in cardiac arrest as well as the immediate post-cardiac arrest care.[16]

Such training has now become mandatory for certain health care practitioner certifications and clinical hospital privileges. The US spends an estimated 1 billion dollars annually on resuscitation training.[17] ACLS training improves skill acquisition and retention as well as increases the total number of attempted resuscitations.[17] *Moretti et al* demonstrated that the presence of an ACLS-trained resuscitator on the rapid response team increased the rate of return of spontaneous circulation (ROSC) (O.R 2.06; 1.038-4.078; IC 95%; p=0.037) and yielded significantly greater long-term patient survival.[17]

In the *2015 AHA Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care* authors' recommendations cover numerous areas of intervention. With regards to supplemental oxygen use, it was recommended that the maximal feasible fraction of inspired oxygen be administered during CPR (Class IIb) as the deleterious effects of hyperoxia that has been demonstrated in the post-cardiac arrest period cannot be extrapolated to the low-flow state of CPR.[1]

With regards to advanced airway management and ventilation the authors emphasise that the choice of airway device is highly dependent on the health care provider's training and experience in the use of a synchronised bag-mask ventilation (BMV) strategy compared to the speed and accuracy of supraglottic airway device (SGA) or endotracheal tube (ETT) placement. BMV may be inadequate to ventilate some patients and this strategy may predispose the patient to pulmonary aspiration of gastric content. With the placement of an advanced airway comes the risk of unrecognised inadvertent oesophageal intubation as well as prolonged hands-off chest time.[1] The recommendation is for trained health care providers to use either SGA or ETT for airway management during CPR (Class IIb).[1] It is challenging assessing retrospective studies comparing BMV to ETT as the studies are confounded by prognostication bias of the resuscitators. Also, the worse the physiological compromise of the patient, the more often the health care provider would opt for more invasive strategies such as ETT.[1]

Authors recommend the use of continuous waveform capnography in addition to clinical assessment to confirm correct ETT placement (Class I). Reasonable alternatives are non-waveform CO_2 detector devices or ultrasound confirmation by an experienced operator (Class IIa).[1] Recommendations for ventilation with an advanced airway is for the resuscitator to deliver one breath every six seconds (rate of ten breaths per minute) with continuous chest compressions (Class IIb).[1]

Further application of ultrasound during cardiac arrest includes screening for potentially treatable cases of cardiac arrest such as hypovolaemia, tension pneumothorax, pericardial tamponade, and pulmonary embolism. Evidence supporting the routine use of ultrasound screening in cardiac arrest is sparse, showing no difference in ROSC when ultrasound was utilised. Thus, the authors recommend that its use may be considered as long as the scanning does not interfere with delivery of high-quality chest compressions and other standard cardiac arrest guidelines (Class IIb).[1]

The authors recommend monitoring physiological parameters as to optimise the quality of CPR performed and guide the vasopressor strategy as well as aid in detection of ROSC (Class IIb).[1] The use of End-Tidal CO_2 ($ETCO_2$) as prognostic tool may be considered as one constituent of a multifactorial approach to decide on termination of resuscitation. Failure to achieve an $ETCO_2$ of more than 10mmHg by waveform capnography after 20 minutes of high-quality CPR in the intubated patient, may be highly predictive of futility of the resuscitative effort.[1]

In VF/ pulseless VT defibrillators using biphasic or monophasic waveform designs may be utilised, with biphasic waveforms being the preferred modality for termination of both atrial and ventricular dysrhythmias (Class IIa).[1,2] Authors conclude using the manufacturer's recommended energy dose for the first shock. If this recommendation is unknown to the rescuer, defibrillation at maximal dose should be administered.[1,2] For subsequent shocks a fixed energy dose may be used if thus specified by the manufacturer's recommendations (Class IIa).[1,2] In the case of manual defibrillation escalating energy is advisable (Class IIb).[1,2] When comparing single shock strategies to stacked shocks there is evidence that immediate resumption of chest compressions may induce recurrent VF, but the benefit incurred by supporting coronary perfusion outweighs the possible benefit of immediate re-defibrillation.[1] Authors recommend a single-shock defibrillation strategy (Class IIa).[1,2]

Regarding vasopressor use in cardiac arrest, the recommendation of standard dose adrenaline (1mg every three to five minutes) was maintained (Class IIb).[1,2] High dose adrenaline (0.1-0.2mg/kg) is not recommended for routine use in cardiac arrest. Trials have shown increased rates of ROSC with high dose adrenaline but survival to discharge and neurological outcomes were comparable.[1,2] Vasopressin as a substitute for adrenaline or in combination with adrenaline confers no additional benefit during cardiac arrest (Class IIb).[1,2] For non-shockable rhythms early adrenaline administration improves survival to hospital discharge (Class IIb). No benefit was demonstrated with the early administration of adrenaline in shockable rhythms, but worse outcomes were found with late administration.[1,2]

With regards to the administration of other antidysrhythmic agents in cardiac arrest amiodarone is recommended for VF/ pulseless VT not responding to defibrillation, CPR and vasopressor therapy (Class IIb).[1,2] Lignocaine may also be considered as an alternative to amiodarone in this scenario (Class IIb).[1,2] The routine use of magnesium is not recommended (Class III).[1,2]

In centres with access to specialised equipment and the human resources trained in extracorporeal membrane oxygenation (ECMO), extracorporeal membrane oxygenation during CPR (ECPR) may be considered as an adjunct in cardiac arrest scenarios where the suspected aetiology is of potentially reversible cardiac origin. The routine use of ECPR in cardiac arrest is not recommended (Class IIb).[1,2]

VII. Other institution's outcomes using the Utstein Model

The standard of CPR at comparable institutions to UAH has been audited utilising the Utstein template.[11,15]

In developing countries there is limited data to this effect. To date no literature has been published about outcomes in comparable institutions in South Africa. *Krittayaphong et al* reviewed 2747 cardiac arrest incidents recorded in the Siriraj Cardiopulmonary Resuscitation Registry in Thailand, for the period of January 2003 to December 2006.[18] They reported 49.8% ROSC, 21% 24 hour survival post cardiac arrest and 7.4% survival to hospital discharge.[18] When assessing collapse-to-treatment intervals, BLS was reportedly initiated within one minute in 83.1% and ACLS within four minutes in 78.6% of arrests.[18] The question begs if this data from this population can be extrapolated to the South African.

Schneider et al published a meta-analysis reviewing 30 years of cardiopulmonary resuscitations (spanning 1960-1990) and found a 15% rate of survival to discharge from hospital.[19] It was demonstrated that general hospitals success rate was higher (18.5%) compared to teaching hospitals (13.6%).[19] This might reflect the poorer general functional status of the patients as well as comorbidity profile of the patients treated at tertiary level institutions, rather than be a signal for poor CPR technique. CPR success declined with patient's age; with 16.2% for patients under the age of 70 years and 12.4% for patients over the age of 70.[19] The limitation of this meta-analysis is the heterogeneity of the data reporting of the studies included, as no standard reporting guideline had been in use during this time period.

The NRCPR 2003 Utstein-based report of 14720 cardiac arrests in the United States for the period January 2000 to June 2002 is to date the largest study of its kind.[11] The average number of cardiac arrests per year per facility was reported as 54.1± 41.5.[11] The initial pulseless rhythm was reported as 36% asystole, 30% PEA, 25% VT/VF and unknown in 9%.[11] The overall ROSC was 44%; 63% in pulseless VT, 58% in VF, 39% in pulseless electrical activity (PEA) and 35% in those with asystole, respectively.[11] When evaluating overall survival to hospital discharge, a success rate of 17% was reported.[11] With pulseless VT at 35% and VF 34% compared to PEA and asystole at 10% respectively.[11] A median time of collapse to first delivered shock for VT/VF was less than one minute, with 75% defibrillated within three minutes. This yielded a 38% survival rate compared to 21% survival rate, if the first shock is delayed for longer than three minutes.[11] About two thirds of VT/VF arrests received at least one antidysrhythmic agent.[11] Non-invasive airway management (BMV or equivalent) was utilized in 67% of cardiac arrests with invasive ETT achieved in 85.9% of patients. Tracheotomies were used in 2.9% and SGA devices in 0.2%. Most common aetiologies for cardiac arrest were cardiac dysrhythmia (49%), acute respiratory insufficiency (37%) and hypotension (32%).[11]

Jones and colleagues reported on 415 cardiac arrests in Auckland City Hospital, New Zealand, for the period of 2004-2006 and reported a survival to hospital discharge rate of 27.2%.[15] They similarly demonstrated higher survival rates with an initial VT/VF rhythm and cardiac arrest in younger patients.[15] If the arrest occurred inside of normal working hours survival was twice as likely.[15] About two thirds of cardiac arrests reported

by *Jones and colleagues* occurred outside of normal working hours.[15] Difference in staffing, leadership and team work,[15] as well as the impact of circadian rhythms on disease severity may all be salient factors.[15,24]

Fredriksson and colleagues reported on 833 cardiac arrests in Sahlgrenska University Hospital, Sweden, and demonstrated a 37% survival to hospital discharge rate with a 83% one year survival rate with good neurological outcomes in 94% of survivors.[20] Other authors reported on smaller cohorts with ROSC success rates of 57%[21], 52%[23], 35%[22], and survival to hospital discharge rates of 30%[21], 26%[22], 14.5%.[23]

An important caveat to these outcome rates is resuscitation attempts which were terminated early due to presumed futility of the resuscitation. The European Resuscitation Guideline directs withholding CPR as an ethical imperative when futility has become evident.[25] *Loisa and colleagues* concluded that futility accounted for around 14% of early terminations of CPR attempts.[25] Factors cited for early termination of CPR includes a non-witnessed arrest with an initial rhythm of asystole, severe acute illness, severe co-morbidity, advanced age, advanced single chronic disease, advanced dementia, massive aspiration and advanced malignancy.[25] *Loisa and colleagues* make the case that in-hospital cardiac arrest outcome rates are not as poor as literature may suggest as numbers do not account for the significant portion of futile attempts undertaken. Due to better training of health care practitioners in BLS and ACLS, resuscitators become more confident regarding their skills and they may attempt resuscitations which when considered prudently were futile from the onset. These early terminations due to futility may account for why the overall prognosis of patients with in-hospital cardiac arrest remains unaffected.[25]

One must consider the possible bias in recording of data during events of cardiac arrest. When an additional person is added to the resuscitation team for the exclusive recording of data, time intervals were still documented erroneously.[26] Missing time data elements were observed by *Kaye et al* on review of the NRCPR in 10.9% of records.[10] This brings into question the validity of using recorded time elements to assess the four *gold-standard* intervention intervals that affect cardiac arrest outcomes. Future efforts must be directed to improve this.[27]

A quality-of-care evaluation in the USA revealed that 70% of patients received care as recommended by guidelines, whereas 30% received care that could be considered contraindicated.[28] The proportion of calls for assistance by the rapid response team in some institutions has been documented between 21%[29] – 62%.[30] These caveats which concern the human element must be considered. Even though extensive algorithms exist to guide cardiopulmonary resuscitation, teamwork and leadership impact on putting these guidelines into clinical practice. Non-adherence of resuscitation teams may negatively impact on resuscitation outcomes.

Early initiation of CPR and rapid defibrillation improves survival, with demonstratable survival rates decreasing 10% for every one-minute treatment is delayed.[31] Collapse to arrival of the rapid response team time was achieved in under five minutes in 81% of hospitals surveyed by *Sandroni et al*.[32] The collapse to arrival time of the rapid response team is associated with improved ROSC and survival to discharge rates if the rapid response team arrives in under three minutes.[33,34]

In units with non-monitored areas and where rapid bystander defibrillation is not available or health care personnel are reluctant to utilise defibrillation in the absence of a medical doctor, survival strongly depends on the early arrival of the rapid response team and early defibrillation.[34] Sandroni and colleagues showed collapse to start of ACLS in survivors was significantly shorter (1.30± 1.70) compared to non-survivors (2.51±2.37; $p < 0.0035$).[34]

VIII. The role of the rapid response resuscitation team in literature

Principles of a highly reliable organizations in health care include a *preoccupation with failure, a reluctance to simplify, sensitivity to operations, resilience and deference to expertise*.[35] The *Big Five* model consists of five essential competencies for adequate team work namely *team leadership, mutual performance monitoring, backup behaviour, adaptability and team orientation*.[35] For these competencies to flourish collaborative decision making with information exchange, closed-loop communication and a culture of mutual trust is essential.[36,37] Factors specifically identified in playing a role in effective resuscitation team dynamics are team design, team composition and role allocation, team communication and leadership, and the training and education of the team.[31] The shortfall in resuscitation guidelines which offer a logical and sequential approach with regards to technical skills and time intervals at which they must be performed, is that they cannot adapt to the complex nature of an actual cardiac arrest scenario and the dynamics of the specific resuscitation team.[40] One must consider individual characteristics of each team member with regards to technical skill training and competency, previous exposures, communication styles, and leadership directives that coalesce during the decision making process during a resuscitation.[38] Specific societal norms and the dynamic interaction of the collective may also lead to deviation from guidelines.[38] Resuscitation team leaders who above their coordinating role also had hands-on responsibilities during CPR simulations were less efficient leaders and team performance suffered.[38] The interplay of these human factors or non-technical skills must be guided to ensure good clinical team performance.[38] Deploying dedicated rapid response teams may help to achieve this.[31]

When a cardiac arrest occurs at UAH, the first responder medical practitioner will initiate CPR with the ward personnel and call for activation of the rapid response Resuscitation Team. This team comprises of registrar from the department of anaesthesiology and a registrar rotating in the critical care unit. This team only renders this service during

normal working hours. After-hours the primary speciality responsible for the patient's care physician on call will be alerted and they will in conjunction with the physician on call for the Critical Care Unit conduct the resuscitation. Upon end of event, the resuscitation team leader completes the resuscitation report, which is then collected by the resuscitation sister.

IX. Future developments in cardiac arrest management and utilisation of the Utstein Model

Future developments in the area of in-hospital cardiac arrest management and monitoring of resuscitation practices include web-based Utstein style care practice cards,[39] web-based Utstein style data management software programs,[40] collaborative efforts to solve the time-data capturing problem,[13] performance check lists[37] and audio recordings of cardiac arrest scenarios.[32] There remains a reluctance of investigators to contribute their data into a universal central registry due to concerns regarding data ownership and security as well as patient confidentiality and resuscitator/ institutional liability.[7] De-identification of data sets and the application of these technologies may aid in the advancement of a standardised data collection initiative.[7]

X. Summary

CPR is a lifesaving skill for health care professionals. The outcome of CPR is influenced by early defibrillation, high-quality chest compressions, assisted ventilation strategies and adherence to advanced life support algorithms.[7] The Utstein Model provides consensus definitions and a template which allows for the reliable and reproducible recording of data during CPR.[7] Which enables the comparison of resuscitation outcomes in different institutions with a better understanding of the elements of resuscitation practice that may enhance outcomes. The authors will endeavour to utilize a ratified Utstein Model to compare resuscitation outcomes at UAH to those of similar institutions in South Africa as well as internationally.

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8. Chapter Two

I. Title Page

Resuscitation Outcomes for Adult Patients with In-hospital cardiac arrest - Are we successful? - *An Audit of Resuscitation Outcomes for the period January 2015 to December 2017 at Universitas Academic Hospital, Bloemfontein, using the Utstein Model.*

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Title

Resuscitation Outcomes for Adult Patients with In-hospital cardiac arrest - Are we successful? *An Audit of Resuscitation Outcomes for the period January 2015 to December 2017 at Universitas Academic Hospital, Bloemfontein, using the Utstein Model.*

Abstract

Background

The Utstein Model consensus definitions and template allows for the reliable and reproducible recording of data during cardiopulmonary resuscitation (CPR). Enabling inter-institutional comparison of resuscitation outcomes to ensure comparable standards of care.

Objectives

To assess resuscitation outcomes for adult patients with in-hospital cardiac arrest at Universitas Academic Hospital (UAH), Bloemfontein, using the Utstein Model and compare them to similar institutional outcomes in South Africa as well as internationally.

Methods

This study is a retrospective audit of resuscitation reports of adult in-patients for the period January 2015 to December 2017.

Results

194 institutional resuscitation reports were collected for adult in-patients for this study period with 189 reports meeting inclusion criteria. 28,0% of patients survived the cardiac arrest event, 32,8% of patients displayed return of spontaneous circulation (ROSC) with a survival to hospital discharge rate of 12,3%. Of the shockable first rhythms, 2,9% were not defibrillated. Median time to defibrillation was 10 minutes (2-38min range), a large deviation from the acceptable norm at comparable institutions. Advanced airway management strategies made no impact on ROSC (p-value 0.77) or survival to hospital discharge (p-value 0.53). Mechanical ventilation was superior to a bag-mask ventilation strategy for ROSC (p-value <0,001) and survival to hospital discharge (p-value 0.0012). Adherence to ACLS protocols for inotropic support was associated with ROSC (p-value < 0.001) and survival to hospital discharge (p-value < 0.001).

Conclusion

Resuscitation outcomes at UAH are comparable to similar institutions. UAH should focus on improving defibrillation practice. Adherence to ACLS principles of adrenaline administration is paramount in the survival of cardiac arrest.

Keywords

Utstein, resuscitation reporting template, resuscitation, resuscitation outcomes, In-hospital resuscitation, adult resuscitation outcomes, CPR outcomes, South Africa

II. Publishable Article:

"Those who cannot remember the past are condemned to repeat it."
- George Santayana, Spanish-American philosopher

Introduction:

Cardiac arrest is the cessation of mechanical output and/or dissociation of electro-mechanical activity of the heart and is recognized by the loss of cardiac output and circulatory collapse. Cardiopulmonary resuscitation (CPR) aims to maintain perfusion to vital organs whilst other resuscitative measures are employed to resynchronize electro-mechanical function.[1,2] Since Kouwenhoven and colleagues demonstrated in 1960 that closed chest compressions were effective,[3] CPR became a life-saving skill for health care professionals. The outcome of CPR is influenced by early defibrillation, high-quality chest compressions, assisted ventilation strategies and adherence to advanced life support algorithms.[4]

Universal consensus definitions regarding the nomenclature of cardiac arrest scenarios are necessary to ensure that data is reliably and reproducibly recorded.[3] The Utstein Reporting Template provides such a consensus definition, as recommended by the task force of the International Liaison Committee on Resuscitation (ILCOR).[3] Templates like these enable comparison of outcomes in different institutions[3] and the better identification and understanding of the elements of resuscitation practice which may enhance outcomes.[3,5]

The original Utstein style guideline was amended in 2004 and is now commonly accepted as the gold standard for outcome comparisons when researching CPR.[3] For the sake of greater validity of data collected, the task force recommended for comparisons to be process based, focussing on three comparators, interval from collapse to first defibrillation for patient in ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT), interval from collapse to achievement of advanced airway management and interval from collapse to first intravenous administration of adrenaline.[3] Formerly ILCOR recognized the two most important time intervals affecting patient survival as the collapse to first CPR attempt and collapse to first defibrillation attempt.[3] The 2019 Consensus Report from the ILCOR on in-hospital Utstein guidelines have foregone these former gold standard time-intervals, emphasizing only time intervals; time of arrest, the time of return of spontaneous circulation (ROSC) or termination of CPR.[5,6]

The American Heart Association sponsored in-hospital event registry, the National Registry of Cardiopulmonary Resuscitation (NRCPR), have identified four gold-standard intervention intervals that affect cardiac arrest outcomes. Following recognition of pulselessness these intervals are: starting CPR within one minute, delivering the first defibrillation within three minutes when VF/pulseless VT is the initial rhythm, successful endotracheal intubation within five minutes, and administering the first dose of intravenous/ intraosseous adrenaline within five minutes.[8,9] Other contributors of survival include: early recognition, call for help, and arrival of the rapid response resuscitation team.[3]

Little evidence for pre- and post-arrest factors serving as prognostic markers exists. Any premorbid conditions of the patient as well as the location of the in-hospital arrest influences resuscitation outcomes.[10]Aarrest factors such as who witnessed the arrest, the initial first rhythm, the time to interventions and the time of day of the arrest may also affect outcomes.[10] System factors such as the teaching status of the institution as well as the availability of a rapid response team may all impact on resuscitation outcomes.[10]

Medical experts are burdened with stewarding aspects of clinical governance, ensuring institutional accountability for continually reviewing and improving on the quality of cardiopulmonary resuscitation rendered by our institutions.[11] Recognizing this as a professional duty bound ethical imperative,[12] the authors considered the question of success of the resuscitation outcomes for adult patients with in-hospital cardiac arrest at Universitas Academic Hospital (UAH), Bloemfontein, and set out to assess how our institutional resuscitation outcomes compared to those in similar centres in South Africa as well as internationally. This was achieved by conducting a clinical audit of UAH resuscitation reports, generated over the study period of January 2015 to December 2017.

When a cardiac arrest occurs at UAH, the first responder medical practitioner will initiate CPR and call for activation of the rapid response Resuscitation Team. This team only renders this service during normal working hours. After-hours the primary speciality responsible for the patient's care physician on call will be alerted and they will, in conjunction with the physician on call for the Critical Care Unit, conduct the resuscitation. Upon end of event, the resuscitation team leader completes the resuscitation report, which is then collected by the resuscitation sister. At UAH a resuscitation report is generated for each cardiac arrest event. This is reviewed by a Resuscitation Committee, which is made up of various institutional stake holders.

Methods:

Approval of the study protocol was obtained from the Health Sciences Research Ethics Committee (HSREC) (UFS-HSD 2018/1605/2805) and Free State Department of Health (FSDoH) in November 2018. This study was conducted in the form of a retrospective audit of resuscitation reports of adult in-patients for the period January 2015 to December 2017.

Lamacraft and colleagues revised the Utstein definitions and template for the purposes of their pilot study and *Audit of Resuscitation Reports from January 2012 to June 2013 at Universitas Hospital, Bloemfontein, using the Utstein model* in 2014 (unpublished manuscript).[13] These revisions permitted the data capturing of the different in-hospital locations *specific* to UAH. Authors' permission was obtained to utilize this revised template for data collection.

Important Utstein definitions are:

-*Return of spontaneous circulation* where no chest compressions have been required for 20 consecutive minutes with persisting signs of sustained circulation

-*Event survival* where there is sustained ROSC for ≥20 minutes.[3,4]

Results:
A total of 194 resuscitation reports were collected for adult in-patients for this study period. Five of these reports were excluded as they were erroneously completed (no cardiac arrest had occurred). Of the 189 cardiac arrests analysed, 28,0% of the patients *survived the event*, 32,8% of outcomes were *successful* as defined in terms of the Utstein definitions, displayed ROSC[3], with 32,8% of the patients having *any ROSC* during the resuscitative effort. *Survival to hospital discharge rate* was 12,3%, with only one patient lost to follow-up.

The study population comprised of 36% resuscitation reports for 2015, 38% for 2016 and 26% for 2017. No statistically significant associations could be made between the month in which the cardiac arrests occurred and factors such as seasonality, number of resuscitations or outcome.

To determine statistical relevance the Chi-square test was performed. Where the Chi-square test was invalid due to data set limitations the Fisher's exact test was performed.

The study population by age group and the impact of patient age on resuscitation outcomes are summarised in **Table I**. Age was not a statistically significant factor for the survival of a cardiac arrest event (p-value 0.39).

Table I: **Study Population Age and Outcomes**

Age group	% of total study population	Successful ROSC	Cardiac arrest event survival	Survival to hospital discharge rate
18-44 years	33,9%	24,4%	22,2%	26,1%
45-64 years	37,6%	40,0%	32,9%	39,1%
65+ years	28,5%	28,5%	28,9%	34,8%

The location of the cardiac arrest event at UAH and the impact on event survival was not statistically significant as depicted in **Figure 1**. The Referral Unit had the highest incidence (18,9%) of event survival followed by the Theatre Complex (15,1%).

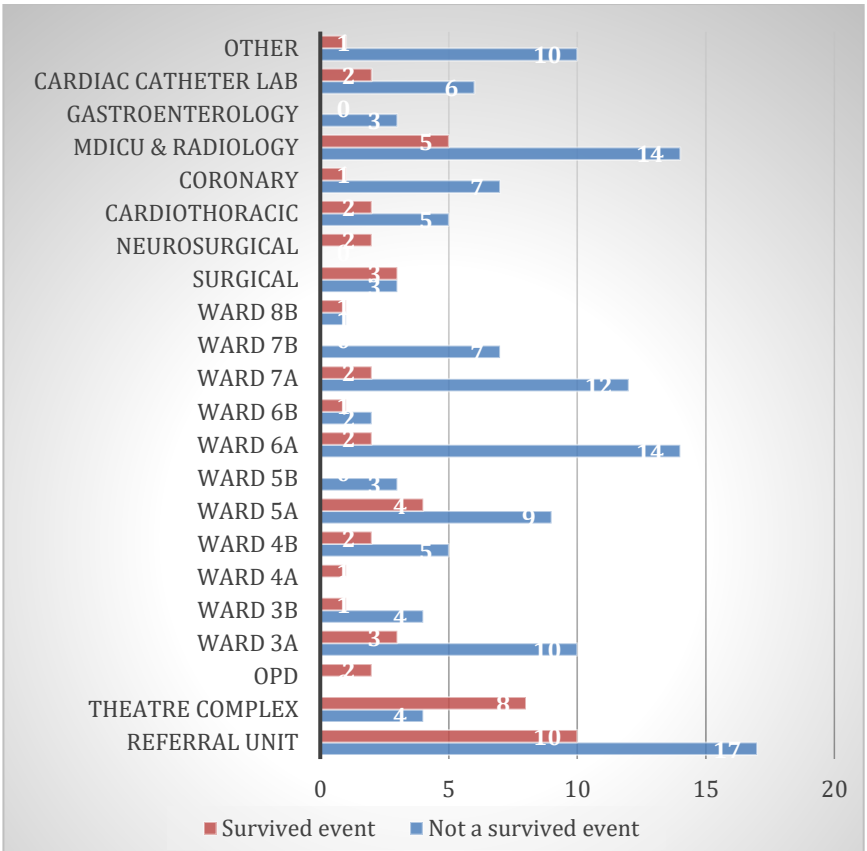

Figure 1: Location of cardiac arrest and impact on event survival

* "Other" refers to all uncategorised locations, i.e., admission waiting area/ comfort areas/ café/ transportation areas such as hallways or lifts.

The day of the week on which the cardiac arrest event occurred and the impact on outcomes are summarised in **Table II**. The day of the week was not a statistically significant factor for the survival of a cardiac arrest event (p-value 0.62). The time of day during which the cardiac arrest occurred and association with event survival was also not statistically significant.

Table II: **The day of the week and impact on outcomes**

Type of day	Successful ROSC	Cardiac arrest event survival	Survival to hospital discharge rate
Normal weekday	32,2%	27,5%	12,9%
Weekend or public holiday	36,9%	31,6%	10,5%

In 5% of cardiac arrests the aetiology was recorded as unknown. The known aetiologies are displayed in **Figure 2**. Aetiology was not a statistically relevant factor for ROSC (p-value 0.33), event survival (p-value 0.61) or survival to hospital discharge (p-value 0.90).

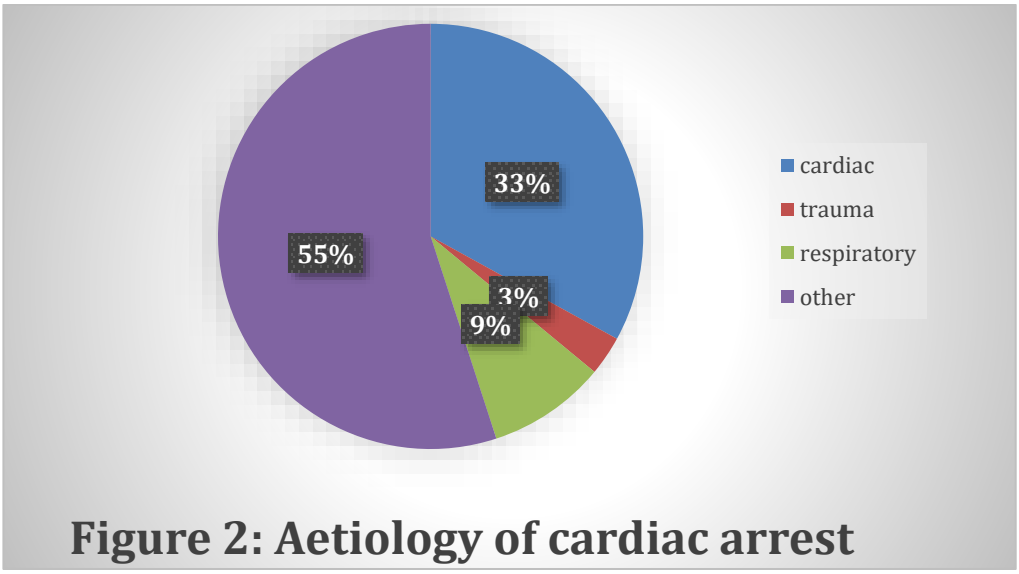

Figure 2: Aetiology of cardiac arrest

* "Other" refers to all uncategorised aetiologies, i.e., sepsis/renal failure/ liver failure/ central nervous system pathology/cancer related/ drugs and toxins.

The time of arrest detection to the time CPR was commenced is summarized in **Figure 3**. CPR was initiated in cardiac arrest events by a nurse practitioner 47%, by a medical doctor 49%, and by another health care worker in 4% of instances. The person initiating CPR was not a statistically significant contributor to event survival. The duration of CPR in the survived events are summarized in **Figure 4**.

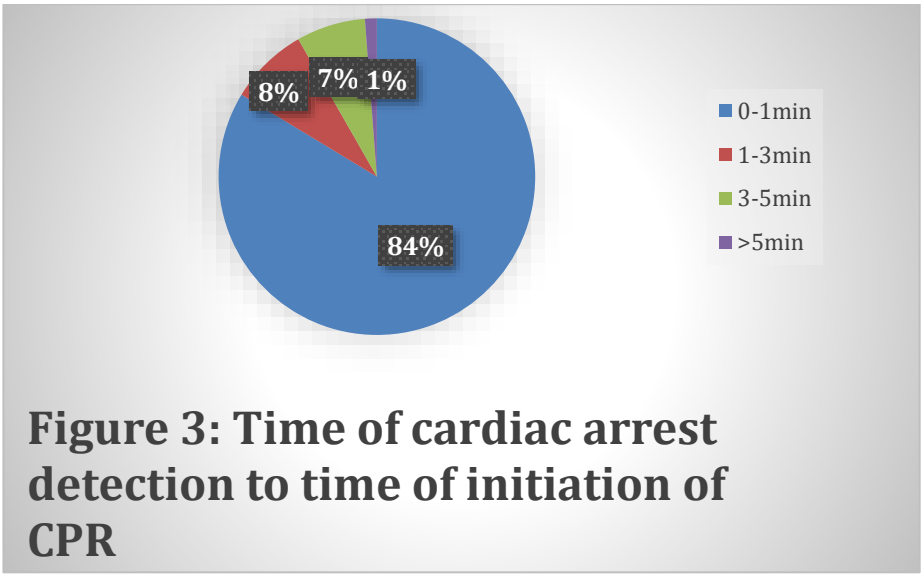

Figure 3: Time of cardiac arrest detection to time of initiation of CPR

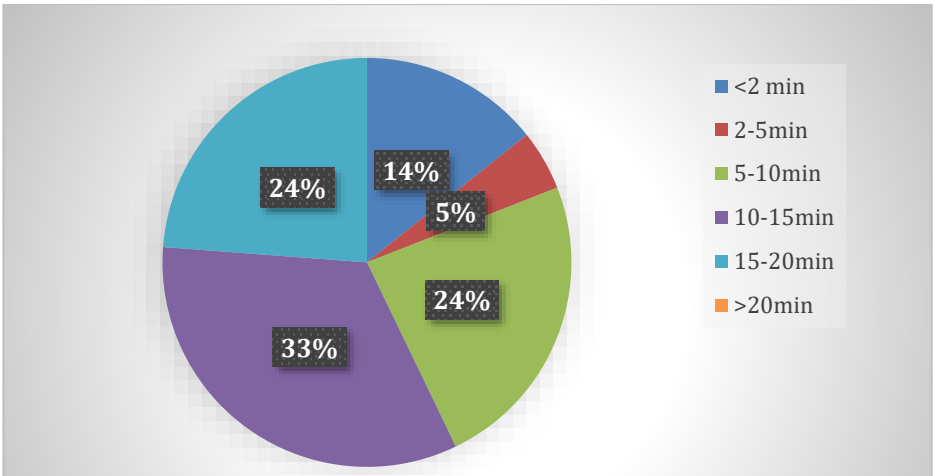

Figure 4: Survived cardiac arrest events and duration of CPR

16% of first rhythms recorded were *unknown*. The known first rhythms as in **Figure 5**.

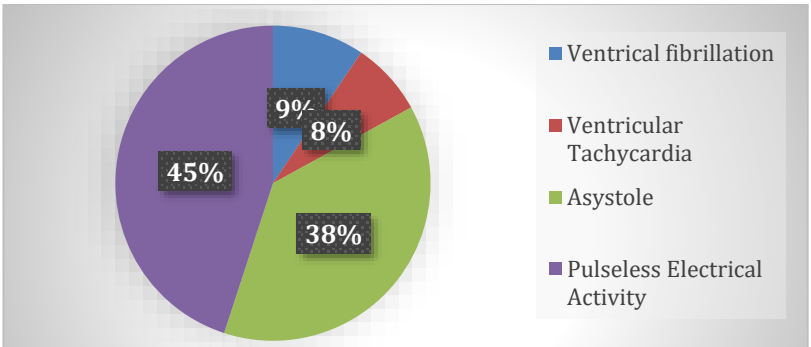

Figure 5: First Rhythm

In the cardiac arrest events where there was an attempt at defibrillation, there was a 31,3% event survival rate compared to 27,0% in those without. Of those not defibrillated 2.9% had a shockable first rhythm. The median time to defibrillation was 10 minutes (2-38min range). In the events where defibrillation was attempted, 33,3% of the patients displayed ROSC, compared to 32,6% in those without defibrillation attempts. When considering the *total number of survived events*, 28,3% of the survivals were associated with a defibrillation attempt whilst 71,7% had no defibrillation attempts. Attempt at defibrillation was not a statistically significant factor for event survival (p-value of 0.57).

In 9,6% of the survived events the airway was managed with a basic face mask and in 88,4% with an endotracheal tube (ETT). The remaining strategies, supraglottic airway device (SGA) and tracheostomy, were only utilized five times and thus had insufficient powering, with event survival rates of less than 1,9%. It is important to note that in 85% of resuscitations, the team opted for an advanced airway management technique. An advanced airway management

strategy is not a statistically significant factor for ROSC (p-value 0.77), event survival (p-value 0.82) or survival to hospital discharge (p-value 0.53).

When analysing the impact of the ventilation strategy during CPR in the total number of survived events; 53,9% of survivals were associated with a bag-mask ventilation (BMV) strategy compared to 46,2% with mechanical ventilation. Fisher's exact test was performed, and mechanical ventilation was superior to a bag-mask ventilation strategy for event survival (p-value <0,001), ROSC (p-value <0,001) as well as survival to hospital discharge (p-value 0.0012). Demonstrating a statistically significant association between ventilation strategy during CPR.

On further analysis it was found that when mechanical ventilation was instituted, 85% of patients were already in a high-dependency/critical care unit. In cardiac arrest events occurring in these units a BMV strategy was still preferred by clinicians in 66% of resuscitations.

In a subgroup analysis of patients already in a high-dependency/ critical care unit considering the total number of survived events, 21,4% of survivals were associated with a BMV strategy compared to 52.7% where a mechanical ventilation strategy was employed. The Fisher's exact test was performed demonstrating that the choice of mechanical ventilation was superior to a bag-mask ventilation strategy for event survival (p-value <0,001).

32,7% of the patients that were admitted in a high-dependency/ critical care unit at the time of the cardiac arrest survived the event, compared to a 22,2% event survival in those who were not. When considering the total number of survived events:66% of the event survivals were in patients already admitted to a high-dependency/ critical care unit during the time of the event, compared to 34% where the arrest was outside of this setting. Admission to a high-dependency/critical care unit at the time of the cardiac arrest is not a statistically relevant factor for event survival (p-value 0.11). Similar outcomes were observed in the ROSC (p-value 0.40) and in survival to hospital discharge (p-value 0.18).

85% of patients who displayed ROSC, ultimately survived the event. Of the patients who had ROSC but were not admitted to ICU post arrest there was a 4.2% event survival, compared to a 100% event survival rate if the patient was admitted to ICU post arrest. The Fisher's exact test was performed (p-value <0.001).

Where there was adherence to ACLS protocol in terms of use of inotropes, there was a 95,5% event survival, compared to 14% in those with non-adherence. Fisher's exact test was performed demonstrating an association between the initiation of inotropic support and event survival (p-value < 0.001), ROSC (p-value < 0.001) and survival to hospital discharge (p-value < 0.001). In the total number of survived events, 48,8% of the survivals were associated with the sustained administration of inotropes after ROSC. In 51,2% of the survivals inotropic support was not required after ROSC.

In 71,7% of the total survived events the rapid response resuscitation team had not been activated, compared with 28,3% where the resuscitation team was involved in the resuscitative effort. The resuscitation team was only activated in 27,7% of all resuscitations. The median time from the identification of cardiac arrest to activation of the resuscitation team was one minute (0-20min range), median time from activation of the resuscitation team to arrival of resuscitation team to the resuscitation was three minutes (0-20min range), and the median time from the identification of cardiac arrest to arrival of resuscitation team to the resuscitation was five minutes (0-25min range).

Of the resuscitations where the resuscitation team was involved, only 29% resulted in event survival. Of the resuscitations without the resuscitation team being involved, 28% survived the event. Fisher's exact test was performed demonstrating no association between the UAH resuscitation team involvement and event survival (p-value 1.0), ROSC (p-value 1.0) or survival to hospital discharge (p-value 0.33). In 64% of events the reason for the resuscitation team not being activated was not recorded and in 25% of instances the resuscitation was after hours and thus the UAH resuscitation team was unavailable to assist. Other reasons stated for not activating the resuscitation team (11%) included having enough sufficiently trained personnel for resuscitation or resuscitation being conducted in a high-level care/advanced technology suite.

Impediments to effective resuscitation identified by resuscitators included the lack of essential resuscitation equipment or equipment failures (11%), technical skill deficiencies (1%), and adverse drug reactions (0,5%).

Discussion:

A total of 194 resuscitation reports were collected for adult in-patients for this study period. Five of these reports were excluded as they were erroneously completed (no cardiac arrest had occurred). Of the 189 cardiac arrests analysed, 28,0% of the patients *survived the event*, 32,8% of outcomes were *successful*, with 32,8% of the patients having *any ROSC* during the resuscitative effort. *Survival to hospital discharge rate* was 12,3%, with only one patient lost to follow-up.

In developing countries there is limited published data of CPR audits at comparable institutions to UAH utilising the Utstein template. To date no literature has been published about outcomes in comparable institutions in South Africa. *Krittayaphong et al* in their review of the Siriraj Cardiopulmonary Resuscitation Registry in Thailand reported CPR outcomes with 49.8% ROSC and 7.4% survival to hospital discharge.[14] Though robust data from developed countries is available the inconsistencies in the authors' reporting of this data make extensive comparisons difficult. The United States NRCPR 2003 Utstein-based report is to date the largest study of its kind.[11] The overall ROSC was 44% and 17% survival to hospital discharge.[9] *Jones and colleagues* reported on 415 cardiac arrests in Auckland City Hospital, New Zealand, with 27,2% survival to hospital discharge.[10] *Fredriksson and colleagues* reported on 833 cardiac arrests in Sahlgrenska University Hospital, Sweden, with 37% survival to hospital

discharge.[14] Other authors reported on smaller cohorts with ROSC success rates of 57%[16], 52%[17], 35%[18], and survival to hospital discharge rates of 30%[16], 26%[18], 14.5%.[17] Due to large inter-institutional variation in success rates it is difficult to comment on how UAH compares This study at UAH demonstrated a 32,80% ROSC and 12,30% survival to hospital discharge, thus faring worse than Thailand for ROSC but better for survival to hospital discharge.

NRCPR reported aetiologies for cardiac arrest as follows; cardiac dysrhythmias (49%), acute respiratory insufficiency (37%) and hypotension (32%).[9] At UAH cardiac pathology (33%) and respiratory pathology (9%) were the major identifiable aetiologies.

NRCRP reported chest compressions were initiated within one minute in 83.1% of arrests[12] comparable to UAH, where CPR was initiated within one minute in 84% of arrests. Early initiation of CPR and rapid defibrillation improves survival rates.[16] Survival decreases with 10% for every one minute that defibrillation is delayed.[16]

NRCPR reported the initial pulseless rhythm as 36% asystole, 30% PEA, 25% VT/VF and unknown in 9%.[9] At UAH the first rhythm was 45% PEA, 38% asystole, 17% VT/VF and unknown in 16%. Lack of ECG monitors and disposables may improve the percentage of known first rhythms at UAH.

NRCPR reported median time of arrest to first defibrillation for VT/VF was less than one minute, with 75% defibrillated within three minutes.[9] This yielded a 38% survival rate compared to 21% survival rate, if the first defibrillation was delayed for longer than three minutes.[9] At UAH in 2.9% of shockable first rhythms the patient was never defibrillated. The median time to defibrillation was 10 minutes (2-38min range). This is a large nonconformity with the acceptable norm and may explain the contradictory findings at UAH where defibrillation attempts did not make a statistical difference to resuscitation outcomes. Impediments to resuscitation efforts reported included the lack of essential resuscitation equipment or equipment failures. Hospital management should ensure that all wards readily have access to functional defibrillators which are maintained and checked as per institutional protocol.

Retrospective studies comparing BMV to ETT are confounded by prognostication bias; the worse the physiological compromise of the patient, the more often the resuscitator would opt for more invasive strategies.[1] BMV was utilized in 67% of cardiac arrests with invasive ETT achieved in 85.9% of patients. Tracheotomies were used in 2.9% and SGA devices in 0.2%.[9] This is similar to findings at UAH.

The investigators postulate that the use of mechanical ventilation during a cardiac arrest event at UAH may be a surrogate for resuscitator prognostication during the CPR, where the clinician would only initiate mechanical ventilation if the likelihood for successful resuscitation was high.

There is a relative association between a higher level of patient monitoring/care in high-level/ critical care units and more favourable event survival rates. The higher level of training of the healthcare workers in these units may also play a role, possibly leading to earlier recognition of pre-arrest signs and symptoms and earlier intervention. Unfortunately, the sample size is too small to prove or disprove this, leaving room for future investigation in this area.

For non-shockable rhythms early adrenaline administration improves survival to hospital discharge. In shockable rhythms no benefit was demonstrated, but worse outcomes were found with late administration.[1,2] At UAH adherence to ACLS protocols for inotropic support was associated with ROSC (p-value < 0.001) and survival to hospital discharge (p-value < 0.001). There was non-adherence to ACLS protocol for adrenaline administration in 87,6% of resuscitations, which is of great concern. As drug shortages was never cited as an impediment to effective resuscitation, one must deduce that there is either a reluctance of responders to administer the drug, or that responders do not have the adequate knowledge of ACLS protocols for inotropic administration.

Advanced cardiac life support (ACLS) training improves skill acquisition and retention as well as increasing the total number of attempted resuscitations.[21] *Moretti et al* demonstrated that the presence of an ACLS-trained resuscitator on the rapid response team increased the ROSC (O.R 2.06; 1.038-4.078; IC 95%; p=0.037) and yielded significantly greater long-term patient survival.[21] *Du Plessis and Lamacraft* (unpublished manuscript)[22] established in their 2019 study evaluating physician CPR knowledge at UAH, that even though the overall CPR knowledge of doctors in our institution is superior to that reflected in similarly conducted studies (doctors on average achieved less than 50% for basic and advanced cardiac CPR knowledge), it is by no means a dictum that the participant's knowledge was adequate nor up to date.[22] In their study 76,3% of participants achieved ≥ 50%, but only 22,5% achieved ≥ 80% which was deemed as adequate CPR knowledge by the investigators.[21]

UAH should focus on improving defibrillation practice and adherence to ACLS principles of inotropic support. This may be achieved by the implementation of a mandatory institutional training programme or requiring ACLS accreditation for all health care workers at UAH. Annual training should be repeated to ensure health care workers are sufficiently knowledgeable and skilled in current CPR practices.

Cardiac arrest to arrival of the rapid response resuscitation team time was achieved in under five minutes in 81% of hospitals surveyed by *Sandroni et al*.[17] This time interval is associated with improved survival to discharge rates if it is under three minutes.[19,20] At UAH the time to arrival of the rapid response team is comparable to findings by *Sandoroni et al*. However, the problem is that the rapid response resuscitation team was only activated for 27,7% of all resuscitations with 64% of resuscitations neglecting to state a reason for the non-activation. The resuscitation team involvement made no impact on outcomes, but this is contrary to other authors findings. Underutilization may account for the inconsistencies in outcome findings, but further research is needed to confirm this.

Limitations:
The study has a limitation in terms of the study population, as only adult patients for whom a resuscitation report was generated and stored by the resuscitation coordinator were included for analysis. Currently the collated institutional resuscitation report audits do not distinguish between paediatric and adult patients, making the cross-checking of the sample population impossible. Limitations in documentation on resuscitation reports audited included the time intervals: cardiac arrest to establishing an advanced airway management strategy, cardiac arrest to administration of first dose of adrenaline as well as whether the resuscitation team leader has valid ACLS accreditation or equivalent training.

Conclusion:
Resuscitation outcomes at UAH for the study period was comparable to similar international institutions but paucity of published South African data makes national comparisons difficult. UAH should focus on improving defibrillation practice and adherence to ACLS principles of adrenaline administration. This could be achieved by the implementation of a mandatory institutional ACLS training programmes. Possibly, the UAH resuscitation team is underutilized providing an area for further investigation.

Conflicts of interest:
The authors have no conflicts of interest to declare.

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9. Suggestions for further research and proposed applications

The clinical audit process endeavours to refine and improve on the current clinical practice by improving patient care and outcomes. This is achieved by measuring performance through a systematic review of care against an agreed to criteria of standard of care with the aim of implementing change.[1] This study proved that resuscitation outcomes at UAH is comparable to other tertiary institutions. There is substandard utilization of defibrillation. This study demonstrated that the rapid response resuscitation team is underutilized.

Institutional system interventions recommended by the authors include procurement of monitoring equipment, better maintenance, and replacement of essential resuscitation equipment and ensuring the uninterrupted supply of essential sundries and disposables for resuscitation. Non-wave form CO_2 detector acquisition may offer an additional monitoring tool to when advanced airway techniques are employed. Further development of the human resource is needed. Adequate training of health care workers in BLS, ACLS or resuscitation training equivalents are recommended. Simulation style training of resuscitation teams to practice team dynamics with closed loop communication could be beneficial. During this training, the need for effective rapid response resuscitation team engagement with the first responders in different locations at UAH must be highlighted. This training offers the opportunity to do observational health profession education research. After the implementation of these suggestions another triennial clinical audit should be undertaken to evaluate the impact of these changes.

Suggested amendments/ additions to the resuscitation report template include documentation of the team leader's ACLS training, as well as the level of training of the other resuscitators. A dedicated timekeeper should be mandatory for resuscitations in order to improve accuracy of data recording.

Future developments in the area of in-hospital cardiac arrest management and monitoring of resuscitation practices include web-based Utstein style care practice cards[2] , web-based Utstein style data management software programs[3], collaborative efforts to solve the time-data capturing problems[4], performance check lists[5] and audio recordings of cardiac arrest scenarios.[6] As these technologies become available locally, they should be implemented in our institution and their effect on resuscitation outcomes should be compared to this benchmark study.

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10. Appendices

A. Letter of approval from Research Ethics Committee

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

Health Sciences Research Ethics Committee

02-May-2019

Dear **Miss Catharina Strydom**

Ethics Clearance: **Resuscitation Outcomes for Adult Patients with In-hospital cardiac arrest- Are we successful?**
Principal Investigator: **Miss Catharina Strydom**
Department: **Anaesthesiology Department (Bloemfontein Campus)**

APPLICATION APPROVED

Please ensure that you read the whole document

With reference to your application for ethical clearance with the Faculty of Health Sciences, I am pleased to inform you on behalf of the Health Sciences Research Ethics Committee that you have been granted ethical clearance for your project.

Your ethical clearance number, to be used in all correspondence is:**UFS-HSD2018/1605/2805**

The ethical clearance number is valid for research conducted for one year from issuance. Should you require more time to complete this research, please apply for an extension.

We request that any changes that may take place during the course of your research project be submitted to the HSREC for approval to ensure we are kept up to date with your progress and any ethical implications that may arise. This includes any serious adverse events and/or termination of the study.

A progress report should be submitted within one year of approval, and annually for long term studies. A final report should be submitted at the completion of the study.

The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

For any questions or concerns, please feel free to contact HSREC Administration: 051-4017794/5 or email EthicsFHS@ufs.ac.za.

Thank you for submitting this proposal for ethical clearance and we wish you every success with your research.

Yours Sincerely

Dr. SM Le Grange
Chair : Health Sciences Research Ethics Committee

Health Sciences Research Ethics Committee
Office of the Dean: Health Sciences
T: +27 (0)51 401 7795/7794 | E: ethicsfhs@ufs.ac.za
IRB 00006240; REC 230408-011; IORG0005187; FWA00012784
Block D, Dean's Division, Room D104 | P.O. Box/Posbus 339 (Internal Post Box G40) | Bloemfontein 9300 | South Africa
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B. Permission letter from the Department of Health

health
Department of Health
FREE STATE PROVINCE

23 April 2019

Miss. Catharina Strydom
Dept. of Anaesthesiology Department
UFS

Dear Miss. Catharina Strydom

Subject: Resuscitation Outcomes for Adult Patient with In-hospital cardiac arrest – Are we successful?

- Please ensure that you read the whole document. Permission is hereby granted for the above – mentioned research on the following conditions:
- Serious Adverse events to be reported to the Free State department of health and/ or termination of the study
- Ascertain that your data collection exercise neither interferes with the day to day running of Universitas Hospital nor the performance of duties by the respondents or health care workers.
- Confidentiality of information will be ensured and please do not obtain information regarding the identity of the participants.
- **Research results and a complete report should be made available to the Free State Department of Health on completion of the study (a hard copy plus a soft copy).**
- Progress report must be presented not later than one year after approval of the project to the Ethics Committee of the University of the Free State and to Free State Department of Health.
- Any amendments, extension or other modifications to the protocol or investigators must be submitted to the Ethics Committee of the University of the Free State and to Free State Department of Health.
- **Conditions stated in your Ethical Approval letter should be adhered to and a final copy of the Ethics Clearance Certificate should be submitted to** sebeelas@fshealth.gov.za / lithekisa@fshealth.gov.za **before you commence with the study**
- No financial liability will be placed on the Free State Department of Health
- **Please discuss your study with Universitas Hospitals CEO's on commencement for logistical arrangements see 2nd page for contact details.**
- Department of Health to be fully indemnified from any harm that participants and staff experiences in the study
- Researchers will be required to enter in to a formal agreement with the Free State department of health regulating and formalizing the research relationship (document will follow)
- You are encouraged to present your study findings/results at the Free State Provincial health research day
- Future research will only be granted permission if correct procedures are followed see http://ehrd.hst.org.za

Trust you find the above in order.

Kind Regards

Dr D Motau
HEAD: HEALTH
Date: 21/04/19

Head : Health
PO Box 227, Bloemfontein, 9300
4th Floor, Executive Suite, Bophelo House, cnr Maitland and, Harvey Road, Bloemfontein
Tel: (051) 408 1648 Fax: (051) 408 1556 e-mail:shuserv@fshealth.gov.za/dhkotwa@fshealth.gov.za
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health
Department of Health
FREE STATE PROVINCE

24 April 2019

Miss. C Strydom
Dep. Of Anaesthesiology
UFS
BFN

Dear Miss. C Strydom

Subject: Resuscitation outcomes for adult patients with in-hospital cardiac arrest – Are we successful?

Please find below the contact details of Universitas Hospital CEO for logistical arrangements.

Universitas Hospital CEO
Name: Dr M Molokomme **Email**: molokommm@universitas.fs.gov.za **Tel**: 051 405 3557/3634 **PA**: Melinda **Email**: vdbergsu@universitas.fs.gov.za

Trust you find the above in order.

Kind Regards

Head : Health
PO Box 227, Bloemfotein, 9300
4th Floor, Executive Suite, Bophelo House, cnr Maitland and, Harvey Road, Bloemfotein
Tel: (051) 408 1646 Fax: (051) 408 1556 e-mail: khusem@fshealth.gov.za/fshealth.gov.za/chikotovup@fshealth.gov.za

C. Permission letter from Head of Department

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

The Chair: Health Sciences Research Ethics Committee
Dr SM Le Grange

For Attention: Mrs M Marais
Block D, Room 104,
Francois Retief Building
PO Box 339 (G40)
Nelson Mandela Drive
Faculty of Health Sciences
University of the Free State
Bloemfontein, 9300

08 November 2018

Dear Dr SM Le Grange,

Catharina Maria Strydom UFS 2004005563

Resuscitation Outcomes for Adult Patients with In-hospital cardiac arrest- Are we successful? An Audit of Resuscitation Outcomes for the period January 2015 to December 2017 at Universitas Academic Hospital, Bloemfontein, using the *Utstein Model*

I, G Lamacraft hereby grant CM Strydom permission to conduct the above-mentioned research project. The research will be completed in accordance with myself as Acting Head of Department of Anaesthesiology with myself as supervisor of this study.

Yours faithfully,

Prof G Lamacraft

KONSULTANTE/CONSULTANTS: Dr EW Turton, Prof G Lamacraft, J Diedericks, CL Odendaal, AM Kachelhoffer, Dr MA Pearson, NG Swanepoel, J Lemmer, RF Wessels, N van der Westhuizen, H Nordt
Department of Anaesthesiology | 205 Nelson Mandela Drive/Rylaan | P.O. Box/Posbus (G67) | UNIVERSITY OF THE FREE STATE
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D. Research Protocol

Resuscitation Outcomes for Adult Patients with In-hospital cardiac arrest- Are we successful?

An Audit of Resuscitation Outcomes for the period January 2015 to December 2017 at Universitas Academic Hospital, Bloemfontein, using the Utstein Model.

Catharina Maria Strydom

Index:

Declaration of own work:

I, Catharina Maria Strydom, declare that the work for the following dissertation with the title:

Resuscitation Outcomes for Adult Patients with In-hospital cardiac arrest- Are we successful?

An Audit of Resuscitation Outcomes for the period January 2015 to December 2017 at Universitas Academic Hospital, Bloemfontein, using the Utstein Model.

was solely undertaken by myself. All sections of the protocol that use quotes or describe an argument or concept developed by another author have been referenced and due citation given.

Title:

Resuscitation Outcomes for Adult Patients with In-hospital cardiac arrest- Are we successful?

An Audit of Resuscitation Outcomes for the period January 2015 to December 2017 at Universitas Academic Hospital, Bloemfontein, using the Utstein Model.

Researchers:

Principal Researcher:
Dr. Catharina Maria Strydom
MBChB (Pret), DA (SA), FCA (SA)
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Supervisor:
Prof Gillian Lamacraft
MB.BS (University of London, UK), FRCA, Certificate in Pain Management (ANZCA), FCA, PhD Anaesthesiology (UFS)
Head of Unit: Pain Control Unit
Chief Specialist in Anaesthesiology
Department of Anaesthesiology
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Introduction:

Cardiac arrest occurs when cardiac mechanical activity ceases and/ or becomes disassociated with electrical activity of the heart. This clinical entity is diagnosed by signs of loss of cardiac output and systemic circulatory collapse. With ensuing hypoperfusion of body tissues, apoptosis will be initiated leading to vital organ death and subsequently death of the individual person. Resuscitative measures by means of cardiopulmonary resuscitation (CPR) aims to maintain perfusion to vital organs, whilst other resuscitative measures are employed to resynchronize the electro-mechanical function of the myocardium. CPR is thus a life saving skill requirement for any health care professional that might witness or be called to assist in in-patient cardiac arrest scenarios. The current body of scientific evidence is well summarized by the American Heart Association ACLS consensus guideline, as to how resuscitative measures for adult patients should be conducted to ensure the best possible patient mortality and morbidity outcome.[1]

When a cardiac arrest occurs at Universitas Academic Hospital, the first responder medical practitioner will initiate CPR and call for activation of the Resuscitation Team. This team only renders this service during normal working hours. After hours the primary speciality responsible for the care of the patient's physician on call will be alerted and they will in conjunction with the physician on call for the Intensive Care Unit conduct the resuscitation. Upon end of event, the resuscitation team leader completes the resuscitation report, which is then collected by the resuscitation sister.

These resuscitation reports are reviewed by a Resuscitation Committee, which are made up of representatives from the department of Anaesthesiology; department of Paediatrics; Bioengineering; assistant manager of nursing; and nursing personnel from theatre, the nursing college and the nursing audit committee. Structured auditing is needed to ascertain if the institution's

resuscitation success rate is comparable with other tertiary level institutions.

The standard of CPR at comparable institutions has been audited exclusively[4,5]. The outcome of CPR is dependent on multiple interventions and the efficacy thereof. In particular early defibrillation, effective chest compressions and advanced life support strategies.[2] Universal Consensus definitions regarding the nomenclature of cardiac arrest scenarios ensure data is reliably and reproducibly recorded. The Utstein Reporting Template (Appendix A) provides such a consensus definition, as recommended by a task force of the International Liaison Committee on Resuscitation[2]. Templates like these enable comparison of outcomes in different institutions[6,7]; and the better understanding and identification of elements of resuscitation practice that may enhance outcomes.[8,9] This is the major strength of the Utstein Model and why it is commonly used in researching CPR.

Aim and Objectives:

The primary aim of this study is to determine the success rate of cardiopulmonary resuscitation in adult in-hospital cardiac arrests at Universitas Academic Hospital by auditing resuscitations performed and documented in the period of January 2015 to December 2017, by using a Revised Modified Utstein template. Successful cardiopulmonary resuscitation will be defined by return of spontaneous circulation.

Secondary objectives include identification of factors associated with improved success rates and survival to discharge from hospital outcomes. The researcher will also endeavour to identify factors which may be contributing to unsuccessful resuscitative efforts.

Methodology:

5.1 Study design

A Retrospective analytical study will be conducted, auditing resuscitation reports compiled by resuscitation teams which were collected by the Universitas Academic Hospital Resuscitation Committee for the period January 2015 to December 2017.

5.2 Sample

The sample population will include adult in-patients who suffered a cardiac arrest in Universitas Academic Hospital between 1 January 2015 to 31 December 2017 for whom resuscitation reports were compiled by resuscitation teams and collected by the Universitas Academic Hospital Resuscitation Committee. In the pilot study at Universital Academic Hospital (see section 5.6) conducted over a period of 18 months (January 2012 to June 2013), 210 reports were collected for adult in-hospital cardiac arrest. It is estimated that approximately 230 resuscitation reports will be assessed for inclusion in the study.

Possible limitation of the proposed study is missed cardiac arrests for which no report was generated.

5.2.1 Inclusion Criteria

Adult patients will be defined in terms of age of full legal capacity as determined by South African legislation. Thus patients aged ≥ eighteen years will be included.

In-patient criteria will be defined in terms of admission to the Universitas Academic Hospital Complex with the proviso of a live-in facility care rendered service- i.e. with lodging, meals and medical/surgical treatments

5.2.2 Exclusion Criteria

Patients under the age of full legal capacity will be excluded from this study.

Resuscitation reports which are deemed incomplete or illegible by the researchers will be excluded. Number of exclusions will be documented in the summation of the study design.

Adult in-patients who suffered a cardiac arrest during the period of the proposed audit, for whom no resuscitation report was compiled or collected, will be excluded from this study.

5.3 Utstein definitions

Consensus definitions regarding the nomenclature of cardiac arrest scenarios ensure data is reliably and reproducibly recorded. The Utstein Reporting Template (Appendix A) provides such a consensus definition, as recommended by a task force of the International Liaison Committee on Resuscitation[2]. The research team for the pilot study deemed modifications to some of these definitions necessary in the context of resuscitation at Universitas Academic Hospital. These initial modifications have been reviewed and amended by the researchers and are highlighted in Appendix C.

5.4 Measurements

The resuscitation reports collected by Sister Botes, the Resuscitation Co-ordinator of Univeritas Academic Hospital will provide the information to be captured on the Revised Modified Utstein Reporting Template for Universitas Academic Hospital (Appendix B). These reporting templates will then be converted data collection sheets (Appendix D) which will be transferred and processed as Excel Spreadsheets for data analysis. For the survival to discharge from hospital outcome, the Free State Department of Health Meditech data base will be utilized.

5.5 Methodological and measurement errors

The resuscitation team may have filed incomplete resuscitation reports. Resuscitation reports which are deemed incomplete by the researchers will be excluded from the main sample and will be analyzed for suitability in inclusion in specific categorical variables by biostatistics. The number exclusions will be documented in the summation of the study design. Special mention will be made of data included from reports deemed incomplete. Illegible resuscitation reports will be excluded from the study.

The resuscitation team may have filed inaccurate resuscitation reports due to the retrospective nature of completing these reports. Reporting bias when resuscitation measures were performed substandard is a possible confounder.

5.6 Pilot Study

A pilot study *(Stud nr 20/2014 UFS-HSD2014/0152)* was conducted by a research team that consisted of Prof G Lamacraft and a group of University of the Free State MBChB students (A Palkowski, C Eggers, C le Roes, J le Roux, M Bhamjee). This study was a part of their GSM213 research module. In the pilot study at Universital Academic Hospital conducted over a period of 18 months (January 2012 to June 2013), 231 resuscitation reports where included in the study. Pilot proved feasibility of this study. [3]

Analysis of data:

Collection of data will be done by the researcher. Success of resuscitation will be defined as spontaneous return of circulation. Survival to discharge from hospital will be a secondary outcome. Data will be analyzed using categorical variables; successful resuscitation being expressed as percentages. Comparison between this success rate and that reported by other institutions in published literature will then serve to answer the study question.

The data will be expressed as frequencies, percentages, means, medians and ranges. Analysis in table form with graphs by utilizing the Revised Modified Utstein Reporting Template for Universitas Academic Hospital (Appendix B) as comparison platform will be conducted by Biostatisticians from the University of the Free State.

Associations between outcome of resuscitation and the following variables will be investigated; location of cardiac arrest, age of the patient, aetiology of the cardiac arrest, time between recognition of cardiac arrest and initiation of cardiopulmonary resuscitation, involvement of Universitas Academic Hospital Resuscitation Team, duration of cardiopulmonary resuscitation, Intensive Care admission for post cardiopulmonary arrest care, continued inotropic support and assisted mechanical ventilation.

Critical review of; cardiac compression ratio to ventilation, first monitored ECG rhythm, any defibrillation attempts and resuscitative drug administration, will assess if resuscitation effort complied with ACLS guidelines[1].

Implementation of findings:

As part of my MMed Anaesthesiology dissertation, I may present this audit at UFS Interdepartmental forums and short registrar presentations. As well as present these findings at a national level during the annual SASA congress and write and submit an article for publication in accredited anaesthesiology journals.

Results and conclusions to be made available to Resuscitation Committee and Hospital Management by highlighting factors associated with improved outcomes and structured suggestions for improvement strategies.

Time schedule:

Protocol to Ethics Committee: November 2018
Data collection: December 2018
Data processing: January 2019
Article writing: February 2019
Submission: February 2019

Budget:

The budget for stationary is R 800.00 and will be covered by the researcher.

Ethical considerations:

The study protocol will be submitted to the Health Sciences Research Ethics Committee, University of the Free State. A report on conclusion of the research will be submitted to the Health Sciences Research Ethics Committee.

Permission from appropriate authorities will be sought after approval of this study protocol (see Appendix F and G).

Confidentiality of patients will be ensured by employing a report number, termed “RN” or research number on the Revised Modified Utstein Reporting Template for Universitas Academic Hospital and data collection sheets, with no recording of the patients’ personal details, rendering it impossible to link a specific patient to the captured data.

Confidentiality of health care workers who formed part of resuscitation team or completed resuscitation report will be ensured by not recording any of their personal details.

The data file will be stored by the researcher, in the researcher’s office number 336, in the Department of Anaesthesiology in the University of the Free State, in a locked filing cabinet, with only the researcher having access to this key. Records will be stored for 5 years. After this time period has lapsed, the data file will be destroyed.

The risk/benefit of this study has been considered by the researcher. Given the retrospective analytical nature of the study design and strict adherence to confidentiality and data securing, the risk to the patients whose resuscitation reports will be included is negligible, as is the risk to the resuscitation teams who completed the resuscitation reports. There is great potential benefit of this study to contribute to the betterment of resuscitative efforts in Universitas Academic Hospital.

References:

1. Advanced Cardiovascular Life Support Guidelines. 2015. American Heart Association
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6. Gullo A. Cardiac arrest, chain of survival and Utstein style. Eur J Anaesthesiol. 2002; 19(9):624-33
7. Cummins O, Cochair DC, et al. Recommended guidelines for reviewing, reporting,and conducting research on in-hospital resuscitation: the in-hospital “Utstein style”. Resuscitation 1997; 34:151-83
8. Keuper W, Brouwer MA, et al. Resuscitations in the hospital: reporting using the Utstein style form and a study of 183 patients in the St Rabound University Medical Center, Nijmegen, the Netherlands, between1997-2000. Ned Tijdschr Geneesk 2003; 147(25):1222-8
9. Krittayaphong R, Saengsung P, et al. Factors predicting outcome of cardiopulmonary resuscitation in a developing country: the Siriraj cardiopulmonary resuscitation registry. J Med Assoc Thai 2009;92(5):618-23

Appendix A:

Utstein Reporting Template[2]

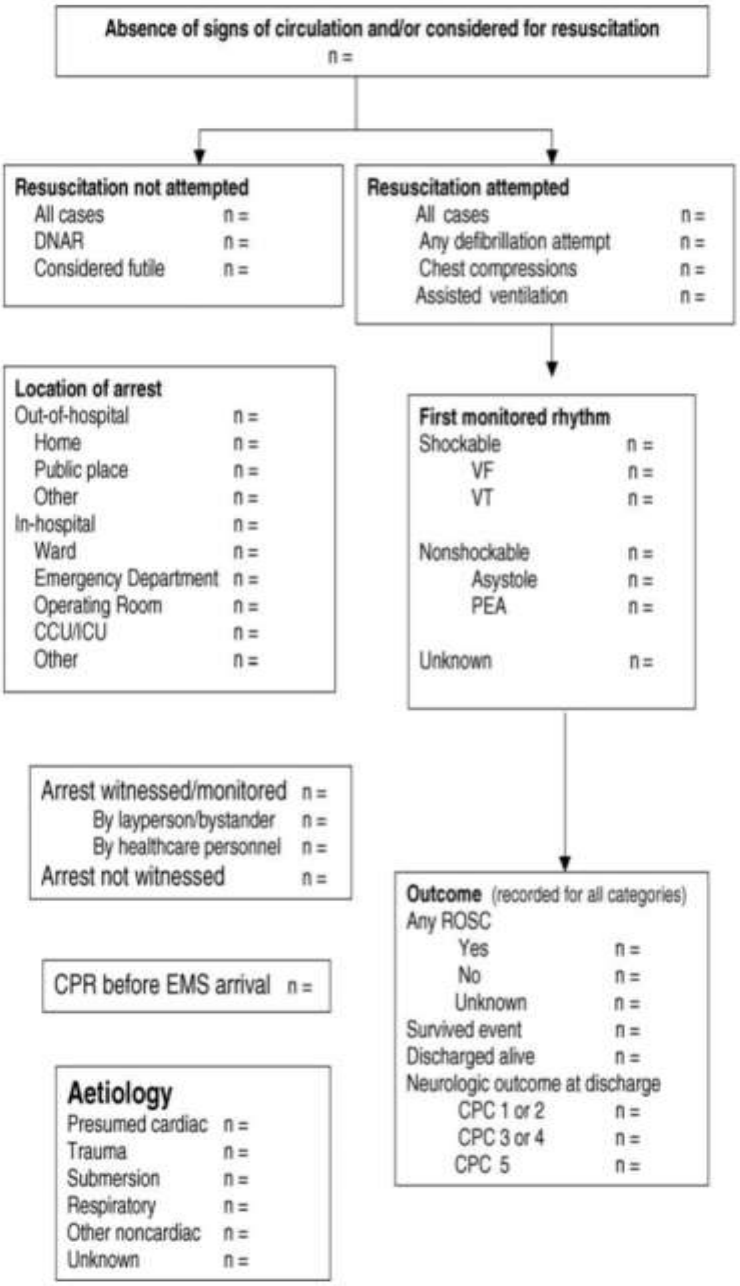

Fig. 1. Utstein reporting template for core data elements. ED, emergency department; OR, operating room; CCU/ICU, critical care unit/intensive care unit; and PEA, pulseless electrical activity.

Appendix B:

Revised Modified Utstein Reporting Template for Universitas Academic Hospital[3]

		Resuscitation			
		Resuscitation Reports	n=		
		RN number			
		Age of patient	n=		
		Any defibrillation attempted	n=		
		Time until first defibrillation	n=		
		Assisted ventilation	n=		
		Chest compressions	n=		
First monitored rhythm		Location of cardiac arrest		Day/Time of resuscitation attempt	
Shockable					
VF	n=	Referral unit	n=	Weekdays	n=
VT	n=	Theatre Complex	n=	00h00-05h59	n=
		OPD	n=	06h00-07h59	n=
		Maternity	n=	08h00-16h00	n=
Non-shockable		**Wards:**		16h01-18h59	n=
Asystole	n=	Ward 3A	n=	19h00-00h00	n=
PEA	n=	Ward 3B	n=		
Unknown	n=	Ward 4A	n=	Weekends or public holidays	
		Ward 4B	n=		n=
		Ward 5A	n=	00h00-05h59	n=
		Ward 5B	n=	06h00-07h59	n=
		Ward 6A	n=	08h00-16h00	n=
		Ward 6B	n=	16h01-18h59	n=
		Ward 7A	n=	19h00-00h00	n=
		Ward 7B	n=		
		Ward 8B	n=		
		Critical Care Units:			
		Surgical	n=		
		Neurosurgical	n=		
		Cardiothoracic	n=		
		Coronary	n=		
		MDICU	n=		
		Procedure Rooms:			
		Radiology	n=		
		Gastroenterology	n=		
		Pain Clinic	n=		
		Cardiac Catheter Lab	n=		

		Outcome			
Successful	n=	Arrest witnessed	n=	Time of cardiac arrest	
Unsuccessful	n=	Layperson/bystander	n=	hh:mm	
		Health care	n=		
				Time CPR	
Any ROSC		professional		commenced	
Yes	n=			hh:mm	
No	n=	arrest not witnessed	n=		
Unknown	n=			Resuscitation team called	
				n=	
Survived event	n=				
Non survival event	n=			Resuscitation team not called	
				n=	
Survived to discharge from					
hospital	n=			Reason team not called	
				Doctor was first responder	
				n=	
				Not recorded	
				n=	
				After hours	
				n=	
				Other	
				n=	
				Time resuscitation team called	
				hh:mm	
				Time resuscitation team arrived	
				hh:mm	

Who initiated resuscitation		Aetiology	
Nurse practitioner	n=	Cardiac	n=
Doctor	n=	Submersion	n=
Other	n=	Other non-cardiac	n=
		Trauma	n=
		Respiratory	n=
		Unknown	n=
		Other	

Appendix C:

Definitions of Terms used in the Utstein Reporting Template[2]

Revisions and modifications[3] are in **bold**.

Arrest, witnessed
A witnessed cardiac arrest is one that is seen or heard by another person or an arrest that is monitored.

Assisted ventilation
Assisted ventilation is the act of inflating the patient's lungs by rescue breathing with or without a bag-mask device or any other mechanical device.

Attempted defibrillation
Defibrillation can be attempted by means of an automated external defibrillator (AED), a semi-automated external defibrillator, an implantable cardioverter-defibrillator (ICD), or a manual defibrillator. The type of device used is not considered a core data element.

Cardiac arrest:
Cardiac arrest is the cessation of cardiac mechanical activity as confirmed by the absence of signs of circulation. If an EMS provider or physician did not witness the cardiac arrest, he/she may be uncertain as to whether a cardiac arrest actually occurred.

Cause of arrest/aetiology:
An arrest is presumed to be of cardiac aetiology unless it is known or likely to have been caused by trauma, submersion, drug overdose, asphyxia, exsanguination, or any other noncardiac cause as best determined by rescuers.

Chest compressions:
Chest compressions are performed by an individual or mechanical device during CPR in an attempt to restore spontaneous circulation.

End of event:
A resuscitation event is deemed to have ended when death is declared or spontaneous circulation is restored and sustained for 20 minutes or longer. If extracorporeal life support is being provided, the end of the event is 20 minutes after establishment of extracorporeal circulation.

First monitored rhythm:
The first monitored rhythm is the first cardiac rhythm present when the monitor or defibrillator is attached to the patient after a cardiac arrest. If the AED does not have a rhythm display, it may be possible to determine the first monitored rhythm from a data storage card, hard drive, or other device used by the AED to record data. If the AED has no data recording device, the first monitored rhythm should be classified simply as shockable or nonshockable. This data point can be updated at a later time if the AED has data download capability.

Location of arrest:
Location of arrest is the specific location where the event occurred or the patient was found. Knowledge of where the cardiac arrests occur may help a community to determine how it can optimize its resources to reduce response intervals. A basic list of predefined locations will facilitate comparisons. Local factors may make creation of subcategories useful.

Therefore various subcategories have been added on the Revised Modified Utstein Reporting Template for Universitas Academic Hospital.

Resuscitation:
A resuscitation attempt is defined as the act of attempting to maintain or restore life by establishing and/or maintaining airway, breathing, and circulation through CPR, defibrillation, and other related emergency care.

Return of spontaneous circulation (ROSC):
Signs of return of spontaneous circulation include breathing (more than an occasional gasp), coughing, or movement. For healthcare personnel, signs of ROSC may also include evidence of a palpable pulse or measurable blood pressure. For the purpose of the Utstein registry template, “successful

resuscitation," or ROSC, is defined for all rhythms as the restoration of a spontaneous perfusing rhythm that results in more than an occasional gasp, fleeting palpated pulse, or arterial waveform. Assisted circulation (e.g. extracorporeal support such as extracorporeal membrane oxygenation or biventricular assist device) should not be considered ROSC until "patient-generated" (i.e. spontaneous) circulation is established. Previous reports focused on outcomes from ventricular fibrillation have variably defined "successful defibrillation" as the termination of fibrillation to any rhythm (including asystole) and the termination of fibrillation to an organized electrical rhythm at 5 seconds after defibrillation (including pulseless electrical activity, PEA). Neither of these definitions of "successful defibrillation" would qualify as ROSC unless accompanied by evidence of restoration of circulation. By consensus, the term "any ROSC" is intended to represent a brief (approximately ≥ 30 seconds) restoration of spontaneous circulation that provides evidence of more than an occasional gasp, occasional fleeting palpable pulse, or arterial waveform. The time that ROSC is achieved is achieved is a core data element.

Shockable/ nonshockable rhythm:

This element refers to the first monitored rhythm, which, when analyzed by the person interpreting the monitor/defibrillator or an AED, was found to be treatable by attempted defibrillation (i.e., shockable or nonshockable). In general, shockable cardiac arrest rhythms are further divided into ventricular fibrillation and pulseless ventricular tachycardia. Nonshockable cardiac arrest rhythms can be categorized as either asystole or PEA. Although a very specific definition of asystole is desirable, no consensus agreement was reached on either specific duration or heart rate to define asystole versus bradycardia/PEA. In future iterations of the registry document, further consideration and additional research resources may need to be devoted to addressing the importance and ability of providers to differentiate between these initial cardiac rhythms.

Survived event:

Sustained ROSC for ≥20 minutes (or return of circulation if extracorporeal circulatory support is applied).

Out of hospital setting has been excluded from the Revised Modified Utstein Reporting Template for Universitas Academic Hospital.

Survival to hospital discharge:

Survival to hospital discharge is the point at which the patient is discharged from the hospital acute care unit regardless of neurological status, outcome, or destination. Ideally this should indicate survival to discharge from acute hospital care, including a possible rehabilitation period in a local hospital before long-term, homecare, or death.

Sustained return of spontaneous circulation:

Sustained ROSC is deemed to have occurred when chest compressions are not required for 20 consecutive minutes and signs of circulation persist (or sustained ROSC if extracorporeal circulatory support is applied). Thus, after resuscitation from in-hospital cardiac arrest, sustained ROSC and survived event have the same definition.

Appendix D:

Data Collection Sheet:

Data Collection Sheet

of the Audit of the Adult Resuscitation Reports at Universitas Academic Hospital, Bloemfontein.

Mark the appropriate block with an X or write the data in the space provided:

For office use:

1. Research number: **RN** | | | |

2. Location of cardiac arrest: | | |

1	Referral unit
2	Theatre Complex
3	OPD
4	Maternity
	Wards:
5	Ward 3A
6	Ward 3B
7	Ward 4A
8	Ward 4B
9	Ward 5A
10	Ward 5B
11	Ward 6A
12	Ward 6B
13	Ward 7A
14	Ward 7B
15	Ward 8B
	Critical Care Units:
16	Surigical
17	Neurosurgical
18	Cardiothoracic
19	Coronary
20	MDICU
	Procedure Rooms:
20	Radiology
21	Gastroenterology
22	Pain Clinic
23	Cardiac Catheter Lab
24	Other: _____

3. Age of the patient | | | |

4. Date of event | | | | d d m

5. Arrest Witnessed | |

1	layperson/ bystander
2	health care professional

6. Time of cardiac arrest

		:
hr	hr	

7. Time resuscitation commenced

		:
hr	hr	

8. Who initiated CPR

1	Nurse practitioner	
2	Doctor	
3	Other	_____

9. Resuscitation team called

1	Yes	
2	No	

if no then

10. Reason resuscitation team not called

1	Doctor was first responder	
2	Not recorded	
3	After hours	
4	Other	_____

11. Time resuscitation team called

		:
hr	hr	

12. Time resuscitation team arrived

		:
hr	hr	

13. Aetiology of cardiac arrest

1	Cardiac
2	Trauma
3	Submersion
4	Respiratory
5	Other non-cardiac
6	Unknown

14. Chest compressions

1	Yes
2	No

15. First monitored rhythm

Shockable

1	VF
2	VT

Non-shockable

3	Asystole
4	PEA
5	Unknown

16. Defibrillation attempt(s)

1	Yes
2	No

Mark the appropriate block with an X or write the data in the space provided:		For office use:

17.Assisted ventilation

1	Yes	
2	No	

18. Outcome

1	ROSC	
2	Did not survive event	
3	Survived event	
4	Survived to hospital discharge	
5	Unknown	

19. Inotropic support post ROSC

1	Yes	
2	No	

20. ICU admission post ROSC

1	Yes	
2	No	

Appendix E:

Curriculum Vitae of Researchers

Curriculum Vitae
Catharina Maria Strydom

Contact information:
Catharina Maria Strydom
Lantana number 17, Chianti Crescent, Shellyvale, Bloemfontein, 9301
PO Box 37202, Langenhovenpark, 9330
Cell phone number: 072 510 8574
Email: carienstrydom85@gmail.com

Personal information:
Born 1985-06-10 in Pretoria (Gauteng, South Africa)
South African citizenship
Female
Unmarried
Christian

Education:
Matriculated (2003) at Hoërskool Brits (North West, South Africa)*
Graduated (2009) from the University of Pretoria with the degree Bachelor of Medicine and Surgery*

Additional Professional qualifications:
The Colleges of Medicine of South Africa Diploma in Anaesthetics 2014*
*See attached supporting documentation
The Colleges of Medicine of South Africa FCA 2018
*Registration pending

Additional Professional certificates of training:
SASA/USABCD/Cardiothoracic Anaesthetic Society of South Africa Basic Focus Assessed Transthoracic Echocardiography

Additional Professional Involvement:
Compiled UFS Department of Anaesthesiology Wellness Initiative Curriculum Content and co-implementer of project.

Employment history:
Employed as a phlebotomist/administrative clerk by Ampath (2007-2009, part time)
Completed Internship at Polokwane Mankweng Hospital Complex, Limpopo Department of Health and Social Development (2010-2012)
Completed Community Service at Polokwane Mankweng Hospital Complex, Limpopo Department of Health and Social Development in the departments General Surgery (January 2012-July 2012), Anaesthesiology (July 2012-December 2012)

January 2013 to January 2015 employed as a level 1 Medical Officer in the Department of Anaesthesiology at Polokwane Mankweng Hospital Complex.
February 2015 employed as registrar in the Department of Anaesthesiology at Universitas/National/Pelonomi Hospital complex.

References:

Prof BJS Diedericks
Emeritus Professor and Head of Clinical Department Anaesthesiology, Faculty of Health Sciences, UFS
051 405 3307
DiedericksBJS@ufs.ac.za

Dr FT Masinge
Consultant Anaesthesiologist and clinical head at Mankweng Hospital
076 947 5443

CURRICULUM VITAE
OF
GILLIAN LAMACRAFT

Department of Anaesthesia,
University of the Free State,
Bloemfontein.
February 2018

SURNAME: LAMACRAFT
(MARRIED SURNAME VAN DER MERWE)
CHRISTIAN NAME: Gillian
ADDRESS: PO Box 37117,
Langenhoven Park,
Bloemfontein 9330
TELEPHONE NUMBER: Home (051) 436 8136
Cell phone 0823768379
FACSIMILE NUMBER: (051) 444 3414
PLACE OF BIRTH: Bridgetown, Barbados
DATE OF BIRTH: January 14th, 1963
NATIONALITY: British
South African Permanent Resident (permit No BFN 71/99)
MARITAL STATUS: Married, 3 children
IDENTITY DOCUMENT No. 630114 0315 181

QUALIFICATIONS

MB,BS July 1986
(Guy's Hospital Medical School, University of London, UK)
MRCP February 1991
(Member of Royal Colleges of Physicians of the United Kingdom)
FRCA March 1994
(Fellow of Royal College of Anaesthetists of the United Kingdom)
Certificate in Pain Management June 1997
(Australian and New Zealand College of Anaesthetists)
Colleges of Medicine of South Africa Examination in Anaesthetics
May 2000
Ph D Anaesthesiology (University of the Free State)
May 2010

REGISTRATION

Full British Medical Registration July 1987
United Kingdom Certificate of Completion of Specialist Training in Anaesthetics August 6th 1999
South African Specialist in Anaesthesiology January 26th 2001

MEDICAL REGISTRATION NUMBERS

(British) (3128527)
South African MP 0481998

EDUCATION

SCHOOL: King's College, Taunton, UK

UNIVERSITY: Guy's Hospital Medical School, University of London, UK

University Awards Leung Keung Prize for Elective Studies

Rogers Fund Medical Research Council Award for Research

Overseas (Research Study in Malnutrition in Bihar, India)

PUBLICATIONS

Roberts PA, Lamacraft G. *Techniques to Reduce the Distress of Paediatric Laceration Repair in Children: A Review Article.*

Medical Journal of Australia 1996: Vol 164 (No.1); 32-35.

Lamacraft G, Cooper MG, Cavalletto B. *Subcutaneous Cannulae for Morphine Boluses in Children: Assessment of a Technique.*

Journal of Pain and Symptom Management 1997: 13 (1); 43-49.

Lamacraft G. *Coloured Infusion lines: Pretty but Dangerous.*

Anaesthesia 1996; 51: 800 (letter).

Lamacraft G. *Lignocaine for acute phantom limb pain reactivation by regional anaesthesia..*

Anaesthesia 1996; 51: 800 (letter).

Lamacraft G, Molloy AR, Cousins MJ. *Peripheral nerve blockade and chronic pain management.*

Pain Reviews 1997; 4 (2): 122-147.

Lamacraft G, Cousins MJ. *Neural blockade in Chronic and Cancer Pain.*

International Anesthesiology Clinics 1997; 35 (2): 131-153.

Lamacraft G, Price CM, Prosser ASJ, Rogers PD, Pounder D. *Interrupting the Sympathetic Flow in Causalgia and Reflex Sympathetic Dystrophy. (Response to article by Schott GD)*
British Medical Journal 1998; 317: 752 (letter)
Lamacraft G. *Complications associated with regional anaesthesia for Caesarean section.*
Southern African Journal of Anaesthesia and Analgesia 2004**;** February**:** 15-20.
Dyer RA, Rout CC, Kruger AM, Van der Vyfer M, Lamacraft G, James MF. *Prevention and treatment of cardiovascular instability during spinal anaesthesia for caesarean section*.
South African Medical Journal 2004; 94 (3): 367-372.
Lamacraft G, Hollingworth S, Dowie JG, Schmidt MJ, Diedericks BJS. *A survey of the use of regional anaesthesia for caesarean section in level 1 and 2 hospitals in the Free State*.
South African Medical Journal 2004; 94 (9): 762 – 763.
Lamacraft G, Schmidt MJ, Diedericks BJS, Joubert G. *An Audit of the Use of regional anaesthesia for Caesarean section in the Free State*: 2002-2004.
Southern African Journal of Anaesthesia and Analgesia 2007; 13(4): 21-26.
Lamacraft G. Complications during obstetric anaesthesia. In: Saving Mothers. Essential steps in the management of common conditions associated with maternal mortality. Ed. J Moodley. Department of Health, South Africa, 2007. Chapter 4, pages 16-18
Lamacraft G. Obstetric anaesthesia: the source of the crisis**. South African Medical Journal** 2008; February. Vol 98 (2): 123-124
Lamacraft G. The ill obstetric case – lessons learnt from the NCCEMD. **CME**. **The SA Journal of CPD** March 2008 Vol 26 No.3: 124-126**.**
Lamacraft G, Kenny PJ, Diedericks BJS, Joubert G. Training and experience of doctors administering obstetric anaesthesia in the Free State level 1 and 2 hospitals. **Southern African Journal of Anaesthesia and Analgesia** 2008; March/April Vol 14 (2): 13-17.

Keenan M, Lamacraft G, Joubert G. A survey of nurses' basic life support knowledge and training at a tertiary hospital. **AJHPE** 2009; Dec Vol 1, No. 1: 3-7.
Lamacraft G, Rout C. Anaesthesia Related Deaths. **Saving Mothers: Fourth Report on Confidential Enquiries into Maternal Deaths in South Africa** 2005 – 2007. Chapter 7: 125-153.
Lamacraft G. Comment on recent advances in the pharmacological management of painful diabetic neuropathy: a South African perspective. **SA Journal of Diabetes and Vascular Care** 2010; November Vol 7, No. 4: 13 –137.
Lamacraft G. Opioids. In: **MIMS Handbook of Pain and Pain Syndromes**. Ed. JR Snyman. MIMS (Avusa Media Ltd), Nov 2011. Pages 137-143.
Lamacraft G. The link between acute postoperative pain and chronic pain syndromes. . **Southern African Journal of Anaesthesia and Analgesia** 2012: 18(1): 45-50.
Lamacraft G, Bechan S. Invited Editorial: South African Guidelines for the Treatment of Cancer Pain. South African Cancer Pain Guidelines Working Group. **Southern African Journal of Anaesthesia and Analgesia January 2015, Volume 21, No. 1, Pages 6-7.** *South Afr J Anaesth Analg: ISSN (Print): 2220-1181, ISSN (Web): 2220-1173*
Kingwill AC, Lamacraft G. Ultrasound-guided neural blockade in Proteus syndrome, **Southern African Journal of Anaesthesia and Analgesia** 2015; 1(1): 1-3
Tarloff D, Lamacraft G. The prevalence of skin scars in patients previously given intramuscular diclofenac injections attending the Pain Clinic at Universitas Academic Hospital, Bloemfontein, South Africa. **South African Medical Journal** 2017; 107 (2): 101-105.
G Lamacraft; C Labuschagne, S Pretorius, M C Prinsloo; M D Smit; J-R Steyn. Preoperative fasting times: Prescribed and actual fasting times at Universitas Hospital Annex, Bloemfontein, South Africa
South African Medical Journal 2017; 107(10): 910-914

NJ Procter, G Lamacraft, G Joubert. Intravenous paracetamol – waste not, want not: a retrospective audit on the appropriate use of intravenous paracetamol at Universitas Academic Hospital Complex – Bloemfontein.
Southern African Journal of Anaesthesia and Analgesia 2018; 1(1)

ORIGINAL PAPERS PERSONALLY PRESENTED AT CONFERENCES

Australian and New Zealand Burns Association's 20th Annual International and Regional Congress (Gold Coast, August 1995):

(1) "Continuous traumatic stress complicating pain management in a 6 year old: a case study."

(2) "An improved technique for giving subcutaneous morphine to post-operative burns children"

Australian Pain Society 17th Annual Scientific Meeting (Canberra, March 1996):

"The Use of Indwelling Subcutaneous Cannulae for Intermittent Morphine and Codeine Administration in a Paediatric Hospital"

11th World Congress of Anaesthesiologists, April 1996, Sydney: Poster presentation:

"Use of Indwelling Subcutaneous Cannulae for Intermittent Opiate Boluses Postoperatively in Children"

University of the Free State Faculty Forum Meeting 2004

*****Lamacraft G. Schmidt MJ, Hollingworth S, Dowie JG, Joubert G, Diedericks BJS.

"A survey of anaesthetic drugs and equipment in theatres used for caesarean sections in level 1 and 2 hospitals in the Free State"

****Won Best Clinical Paper Prize***

University of the Free State Faculty Forum Meeting 2004

Hollingworth S, Lamacraft G, Dowie J, Schmidt MJ, Joubert G, Diedericks BJS.

"*A survey of the use of regional anaesthesia for caesarean sections in level 1 and 2 hospitals in the Free State"*.

South African Society of Anaesthesiologists Annual Congress, March 2014, Sun City. Poster presentation.

Labuscagne C, Pretorius S, Prinsloo C, Smit M, Steyn J, Lamacraft G. 8

"Pre-operative fasting times: prescribed and actual fasting times at Universitas Hospital Annex, Bloemfontein".

OTHER PRESENTATIONS AT CONFERENCES/COURSES

South African Society of Anaesthesiologists Congress, May 2002
Breakfast Meetings: Obstetric Anaesthesia (with Dr. R Dyer) and Ophthalmic Anaesthesia (with Prof. Stulting).

South African Society of Anaesthesiologists Refresher Course, May 2002
"HELLP Syndrome

Regional and Pain Symposium, Bloemfontein February 2004.
"*Complications Associated with Regional Anaesthesia for Caesarean Section".*

M. Fam. Med Course, Bloemfontein 2005
" Spinal Anaesthesia for Caesarean Section"

South African Society of Anaesthesiologists Congress, Port Elizabeth, 2006
Lamacraft G, Schmidt MJ, Kenny PJ, Diedericks BJS
"The Free State Level 1 and 2 Hospitals Obstetric Anaesthesia Audit: 2002/3 versus 2005".

South African Society for Surgery of the Hand. **Refresher Course , Bloemfontein, 2006 (***2 lectures)*
"Complex Regional Pain Syndrome: Prevention, Pathophysiology, Treatment"
And:
"Upper Limb Blocks"

M. Fam Med Course, Bloemfontein 2006 *(2 lectures)*
"*New Muscle Relaxants"*
"Anaesthesia for C. Section"

World Congress of Anaesthesiologists 2008 (Cape Town)
"Anaesthesia for the Sick Obstetric Patient in Developing Countries"

South African Society of Anaesthesiologists Congress, Durban, 2009.
"The Saving Mothers Report 2005-2007: The Anaesthesia Chapter".
South African Society of Anaesthesiologists Congress, Bloemfontein, 2010.
"The Transition from Acute to Chronic Pain"
Department of Family Medicine, Cardiology Refresher Course, Bloemfontein 2010.
"When To Resuscitate a Patient"
South African Society for Surgery of the Hand, Annual Refresher Course, Bloemfontein 2011.
"Pharmacological Treatment of Complex Regional Pain Syndrome"
South African Society of Anaesthesiologists Congress, Cape Town, 2012.
"The Link Between Acute Postoperative Pain and Chronic Pain Syndromes"
South African Society of Anaesthesiologists Congress, *Bloemfontein 2016*
"Intrathecal Drugs in Theatre and the Pain Clinic"
Department of Family Medicine, University of the Free State, Anaesthesia Refresher Course, Bloemfontein 2017.
"Post-operative Analgesia"

OTHER ORIGINAL PAPERS, BUT PRESENTED AT CONFERENCE BY CO-AUTHOR (UNDERLINED)
South Africa Society of Anaesthesiologists Conference 2004 (Johannesburg):
Hollingworth S, Lamacraft G, Dowie J, Schmidt MJ, Joubert G, Diedericks BJS.

"*A survey of the use of regional anaesthesia for caesarean sections in level 1 and 2 hospitals in the Free State"*.

South Africa Society of Anaesthesiologists Conference 2004 (Johannesburg):

Kenny P, Lamacraft G, Joubert G, Diedericks BJS.
"*The Free State Provincial Obstetric Anaesthesia Manpower Survey"*

COURSES and OTHER CONFERENCES ATTENDED INCLUDE:

Acupuncture Bristol, UK: 1989
Jilin, Republic of China: 1991
Pain and Nociception Charing Cross Hospital, UK:
Group (PANG) 1990, 1992, 1997
Advanced Trauma Jersey: February 1993
and Life Support (passed course exam)
International Association Vancouver, Canada: August 1996
for the Study of Pain:

8th World Congress. Keele	Keele University, Staffs, UK.
National Health Service Management Course	March 1998

Appendix F:

Permission Letter (Sister Botes, Resuscitation Co-ordinator, Universitas Academic Hospital)

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

Dr CM Strydom
Department of Anaesthesiology
UFS Faculty of Health Sciences
Francois Retief Building
Bloemfontein, 3901
08 November 2018

Sister Botes
Resuscitation Co-ordinator/ Chair Person of the Resuscitation Committee
Universitas Academic Hospital
Bloemfontein, 3901

Resuscitation Outcomes for Adult Patients with In-hospital cardiac arrest- Are we successful? An Audit of Resuscitation Outcomes for the period January 2015 to December 2017 at Universitas Academic Hospital, Bloemfontein, using the *Utstein Model/ Template*

I am currently a registrar in the UFS Department of Anaesthesiology and propose the above mentioned, for my MMed Anaesthesiology dissertation. My intent is to conduct a retrospective audit of the resuscitation reports completed at Universitas Academic Hospital for adult In-Hospital cardiac arrest.

This study will build on the pilot study that Prof Lamacraft (Head of Universitas Pain Control Unit and member of the Universitas Academic Hospital Resuscitation Committee) conducted in conjunction with the GSM 213 module MBChB students in 2014. The reports will be audited by means of a modified Utstein Template, based on the Utstein Model which is recognized by the South African Resuscitation Council.

For this purpose, I will require access to the Universitas Academic Hospital resuscitation reports for the period January 2015 to December 2017. I will include all adult patients for whom a resuscitation report was compiled following an In-hospital cardiac arrest, and was filed with the resuscitation sister, Sister Botha. Patient names and other possible identification information will be kept confidential.

As part of my MMed Anaesthesiology dissertation, I will present this audit at UFS Interdepartmental forums and short registrar presentations. I plan on presenting these findings at a national level during the annual SASA congress and also write and submit an article for publication in accredited anaesthesiology journals.

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and/en Prof. BJS Diedericks: diedericksbjs@ufs.ac.za

Thank you in advance for considering my request. I look forward to your response in this regard. For any queries please contact me at carienstrydom85@gmail.com or telephonically at +27725108574.

Kind regards

_____

Catharina Maria Strydom

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Appendix G:

Permission Letter (Free State Department of Health)

Dr CM Strydom
Department of Anaesthesiology
UFS Faculty of Health Sciences
Francois Retief Building
Bloemfontein, 3901
08 November 2018

Free State Department of Health

Resuscitation Outcomes for Adult Patients with In-hospital cardiac arrest- Are we successful? An Audit of Resuscitation Outcomes for the period January 2015 to December 2017 at Universitas Academic Hospital, Bloemfontein, using the *Utstein Model*

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For this purpose, I will require access to the Universitas Academic Hospital resuscitation reports for the period January 2015 to December 2017. I will include all adult patients for whom a resuscitation report was compiled following an in-hospital cardiac arrest, and was filed with the resuscitation sister, Sister Botha. These records belong to Universitas Academic Hospital and will be returned intact upon completion of data capture sheets.

Due permission will also be obtained from Sister Botes, the Resuscitation Co-ordinator of Universitas Academic Hospital. Commencement of data capture will only begin, upon protocol approval from the Ethics Committee and permission from the Free State Department of Health.

Patient names and other possible identification information will be kept confidential.

As part of my MMed Anaesthesiology dissertation, I will present this audit at

As part of my MMed Anaesthesiology dissertation, I will present this audit at UFS Interdepartmental forums and short registrar presentations. My aim is to present these findings at a national level during the annual SASA congress and also write and submit an article for publication in accredited anaesthesiology journals. I will inform the Chief Executive Officer if any of the findings are to be published.

Thank you in advance for considering my request. I look forward to your response in this regard. For any queries please contact me at carienstrydom85@gmail.com or telephonically at +27725108574.

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E. Utstein Reporting Template

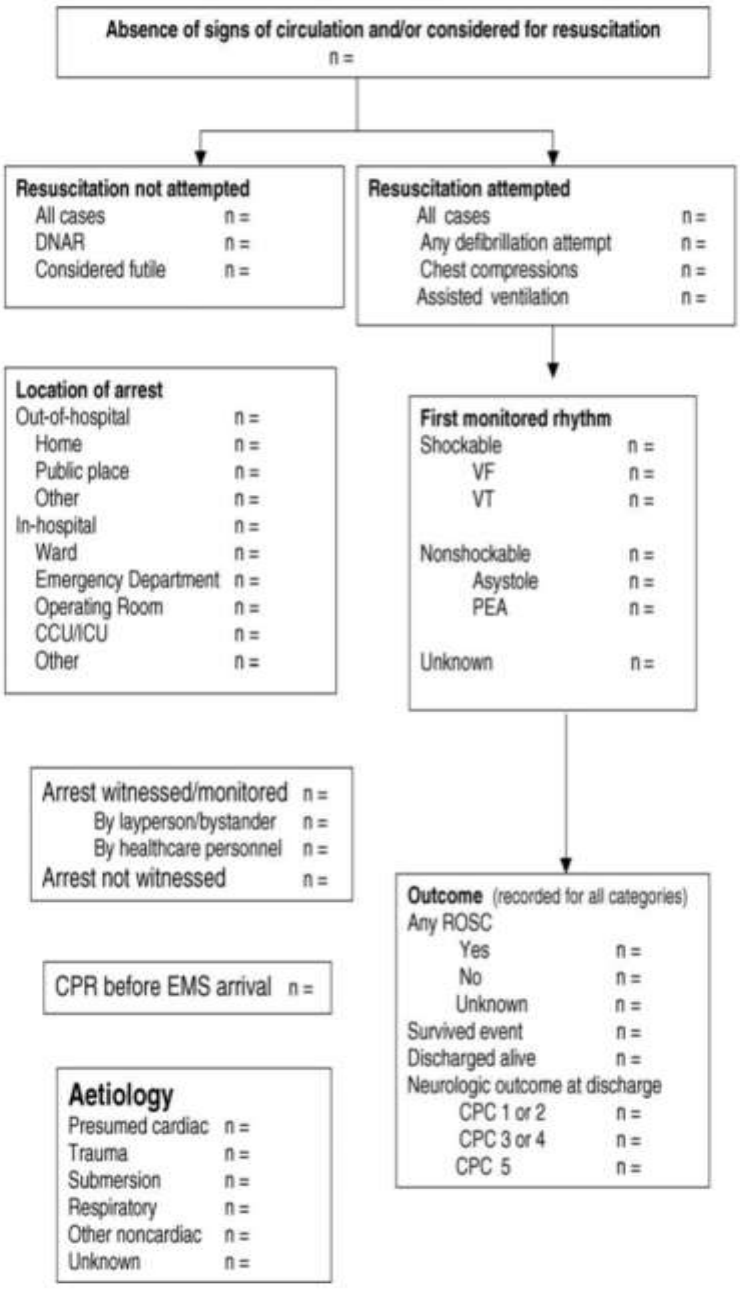


Fig. 1. Utstein reporting template for core data elements. ED, emergency department; OR, operating room; CCU/ICU, critical care unit/intensive care unit; and PEA, pulseless electrical activity.

F. Revised Modified Utstein Reporting Template for Universitas Academic Hospital

Resuscitation					
Resuscitation Reports		n=			
RN number					
Age of patient		n=			
Any defibrillation attempted		n=			
Time until first defibrillation		n=			
Assisted ventilation		n=			
Chest compressions		n=			
First monitored rhythm		Location of cardiac arrest		Day/Time of resuscitation attempt	
Shockable					
VF	n=	Referral unit	n=	Weekdays	n=
VT	n=	Theatre Complex	n=	00h00-05h59	n=
		OPD	n=	06h00-07h59	n=
		Maternity	n=	08h00-16h00	n=
Non-shockable		**Wards:**		16h01-18h59	n=
Asystole	n=	Ward 3A	n=	19h00-00h00	n=
PEA	n=	Ward 3B	n=		
Unknown	n=	Ward 4A	n=	Weekends or public holidays	
		Ward 4B	n=		n=
		Ward 5A	n=	00h00-05h59	n=
		Ward 5B	n=	06h00-07h59	n=
		Ward 6A	n=	08h00-16h00	n=
		Ward 6B	n=	16h01-18h59	n=
		Ward 7A	n=	19h00-00h00	n=
		Ward 7B	n=		
		Ward 8B	n=		
		Critical Care Units:			
		Surgical	n=		
		Neurosurgical	n=		
		Cardiothoracic	n=		
		Coronary	n=		
		MDICU	n=		
		Procedure Rooms:			
		Radiology	n=		
		Gastroenterology	n=		
		Pain Clinic	n=		
		Cardiac Catheter Lab	n=		

		Outcome		
Successful	n=	Arrest witnessed	n=	Time of cardiac arrest
Unsuccessful	n=	Layperson/bystander	n=	hh:mm
		Health care	n=	
				Time CPR
Any ROSC		professional		commenced
Yes	n=			hh:mm
No	n=	arrest not witnessed	n=	
Unknown	n=			Resuscitation team called
				n=
Survived event	n=			
Non survival event	n=			Resuscitation team not called
				n=
Survived to discharge from				
hospital	n=			Reason team not called
				Doctor was first responder
				n=
				Not recorded
				n=
				After hours
				n=
				Other
				n=
				Time resuscitation team called
				hh:mm
				Time resuscitation team arrived
				hh:mm

Who initiated resuscitation		Aetiology	
Nurse practitioner	n=	Cardiac	n=
Doctor	n=	Submersion	n=
Other	n=	Other non-cardiac	n=
		Trauma	n=
		Respiratory	n=
		Unknown	n=
		Other	

G. Data Collection Sheet

Mark the appropriate block with an X or write the data in the space provided:

For office use:

1. Research number: **RN** | | |

2. Location of cardiac arrest: | | |

1	Referral unit
2	Theatre Complex
3	OPD
4	Maternity
	Wards:
5	Ward 3A
6	Ward 3B
7	Ward 4A
8	Ward 4B
9	Ward 5A
10	Ward 5B
11	Ward 6A
12	Ward 6B
13	Ward 7A
14	Ward 7B
15	Ward 8B
	Critical Care Units:
16	Surigical
17	Neurosurgical
18	Cardiothoracic
19	Coronary
20	MDICU
	Procedure Rooms:
20	Radiology
21	Gastroenterology
22	Pain Clinic
23	Cardiac Catheter Lab
24	Other: _____

3. Age of the patient | | |

4. Date of event | | |

d d

5. Arrest Witnessed

1	layperson/ bystander
2	health care professional

6. Time of cardiac arrest | | |

hr hr

7. Time resuscitation commenced | | |

hr hr

8. Who initiated CPR

1	Nurse practitioner	
2	Doctor	
3	Other	_____

9. Resuscitation team called

1	Yes
2	No

if no then

10. Reason resuscitation team not called

1	Doctor was first responder	
2	Not recorded	
3	After hours	
4	Other	_____

11. Time resuscitation team called

hr hr

12. Time resuscitation team arrived

hr hr

13. Aetiology of cardiac arrest

1	Cardiac
2	Trauma
3	Submersion
4	Respiratory
5	Other non-cardiac
6	Unknown

14. Chest compressions

1	Yes
2	No

15. First monitored rhythm

Shockable

1	VF
2	VT

Non-shockable

3	Asystole
4	PEA
5	Unknown

16. Defibrillation attempt(s)

1	Yes
2	No

17.Assisted ventilation

1	Yes	
2	No	

18. Outcome

1	ROSC	
2	Did not survive event	
3	Survived event	
4	Survived to hospital discharge	
5	Unknown	

19. Inotropic support post ROSC

1	Yes	
2	No	

20. ICU admission post ROSC

1	Yes	
2	No	

H. Supplementary

I. Definitions of Terms used in the Utstein Reporting Template

Revisions and modifications made by *Lamacraft and colleagues.* are in **bold**.

Arrest, witnessed

A witnessed cardiac arrest is one that is seen or heard by another person or an arrest that is monitored.

Assisted ventilation

Assisted ventilation is the act of inflating the patient's lungs by rescue breathing with or without a bag-mask device or any other mechanical device.

Attempted defibrillation

Defibrillation can be attempted by means of an automated external defibrillator (AED), a semi-automated external defibrillator, an implantable cardioverter-defibrillator (ICD), or a manual defibrillator. The type of device used is not considered a core data element.

Cardiac arrest:

Cardiac arrest is the cessation of cardiac mechanical activity as confirmed by the absence of signs of circulation. If an EMS provider or physician did not witness the cardiac arrest, he/she may be uncertain as to whether a cardiac arrest actually occurred.

Cause of arrest/aetiology:

An arrest is presumed to be of cardiac aetiology unless it is known or likely to have been caused by trauma, submersion, drug overdose, asphyxia, exsanguination, or any other non-cardiac cause as best determined by rescuers.

Chest compressions:

Chest compressions are performed by an individual or mechanical device during CPR in an attempt to restore spontaneous circulation.

End of event:

A resuscitation event is deemed to have ended when death is declared, or spontaneous circulation is restored and sustained for 20 minutes or longer. If extracorporeal life support is being provided, the end of the event is 20 minutes after establishment of extracorporeal circulation.

First monitored rhythm:

The first monitored rhythm is the first cardiac rhythm present when the monitor or defibrillator is attached to the patient after a cardiac arrest. If the AED does not have a rhythm display, it may be possible to determine the first monitored rhythm from a data storage card, hard drive, or other device used by the AED to record data. If the AED has no data recording device, the first monitored rhythm should be classified simply as shockable or non-shockable. This data point can be updated at a later time if the AED has data download capability.

Location of arrest:

Location of arrest is the specific location where the event occurred, or the patient was found. Knowledge of where the cardiac arrests occur may help a community to determine how it can optimize its resources to reduce response intervals. A basic list of predefined locations will facilitate comparisons. Local factors may make creation of subcategories useful.

Therefore, various subcategories have been added on the Revised Modified Utstein Reporting Template for Universitas Academic Hospital.

Resuscitation:

A resuscitation attempt is defined as the act of attempting to maintain or restore life by establishing and/or maintaining airway, breathing, and circulation through CPR, defibrillation, and other related emergency care.

Return of spontaneous circulation (ROSC):

Signs of return of spontaneous circulation include breathing (more than an occasional gasp), coughing, or movement. For healthcare personnel, signs of ROSC may also include evidence of a palpable pulse or measurable blood pressure. For the purpose of the Utstein registry template, “successful resuscitation,” or ROSC, is defined for all rhythms as the restoration of a spontaneous perfusing rhythm that results in more than an occasional gasp, fleeting palpated pulse, or arterial waveform. Assisted circulation (e.g. extracorporeal support such as extracorporeal membrane oxygenation or biventricular assist device) should not be considered ROSC until “patient-generated” (i.e. spontaneous) circulation is established. Previous reports focused on outcomes from ventricular fibrillation have variably defined “successful defibrillation” as the termination of fibrillation to any rhythm (including asystole) and the termination of fibrillation to an organized electrical rhythm at 5 seconds after defibrillation (including pulseless electrical activity, PEA). Neither of these definitions of “successful defibrillation” would qualify as ROSC unless accompanied by evidence of restoration of circulation. By consensus, the term “any ROSC” is intended to represent a brief (approximately ≥ 30 seconds) restoration of spontaneous circulation that provides evidence of more than an occasional gasp, occasional fleeting palpable pulse, or arterial waveform. The time that ROSC is achieved is achieved is a core data element.

Shockable/ non-shockable rhythm:

This element refers to the first monitored rhythm, which, when analyzed by the person interpreting the monitor/defibrillator or an AED, was found to be treatable by attempted defibrillation (i.e., shockable or non-shockable). In general, shockable cardiac arrest rhythms are further divided into ventricular fibrillation and pulseless ventricular tachycardia. Non-shockable cardiac arrest rhythms can be categorized as either asystole or PEA. Although a very specific definition of asystole is desirable, no consensus agreement was reached on either specific duration or heart rate to define asystole versus bradycardia/PEA. In future iterations of the registry document, further consideration and additional research resources may need to be devoted to addressing the importance and ability of providers to differentiate between these initial cardiac rhythms.

Survived event:
Sustained ROSC for ≥20 minutes (or return of circulation if extracorporeal circulatory support is applied).

Out of hospital setting has been excluded from the Revised Modified Utstein Reporting Template for Universitas Academic Hospital.

Survival to hospital discharge:
Survival to hospital discharge is the point at which the patient is discharged from the hospital acute care unit regardless of neurological status, outcome, or destination. Ideally this should indicate survival to discharge from acute hospital care, including a possible rehabilitation period in a local hospital before long-term, homecare, or death.

Sustained return of spontaneous circulation:
Sustained ROSC is deemed to have occurred when chest compressions are not required for 20 consecutive minutes and signs of circulation persist (or sustained ROSC if extracorporeal circulatory support is applied). Thus, after resuscitation from in-hospital cardiac arrest, sustained ROSC and survived event have the same definition.

II. Additional tables, graphs, and commentary

Out of a total of 189 cardiac arrests that occurred at the Universitas Academic Hospital within this study period, **28,04%** of the patients **survived the event**, **32,80%** of outcomes were **successful,** with **32,80%** of the patients having any ROSC during the resuscitative effort. Survival to hospital discharge rate was **12,30%**, with only one patient lost to follow-up.

a) Table I: Comparison of UAH resuscitation outcomes to other outcomes reported in literature

Authors	Country	Return of spontaneous circulation	Survival to hospital discharg
Strydom et al	South Africa	32,8%	12,3%
Krittayaphong et al[18]	Thailand	49,8%	7,4%
Perby et al[11]	USA	44,0%	17,0%
Jones et al[15]	New Zealand	*	27,2%
Fredriksson et al[20]	Sweden	*	37,0%
Keuper et al[21]	Nijmegen	57%	14,5%
Patrick et al[22]	New Zealand	52%	26,0%
Eftychiou et al[23]	Cyprus	35%	12,3%

* not reported
#Note references from Chapter 1

b) Table I: Study population by year

Year	**Frequency**	Percent	Cumulative Frequency	Cumulative Percent
2015	68	35.98	68	35.98
2016	72	38.10	140	74.07
2017	49	25.93	189	100.00

35,98% of the cardiac arrests that were recorded for this research occurred during **2015, 38,10%** during **2016** and **25,93%** during **2017**.

Limitation in study population: only adult patients for whom a resuscitation report was generated and stored by the resuscitation coordinator were included for analysis. An attempt was made to quantify the total amount of reported resuscitations in the institution for the study period, to the ones included in the study population, by comparing the study population to the resuscitation reports generated by the institutional resuscitation review committee. **Currently these reports do not distinguish between paediatric and adult patients making this comparison impossible.**

c) Table II: Study population by month

Month	Frequency	Percent	Cumulative Frequency	Cumulative Percentage
January	12	6.42	12	6.42
February	23	12.30	35	18.72

March	14	7.49	49	26.20
April	17	9.09	66	35.29
May	16	8.56	82	43.85
June	9	4.81	91	48.66
July	17	9.09	108	57.75
August	22	11.76	130	69.52
September	12	6.42	142	75.94
October	20	10.70	162	86.63
November	12	6.42	174	93.05
December	13	6.95	187	100.00

*values in red highlight months with highest CPR rate, though this was not statistically significant.

d) Figure 1: Study population by age group

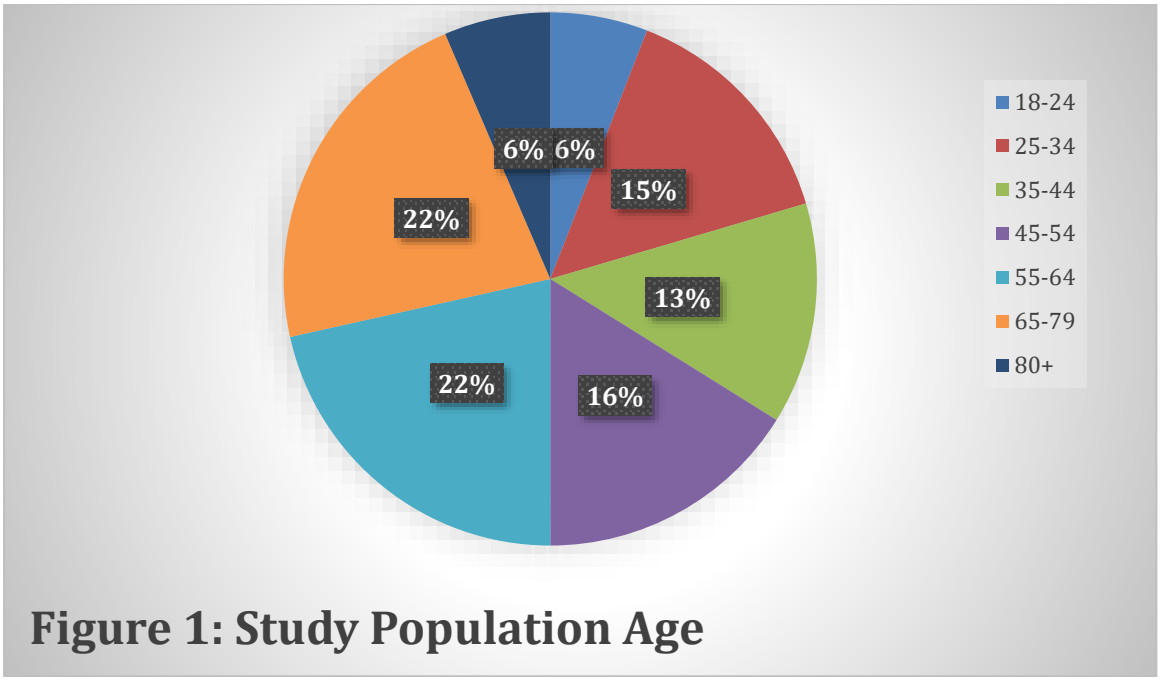


Figure 1: Study Population Age

The **65-79 age group** accounted for most of the cardiac arrests, with **22,04%.**
Whilst the **18-24 age group** accounted for the least with **5,91%**

Age of the patient in association with cardiac arrest event survival:

The **18-44 age group** comprises 33,87% of the total patient population with 22,22% of the patients within this age group having survived the event. The **18-44 age group** has *the lowest patient survival rate of the three age groups*. The investigators postulate that the younger age group has a greater physiological reserve and thus by the time of the cardiac arrest, may already be such an extremist in terms of physiological derangements that the CPR is less affective in establishing ROSC.

The **45-64 age group** comprises 37,63% of the total patient population with 32,86% of the patients within this age group having survived the event. The **45-64 age group** has *the highest patient survival rate of the three groups*.

The **65 and above age group** comprises the smallest portion of the total patient population, 28,49%. However, this population group had a higher rate of survival following a cardiac arrest 28,85% when compared to patients within the youngest age group.

After conducting a Chi-square Test (p-value of 0.39) age is not a statistically relevant factor for the survival of a cardiac arrest event.

e) Figure 2: Influence of patient age on event survival

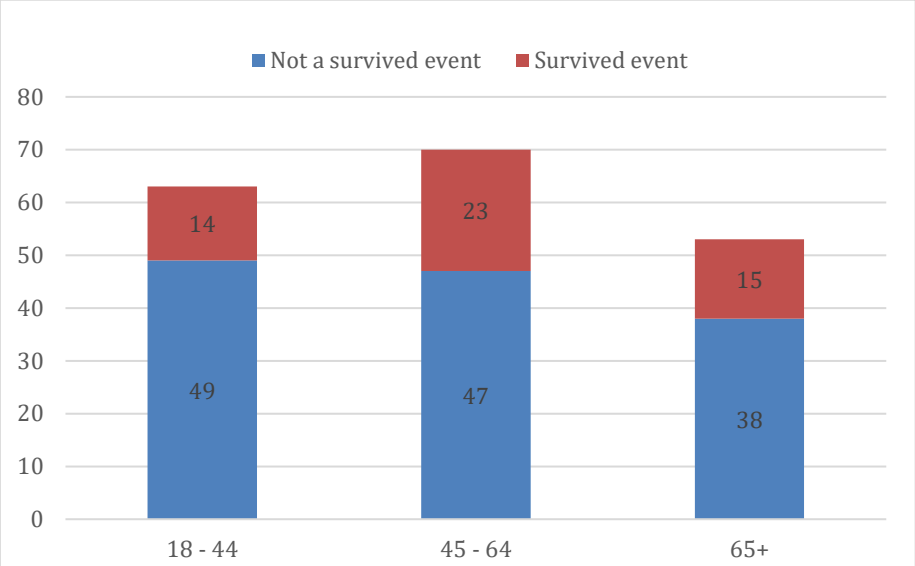


Figure 2: Age vs Survival

Successful resuscitation as evidenced by **ROSC** in these groups showed similar trends: the **18-44 age group** with 24,40%, the **45-64 age group** with 40% and the **65 and above age group** 28,45%.

Survival to hospital discharge in these groups also followed this trend; **18-44 age group** with 26,09%, the **45-64 age group** with 39,13% and the **65 and above age group** 34,78%.

f) Figure 3: Location of cardiac arrest and association with event survival

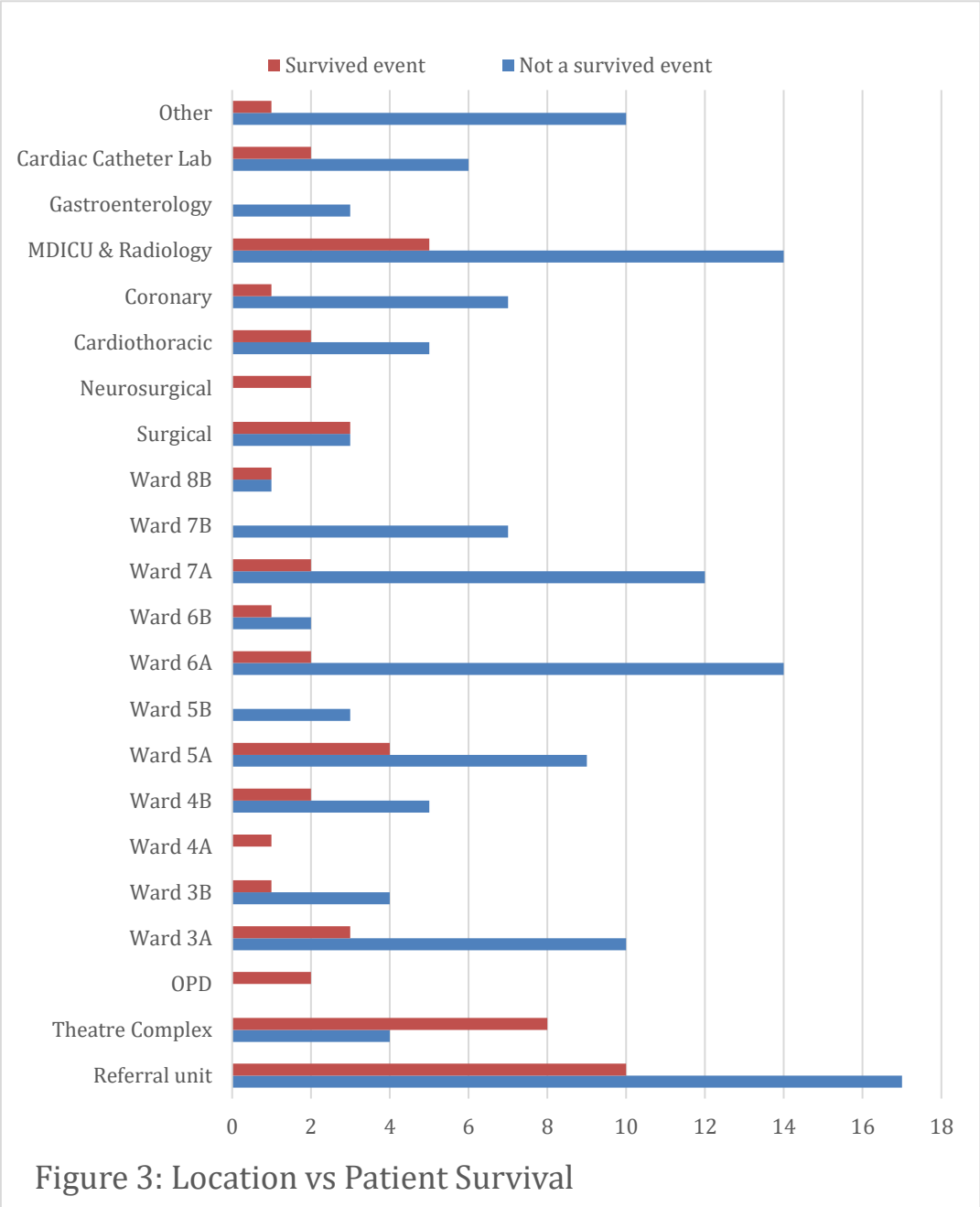


Figure 3: Location vs Patient Survival

Location of cardiac arrest in association with event survival:

The **Referral Unit** had the highest incidence (18,87%) of patient survival after a cardiac arrest event, followed by the **Theatre Complex** (15,09%). The Referral Unit also had the highest incidence of successful resuscitation events as well as ROSC.

When considering **survival to hospital discharge**; the Referral Unit, Ward 5A and Radiology/MDICU each contributed **13,04%**, with the Cardiac Catheter Lab contributing **8,70%** and the OPD, Ward 4B, Ward 6A, Surgical, Neurosurgical, Cardiothoracic, Coronary and Other locations each contributing **4,35%.**

g) *Figure 4: Type of workday and association with event survival*

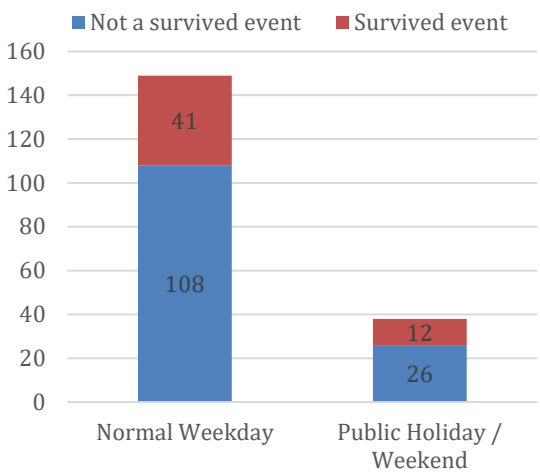


Figure 4: Type of day vs Survival

Type of workday in association with cardiac arrest event survival:

On a normal weekday **27,52%** of the investigated population, **survived the cardiac arrest event** compared to **31,58%** on a public holiday or weekend weekday. After conducting a Chi-square Test (p-value of 0.62) the type of workday is not a statistically relevant factor for the survival of a cardiac arrest event.

On a normal weekday **32,21%** of the investigated population had **successful outcomes** of resuscitation as evident by RSOC, compared to **36,84%** on public holiday or weekend weekday.

If the cardiac arrest event occurred on a normal weekday **12,93%** of the investigated population, **survival to hospital discharge** compared to **10,53%** on public holiday or weekend weekday.

h) *Figure 5: Time of normal workday and occurrence of cardiac arrest event*

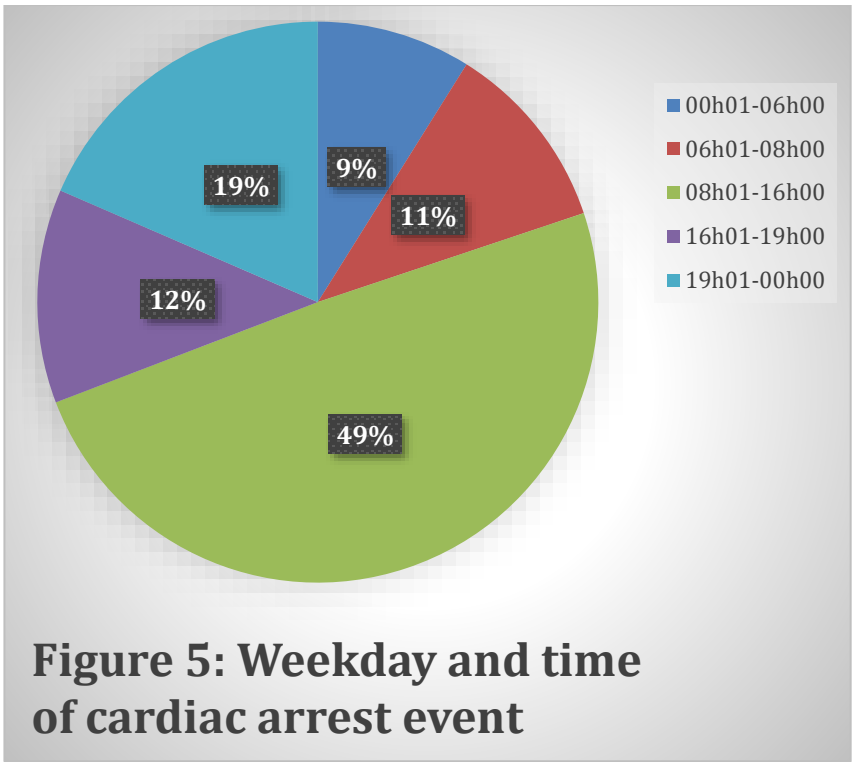


Figure 5: Weekday and time of cardiac arrest event

i) *Figure 6: Time of public holiday or weekend workday and occurrence of cardiac arrest event*

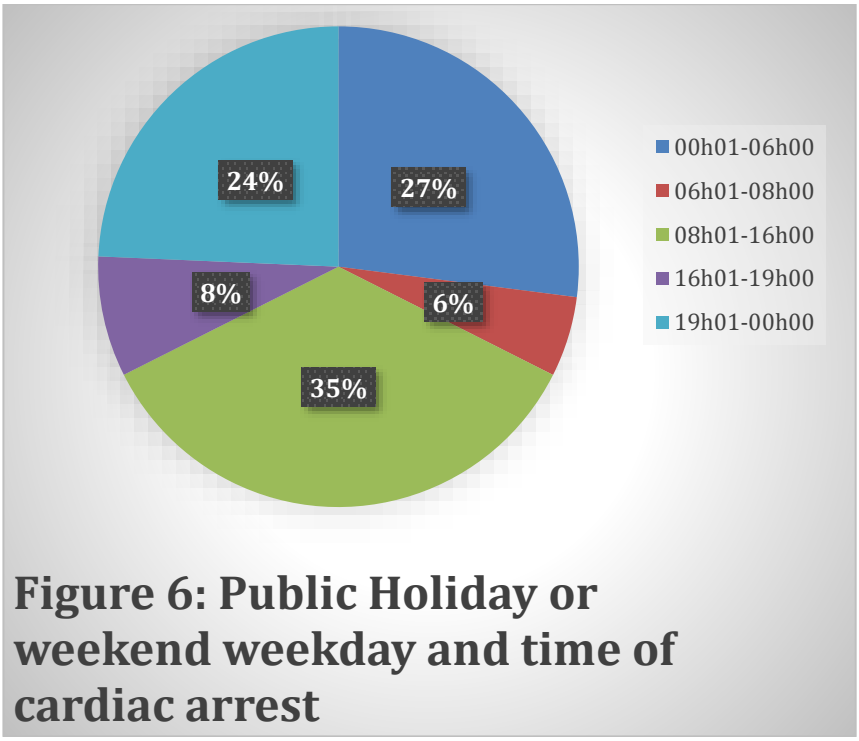


Figure 6: Public Holiday or weekend weekday and time of cardiac arrest

j) *Figure 7: Defibrillation attempt in association with event survival*

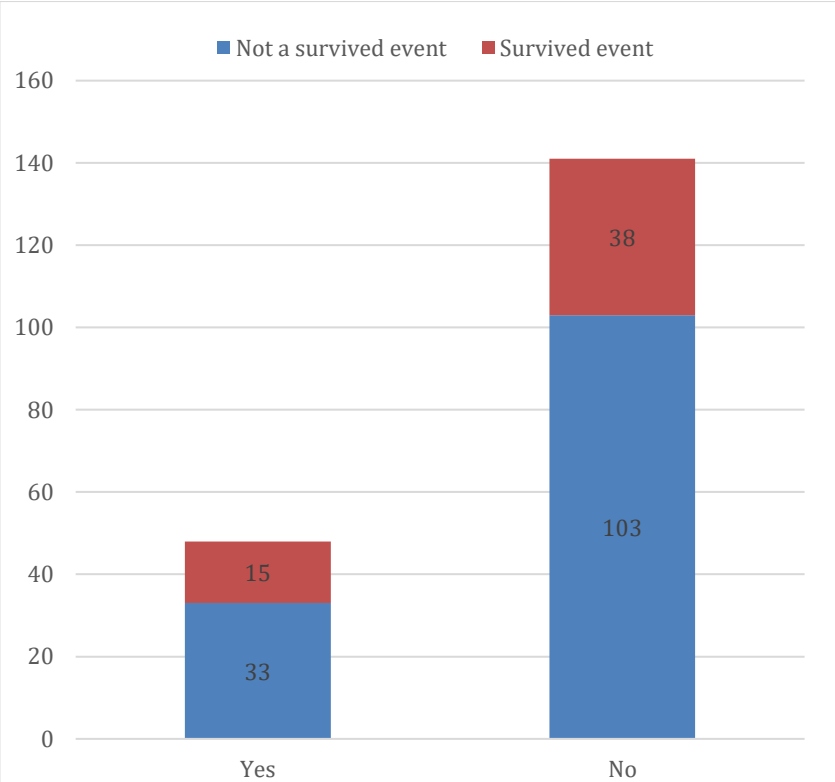


Figure 7: Defibrillation attempt vs Survival

In the event where there was an attempt at defibrillation, **31,25%** of the *patients survived*, compared to **26,95%** in the events with no defibrillation attempts.

In the event where defibrillation was attempted, **33,33%** of the *patients displayed ROSC*, compared to **32,62%** in the events with no defibrillation attempts.

The **median time** to defibrillation was **10 minutes**.

Of those not defibrillated **2.9%** had a shockable first rhythm.

When considering **the total number of survived events**, 28,30% of the survivals were associated with a defibrillation attempt whilst 71,70% had no defibrillation attempts.

After conducting a Chi-square Test (p-value of 0.57) attempt at defibrillation is not a statistically relevant factor for the survival of a cardiac arrest event.

16% of first rhythms recorded were **unknown**.

k) *Figure 8: Known first rhythms:*

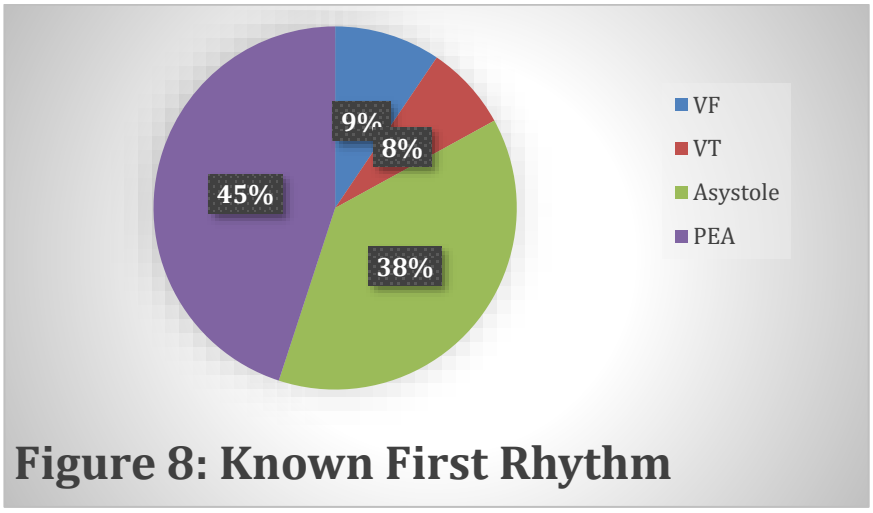


Figure 8: Known First Rhythm

l) *Figure 9: Person initiating CPR*

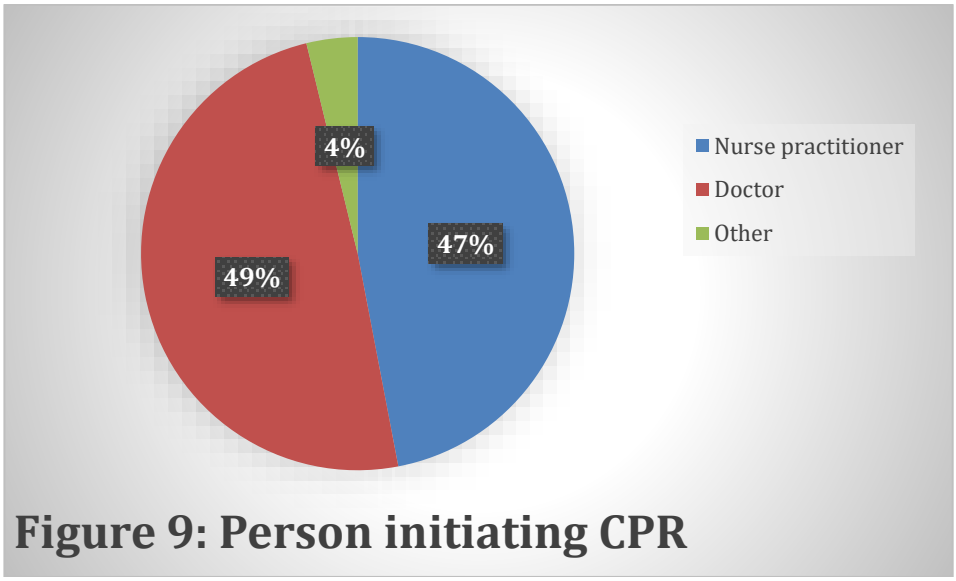


Figure 9: Person initiating CPR

m) *Figure 10: Time interval from identification of cardiac arrest event to initiation of CPR*

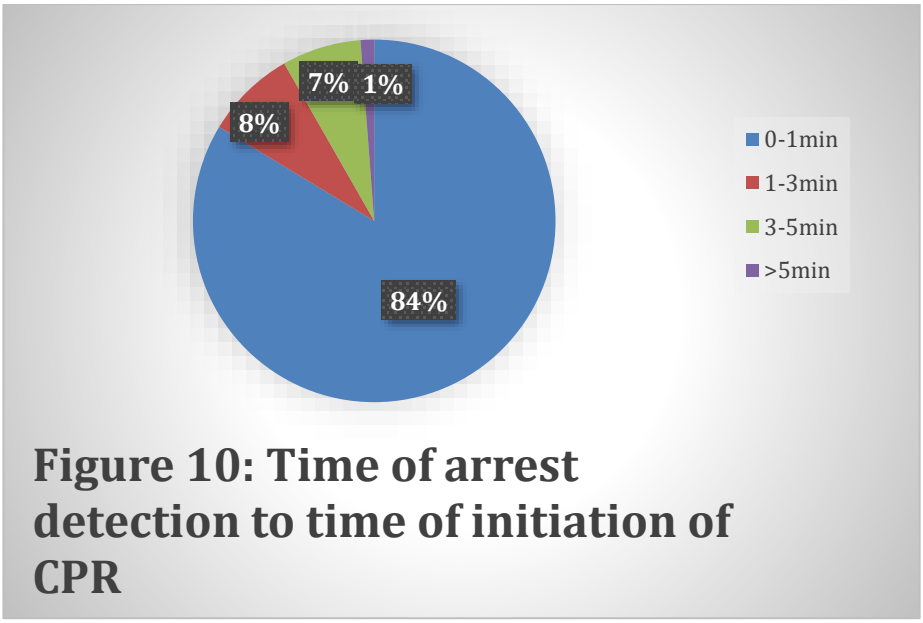


Figure 10: Time of arrest detection to time of initiation of CPR

n) *Figure 11: Duration of CPR and association with cardiac arrest event survival*

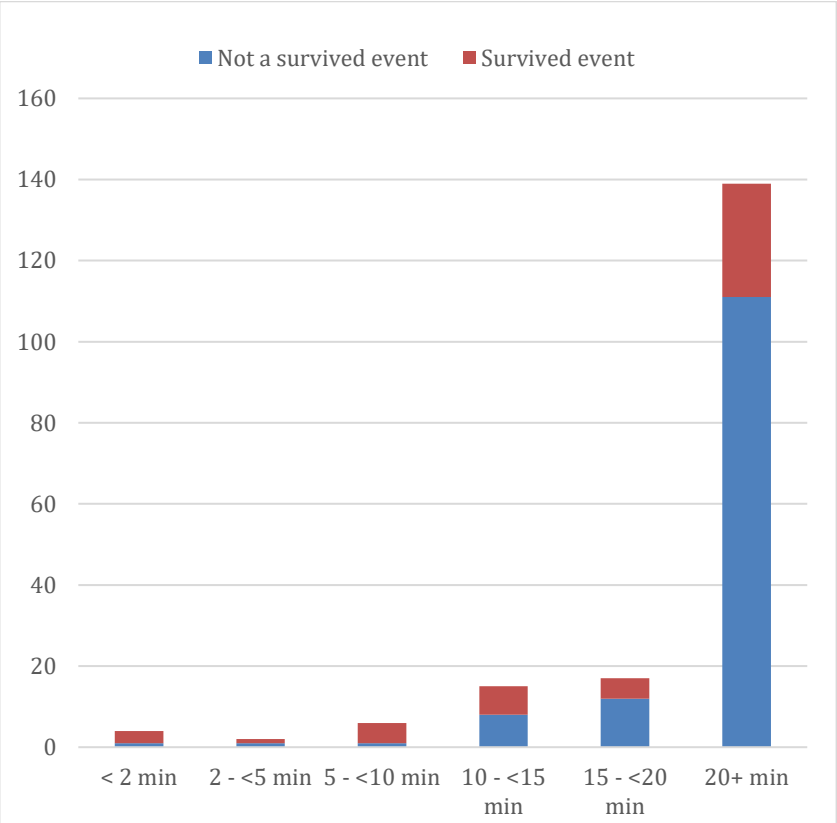


Figure 11: CPR duration vs Survival

o) *Figure 12: Survived events and the duration of CPR*

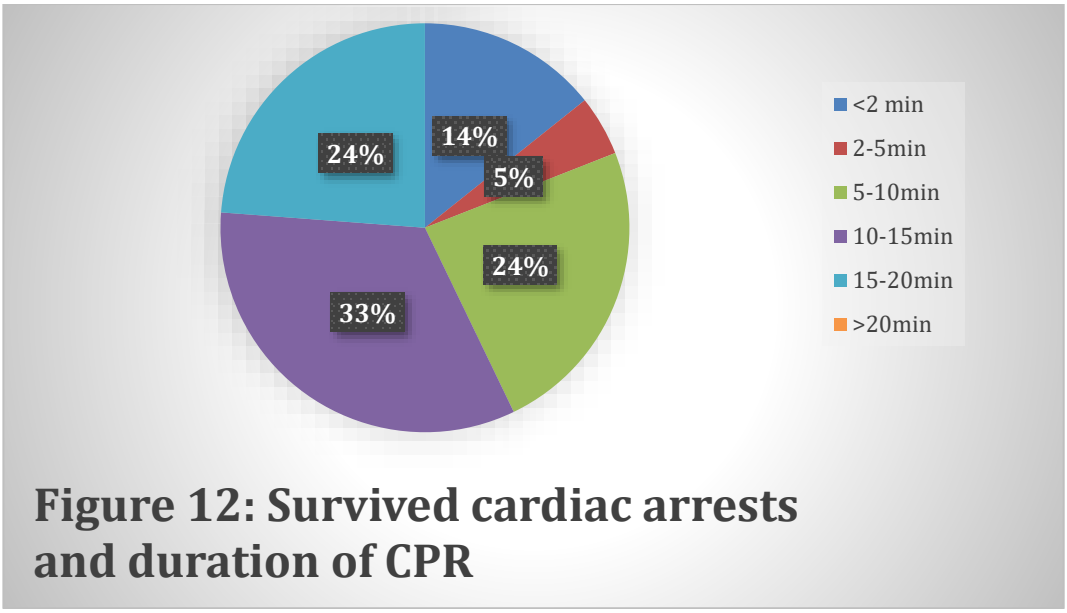


Figure 12: Survived cardiac arrests and duration of CPR

p) *Figure 13: Admission to a High-dependency/ Critical Care Unit at the time of the cardiac arrest and the association with event survival*

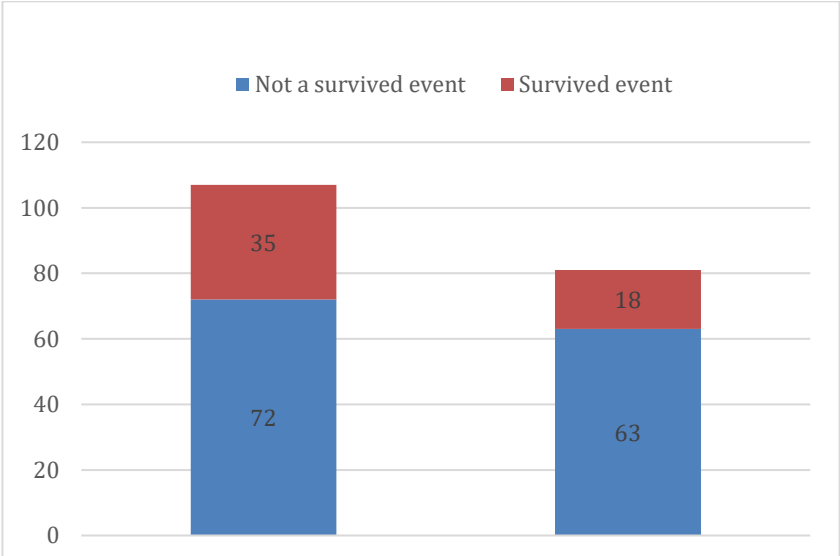


Figure 13: High-dependency care unit vs Survival

32,71% of the patients that were admitted in a high-dependency/ critical care unit at the time of the cardiac arrest, **survived the event**. Compared to **22,22%** survival of patients that were not in a high-dependency/ critical care unit at the time of arrest.

When one considers the **total number of survived events**; 66,04% of the survivals where in patients who had been in a high-dependency/ critical care unit during the time of the event, compared to 33,96% were the patient had not been admitted to high-dependency/ critical care unit.

After conducting a Chi-square Test (p-value of 0.11) admission to a high-dependency/critical care unit at the time of the cardiac arret event is not a statistically relevant factor for the **survival of a cardiac arrest event**.

35,51% of the patients that were admitted in a high-dependency/ critical care unit at the time of the cardiac arrest, displayed ROSC. Compared to **29,63%** survival of patients that were not in a high-dependency/ critical care unit at the time of arrest.

When one considers the **total number of survived events**; 61,29% of the survivals where in patients who had been in a high-dependency/ critical care unit during the time of the event, compared to 38,71% were the patient had not been admitted to high-dependency/ critical care unit.

After conducting a Chi-square Test (p-value of 0.40) admission to a high-dependency/ critical care unit at the time of the cardiac arret event is not a statistically relevant factor for **ROSC** after a cardiac arrest event.

15,24% of the patients that were admitted in a high-dependency/ critical care unit at the time of the cardiac arrest, **survived to hospital discharge**. Compared to **8,64%** survival to hospital discharge of patients that were not in a high-dependency/critical care unit at the time of arrest.

When one considers the **total number of survivals to hospital discharge**; 69,57% of the survivals where in patients who had been in a high-dependency/ critical care unit during the time of the event, compared to 30,43% were the patient had not been admitted to high-dependency/critical care unit.

After conducting a Chi-square Test (p-value of 0.18) admission to a high-dependency/ critical care unit at the time of the cardiac arrest event is not a statistically relevant factor for the **survival to hospital discharge after a cardiac arrest event**.

There may be *a signal* when considering the *relative association*, that the higher level of patient monitoring (either due to continuous vitals monitoring and/or higher nurse to patient care ratio) may be associated with better patient survival rates after a cardiac arrest event.

The higher level of training of the healthcare workers in these units may also play a role, possibly leading to earlier recognition of pre-arrest signs and symptoms and earlier intervention. *Unfortunately, the sample size is too small to prove or disprove this leaving room for future investigation in this area.*

Admission to a High-dependency Care Unit/ Critical Care Unit AFTER the cardiac arrest and the association with cardiac arrest event survival:

85% of patients who displayed ROSC, ultimately survived the event. Of the patients who had ROSC but were **not** admitted to ICU post arrest there was a **4.23%** event survival, compared to a **100%** event survival rate if the patient was admitted to ICU post arrest.

The Chi-square test was invalid due to limitations in data sets thus the Fisher's exact Test was performed. Evidence of an association between ICU admission post arrest and event survival (p-value <0.001).

This difference cannot be accounted for purely by the higher level of monitoring, care or training in the critical care units *(see above),* thus the investigator postulates that it may be due to physician

prognostication of patient's disposition at time of cardiac arrest with subsequent decision on post arrest level of care.

q) *Figure 14: Airway device utilized for management of airway and ventilation and association with event survival*

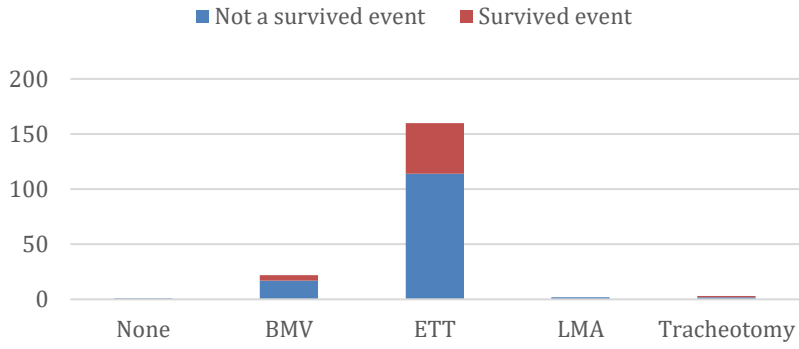


Figure 14: Airway adjunct vs Survival

When considering **the total number of survived events**; in **9,62%** a basic face mask was utilized in airway management during the event compared to **88,46%** where an advanced airway technique (endotracheal intubation) was utilized. The remaining strategies was employed only 5 times and thus had insufficient powering, with event survival rates of **<1,93%**. It is important to note that in **85% of resuscitations**, the team opted for an advanced airway management technique (endotracheal intubation).

After conducting a Chi-square Test an advanced airway management strategy is not a statistically relevant factor for ROSC (p-value 0.77), survival (p-value of 0.82) of a cardiac arrest event or survival to hospital discharge (p-value 0.53).

r) *Figure 15: Ventilation strategy and association with event survival*

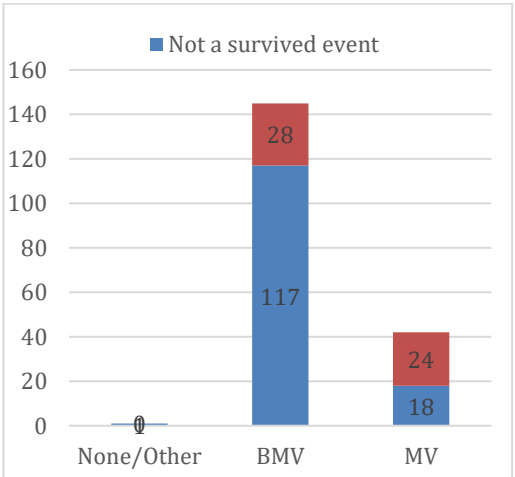


Figure 15: Bag-mask vs Mechanical Ventilation by Survival

Considering **the total number of survived events**; **53,85%** of survivals were associated with a bag-mask ventilation strategy compared to **46,15%** where a mechanical ventilation strategy was employed.

The Chi-square test was invalid due to limitations in data sets thus the Fisher's exact Test was performed. Mechanical ventilation was superior to a bag-mask ventilation strategy for survival of event (p-value <0,001), ROSC (p-value <0,001) as well as survival to hospital discharge (p-value 0.0012). Thus, we may infer that there is evidence of association between ventilation type and patient survival when comparing bag-mask ventilation with mechanical ventilation.

In subgroup analysis it was found that when mechanical ventilation was instituted, **85%** of those patients were already in a high-dependency/critical care unit. In cardiac arrest events in high-dependency/ critical care units a bag-mask ventilation strategy was still preferred by clinicians in **66%** of resuscitations.

In this subgroup analysis of patients **already in a high-dependency/ critical care unit** considering **the total number of survived events**; **21,43%** of survivals were associated with a bag-mask ventilation strategy compared to **52.78%** where a mechanical ventilation strategy was employed. The Chi-square test was invalid due to limitations in data sets thus the Fisher's exact Test was performed. The choice of mechanical ventilation was superior to a bag-mask ventilation strategy for survival of event (p-value <0,001).

The investigators postulate that the use of mechanical ventilation during a cardiac arrest event at this institution may be viewed as a surrogate for clinician prognostication during the CPR, where the clinician would only initiate mechanical ventilation if the likelihood for successful resuscitation was high.

s) Figure 16: Inotropic support and association with event survival

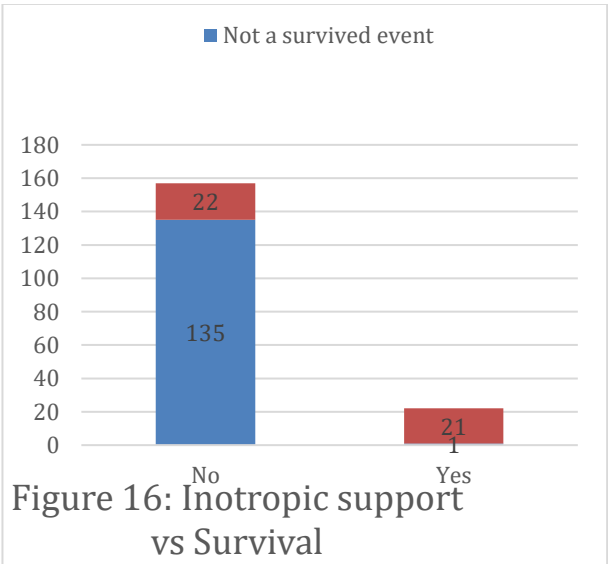


Figure 16: Inotropic support vs Survival

In the event where inotropes were initiated, **95,5%** of the *patients survived*, compared to **14.01%** in the events without inotropic support.

In the event where inotropes were initiated, **100%** of the *patients displayed ROSC,* compared to **19,11%** in the events without inotropic support.

When considering **the total number of survived events**, 48,84% of the survivals were associated with the administration of inotropic support post ROSC. In 51,16% of the survivals inotropic support post ROSC was not required.

The Chi-square test was invalid due to limitations in data sets thus the Fisher's exact Test was performed. Evidence of association between the initiation of inotropic support and successful event survival (p-value < 0.001), ROSC (p-value < 0.001) and survival to hospital discharge (p-value < 0.001) was demonstrated.

Person witnessing cardiac arrest and association with cardiac arrest event survival:

3,19% of cardiac arrests that occurred were witnessed by a lay-person bystander whilst the remaining 96,81% were witnessed by a health care professional. Considering **the total number of survived events**; **96,23%** of survivals were associated with a healthcare worker witnessing the arrest and **3,77%** where witnessed by lay-person bystanders.

The Chi-square test was invalid due to limitations in data sets thus the Fisher's exact Test was performed. No evidence of association between who witnessed the arrest and successful event survival (p-value 0.68), ROSC (p-value 1.0) or survival to hospital discharge (p-value 1.0) was demonstrated.

Aetiology of cardiac arrest:

5% of recorded aetiologies were **unknown**.

t) *Figure 17: Break down of the known cardiac arrest aetiologies*

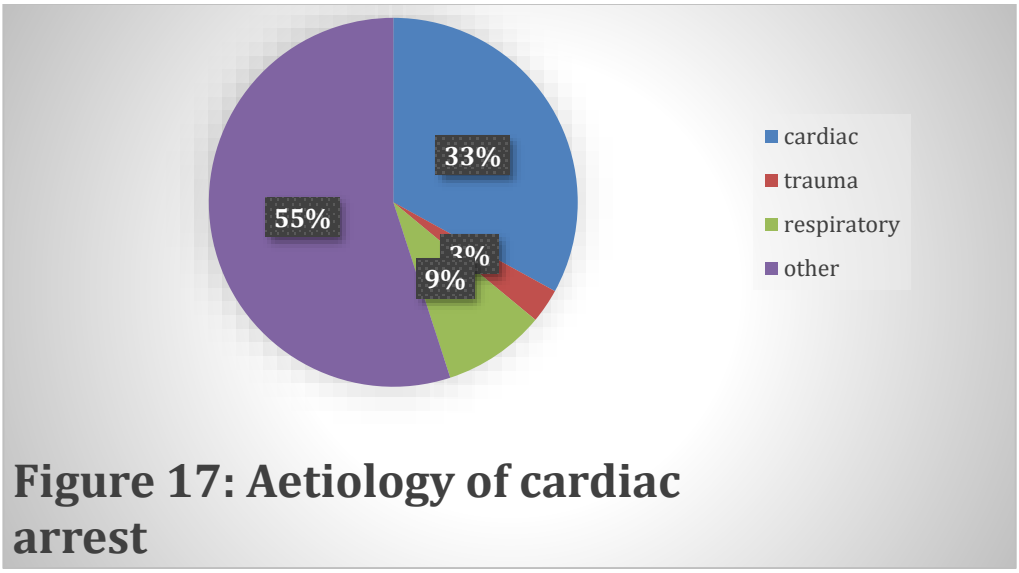


Figure 17: Aetiology of cardiac arrest

u) *Figure 18: Aetiology of arrest and association with event survival*

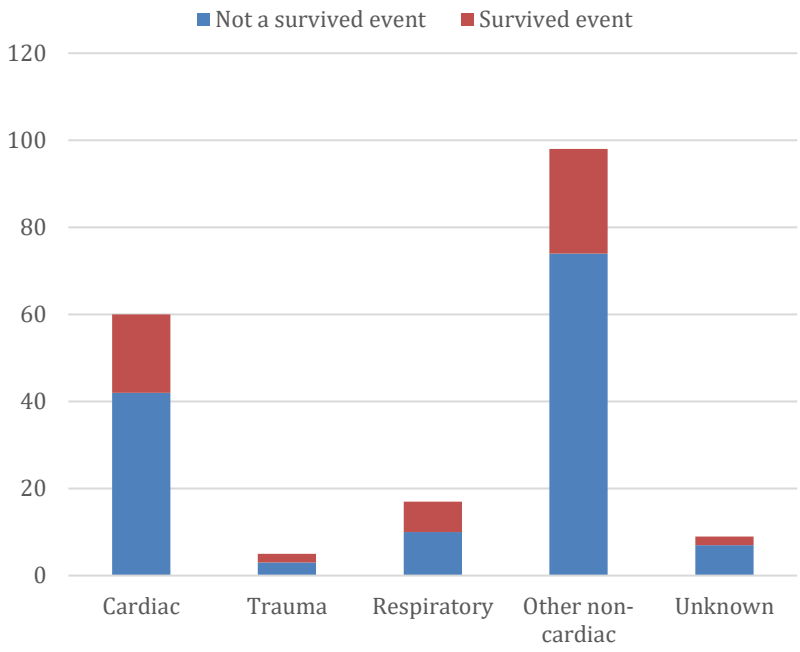


Figure 18: Aetiology vs Survival

After conducting a Chi-square Test aetiology is not a statistically relevant factor for ROSC (p-value 0.33), survival after a cardiac arrest event (p-value of 0.61) or survival to hospital discharge (p-value 0.90).

v) *Figure 19: Presence of resuscitation team and association with event survival*

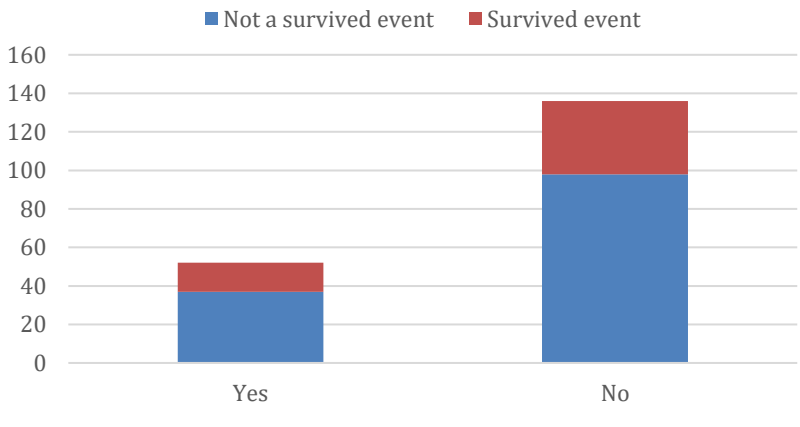


Figure 19: Resuscitation team involvement vs Survival

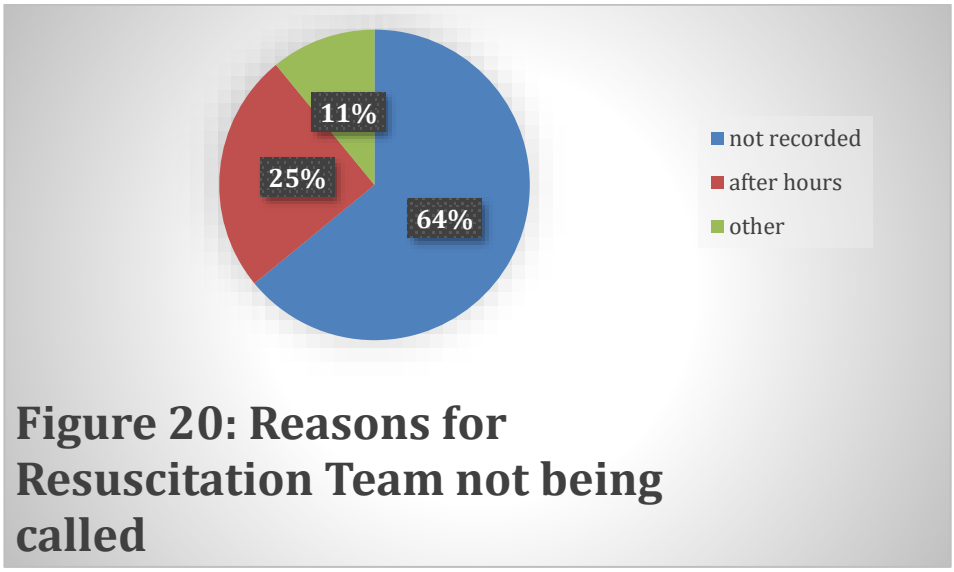
In **71,70%** of the **total survived events** the resuscitation team had not been activated, compared with **28,30%** where the resuscitation team was involved in the resuscitative effort. The resuscitation team was only activated in **27,66%** of resuscitations.

The **median time** from the identification of cardiac arrest to activation of the resuscitation team was 1 minute, **median time** from activation of the resuscitation team to arrival of resuscitation team to the resuscitation was 3 minutes, and the **median time** from the identification of cardiac arrest to arrival of resuscitation team to the resuscitation was 5 minutes.

Of the resuscitations where the resuscitation team was involved, only **28,85%** resulted in patient surviving the cardiac arrest event. Of the resuscitations without the resuscitation team being involved, **27,94%** survived the event.

The Chi-square test was invalid due to limitations in data sets thus the Fisher's exact Test was performed. No evidence of association between resuscitation team involvement in the resuscitation and successful event survival (p-value 1.0), ROSC (p-value 1.0) or survival to hospital discharge (p-value 0.33) was demonstrated.

w) Figure 20: The reasons for the resuscitation team not being called for assistance



Other reasons cited most often included having enough sufficiently trained personnel for resuscitation or resuscitation being conducted in a high-level care/advanced technology suite.

Miscellaneous problems and impediments to resuscitative efforts identified during audit of resuscitation reports:

Lack of essential resuscitation equipment or equipment failures:

Airway equipment:

Laryngoscope batteries too dim: 4 incidents

No suction available: 3 incidents

Oxygen supply and ventilation:

Bag-mask resuscitator broken: 1 incident

Dysfunctional ventilator: 1 incident

Oxygen connection failure: 1 incident

Defibrillator or AED:

No available defibrillator/AED: 3 incidents

Defibrillator malfunction: 4 incidents

Monitors:

No ECG: 3 incidents

Lack of sundries/ disposables:

No ECG stickers: 1 incident

No appropriately sized ETT: 1 incident

Clinical technique failure:

Failed intubation: 1 incident

Failure to establish IV access: 1 incident

Failure to insert oropharyngeal airway: 1 incident

Adverse drug reactions: 1 incident

I. SAJAA Author Publication Guidelines

Obtained from http://www.sajaa.co.za/index.php/sajaa/about/submissions on 4 December 2020

"Submission Preparation Checklist

As part of the submission process, authors are required to check off their submission's compliance with all of the following items, and submissions may be returned to authors that do not adhere to these guidelines.
This manuscript has currently only been submitted to SAJAA and has not been published previously.
This work is original and all third party contributions (images, ideas and results) have been duly attributed to the originator(s).
Permission to publish licensed material (tables, figures, graphs) has been obtained and the letter of approval and proof of payment for royalties have been submitted as supplementary files.
The submitting/corresponding author is duly authorised to herewith assign copyright to the South African Society of Anaesthesiologists (SASA).
All co-authors have made significant contributions to the manuscript to qualify as co-authors.
Ethics committee approval has been obtained for original studies and is clearly stated in the methodology as well as provided as a supplementary file.
A conflict of interest statement has been included where appropriate.
The submission adheres to the instructions to authors in terms of all technical aspects of the manuscript.
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Named authors must consent to publication by signing a covering letter which should be submitted as a supplementary file. Authorship should be based on substantial contribution to:

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(ii) drafting or critical revision for important intellectual content; and

(iii) approval of the version to be published. These conditions must all be met (uniform requirements for manuscripts submitted to biomedical journals; refer to www.icmje.org); and

(iv) exact contribution of each author must be stated.

DECLARATION OF CONFLICT OF INTEREST

Authors must declare all sources of support for the research and any association with a product or subject that may constitute a conflict of interest. If there is no conflict of interest to declare please include the following statement: The authors declare no conflict of interest.

FUNDING SOURCE

All sources of funding should be declared. Also define the involvement of study sponsors in the study design, collection, analysis and interpretation of data; the writing of the manuscript; the decision to submit the manuscript for publication. If the study sponsors had no such involvement, this should be stated as follows: No funding source to be declared.

RESEARCH ETHICS COMMITTEE APPROVAL

The submitting author must provide written confirmation of Research Ethics Committee approval for all studies including case reports. The ethics committee as well as the approval number should be included.

STATISTICAL ANALYSIS

Authors are advised to involve medical statisticians at the protocol stage of their research project: to plan sample size, and the selection of appropriate statistical tests for analysis and presentation.

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Identifying information should not be published in written descriptions, photographs, and pedigrees unless the information is essential for scientific purposes and the patient (or parent or guardian) gives informed written consent for publication. The patient should be shown the manuscript to be published. Refer to www.icmje.org.

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The rationale for analysis based on racio-ethnic-cultural categorisation should be indicated.

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Shorter items are more likely to be accepted for publication, owing to space constraints and reader preferences.

Original articles

Original articles on research relevant to anaesthesia and analgesia should not exceed 3 200 words, no more than 30 references, with up to 6 tables or figures. A structured abstract under the following headings, Background, Methods, Results, and Conclusions is a requirement and should not exceed 300 words.

Clinical Review articles

Review articles relevant to anaesthesia and analgesia should not exceed 2 400 words, with a maximum of 20 references and no more than 6 tables or figures. A summary of 300 words or less is required.

Case reports

Case reports should not exceed 1 800 words with no more than 10 references. Figures are limited to 2 figures and may include images or photographs. The case report should have three headings: Summary (not exceeding 100 words), Case report (with no introduction) and Discussion. Case reports will be published online only. The summary and the URL will appear in the printed version.

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Scientific Letters should not exceed 2 400 words with a maximum of 10 references. Only one table or illustration is permissible. A structured abstract under the following headings, Background, Methods, Results, and Conclusions, is a requirement and should not exceed 250 words.

Letters to the editor

Letters to the editor should be 800 words or less with only one image or table.

MANUSCRIPT PREPARATION

Refer to articles in recent issues for the presentation of headings and subheadings. If in doubt, refer to 'uniform requirements' - www.icmje.org. Manuscripts must be provided in UK English.

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This information must be provided for ALL authors and must be submitted as a supplementary file.

Email addresses of all author must be provided.

ORCID number of ALL authors must be provided – if authors do not have ORCID, please register at https://orcid.org/

Abbreviations

All abbreviations should be spelt out when first used and thereafter used consistently, e.g. 'intravenous (IV)' or 'Department of Health (DoH)'.

Scientific measurements

Scientific measurements must be expressed in SI units except blood pressure (mmHg) and haemoglobin (g/dl). Liters is denoted with a lowercase 'l' e.g. 'ml' for milliliters). Units should be preceded by a space (except for %), e.g. '40 kg' and '20 cm' but '50%'.

Greater/smaller than signs (> and 40 years of age) should also be preceded by a space e.g. > 20 years. No spaces should precede ± and °, i.e. '35±6' and '19°C'.

Numbers should be written as grouped per thousand-units, i.e. 4 000, 22 160...

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If tables or illustrations submitted have been published elsewhere, the author(s) should provide consent to republication obtained from the copyright holder.

*Tables may be embedded in the manuscript file and provided as 'supplementary files'. They must be numbered in Arabic numerals (1,2,3...) and referred to consecutively in the text (e.g. 'Table 1'). Tables should be constructed carefully and simply for intelligible data representation. Unnecessarily complicated tables are strongly discouraged. Tables must be cell-based (i.e. not constructed with text boxes, tabs or enters) and accompanied by a concise title and column headings. Footnotes must be indicated with consecutive use of the following symbols: * † ‡ § ¶ || then ** †† ‡‡ etc.*

Figures must be numbered in Arabic numerals and referred to in the text e.g. '(Figure 1)'. Figure legends: Figure 1: 'Title...'. All illustrations/figures/graphs must be of high resolution/quality: 300 dpi or more is preferable, but images must not be resized to increase resolution. Unformatted and uncompressed images must be attached as 'supplementary files' upon submission (not embedded in the accompanying manuscript). TIFF and PNG formats are preferable; JPEG and PDF formats are accepted, but authors must be wary of image compression. Illustrations and graphs prepared in Microsoft PowerPoint or Excel must be accompanied by the original workbook.

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Authors must verify references from the original sources. Only complete, correctly formatted reference lists will be accepted. Reference lists may be generated with the use of reference manager software, but the final document must be delinked from the reference database or otherwise generated manually. Citations should be inserted in the text as superscript, e.g. These regulations are endorsed by the World Health Organization,2 and others.3,4-6 The superscript reference number should come after the punctuation mark and should not be in brackets.

All references should be listed at the end of the article in numerical order of appearance in the Vancouver style (not alphabetical order). Approved abbreviations of journal titles must be used; see the List of Journals in Index Medicus. Names and initials of all authors should be given; if there are more than six authors, the first four names should be given followed by et al. First and last page, volume and issue numbers should be given. Wherever possible, references must be accompanied by a digital object identifier (DOI) link and PubMed ID (PMID)/PubMed Central ID (PMCID). Authors are encouraged to use the DOI lookup service offered by CrossRef. Crossref DOIs should always be displayed as a full URL link in the form https://doi.org/10.xxxx/xxxxx

Journal references:

Jun BC, Song SW, Park CS, Lee DH. The analysis of maxillary sinus aeration according to aging process: volume assessment by 3-dimensional reconstruction by high-resolutional CT scanning. Otolaryngol Head Neck Surg. 2005 Mar;132(3):429-34.
Polgreen PM, Diekema DJ, Vandeberg J, Wiblin RT, et al. Risk factors for groin wound infection after femoral artery catheterization: a case-control study. Infect Control Hosp Epidemiol [Internet]. 2006 Jan [cited 2007 Jan 5];27(1):34-7. Available from: http://www.journals.uchicago.edu/ICHE/journal/issues/v27n1/2004069/2004069.web.pdf. Book references: Jeffcoate N. Principles of Gynaecology. 4th ed. London: Butterworth, 1975:96-101. Chapter/section in a book: Weinstein L, Swartz MN. Pathogenic Properties of Invading Microorganisms. In: Sodeman WA jun, Sodeman WA, eds. Pathologic Physiology: Mechanisms of Disease. Philadelphia: WB Saunders, 1974:457-472.

Internet references: World Health Organization. The World Health Report 2002 - Reducing Risks, Promoting Healthy Life. Geneva: World Health Organization, 2002. http://www.who.int/whr/2002 (accessed 16 January 2010).

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J. Instructions to the editors of SAJAA

Title Page
Resuscitation Outcomes for Adult Patients with In-hospital cardiac arrest - Are we successful? An Audit of Resuscitation Outcomes for the period January 2015 to December 2017 at Universitas Academic Hospital, Bloemfontein, using the Utstein Model.

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Title

Resuscitation Outcomes for Adult Patients with In-hospital cardiac arrest - Are we successful? *An Audit of Resuscitation Outcomes for the period January 2015 to December 2017 at Universitas Academic Hospital, Bloemfontein, using the Utstein Model.*

Abstract

Background

The Utstein Model consensus definitions and template allows for the reliable and reproducible recording of data during cardiopulmonary resuscitation (CPR). Enabling inter-institutional comparison of resuscitation outcomes to ensure comparable standards of care.

Objectives

To assess resuscitation outcomes for adult patients with in-hospital cardiac arrest at Universitas Academic Hospital (UAH), Bloemfontein, using the Utstein Model and compare them to similar institutional outcomes in South Africa as well as internationally.

Methods

This study is a retrospective audit of resuscitation reports of adult in-patients for the period January 2015 to December 2017.

Results

194 institutional resuscitation reports were collected for adult in-patients for this study period with 189 reports meeting inclusion criteria. 28,0% of patients survived the cardiac arrest event, 32,8% of patients displayed return of spontaneous circulation (ROSC) with a survival to hospital discharge rate of 12,3%. Of the shockable first rhythms, 2,9% was never defibrillated. Median time to defibrillation was 10 minutes (2-38min range), a large deviation from the acceptable norm at comparable institutions. Advanced airway management strategies made no impact on ROSC (p-value 0.77) or survival to hospital discharge (p-value 0.53). Mechanical ventilation was superior to a bag-mask ventilation strategy for ROSC (p-value <0,001) and survival to hospital discharge (p-value 0.0012). Adherence to ACLS protocols for inotropic support was associated with ROSC (p-value < 0.001) and survival to hospital discharge (p-value < 0.001).

Conclusion

Resuscitation outcomes at UAH are comparable to similar institutions. UAH should focus on improving defibrillation practice. Adherence to ACLS principles of adrenaline administration is paramount in the survival of cardiac arrest.

Keywords

Utstein, resuscitation reporting template, resuscitation, resuscitation outcomes, In-hospital resuscitation, adult resuscitation outcomes, CPR outcomes, South Africa

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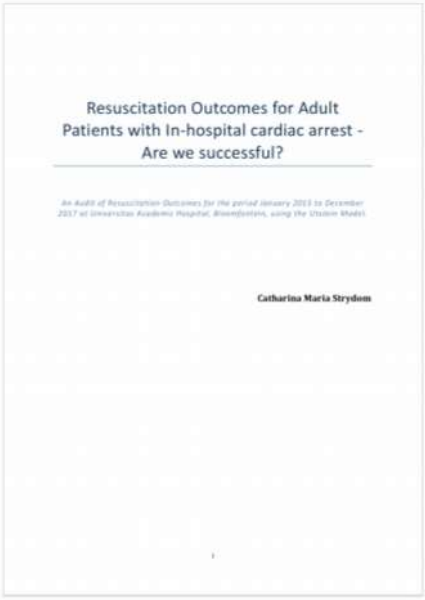
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