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# Is the treatment and transport of asystolic cardiac arrest patients to hospital by ambulance services appropriate?

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# USE OF THESIS

# Is the Treatment and Transport of Asystolic Cardiac Arrest Patients to Hospital by Ambulance Services Appropriate?

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# ABSTRACT

**Background**

The Paramedic's role requires them to attend many patients in cardiac arrest. The victim's survival depends on a variety of issues, such as previous medical history, pathological cause of cardiac arrest, presenting cardiac arrest dysrhythmias, and the time elapsed before medical aid is administered. The purpose of this present study was to review current practice advocated by St John Ambulance Service WA for the treatment of the cardiac arrest dysrhythmia 'asystole'. At present, certain victims of an asystolic arrest are treated and transported to hospital irrespective of time in arrest. As such, questions are raised as to the suitability of transporting these patients with respect to actual or possible patient survival. To evaluate the appropriateness of this management, treatment options promoted by other ambulance services, hospitals and international resuscitation bodies are reviewed for comparison. Additionally, current literature relevant to the treatment of cardiac arrest patients in asystole is evaluated.

**Methods**

This research study aimed to examine 9505 cardiac arrests cases attended by St John Ambulance Service (WA) between January 1996 and November 2004. Of this number, 219 patients survived and were later discharged from hospital. This study categorised three distinct groups of patient; all

cardiac arrest patients attended by ambulance officers, all patients that were subsequently transported to hospital, and those patients that survived to leave hospital. Statistical analyses of the normal measures of mean and standard deviation, followed by Chi-square analysis further examined gender, age and cardiac dysrhythmia in all categories.

**Results**

Of the 9505 cardiac arrest patients, 6927 died on scene, 2123 patients were transferred to hospital, and only 219 patients survived to leave hospital. 1488 male patients were transferred to hospital and their survival rate was 11%. Of all female patients transferred to hospital, 8.8% survived. There was no statistical significance between gender and death (P= 0.6171) or gender and survival (P= 0.1833).

Most male survivors were aged between 40-79 years of age, and the best age for survival for females was those aged 60-69 (13.7%). Survival outside these ranges for both males and females was statistically significantly low. There was no statistical significance between age and death (P= 0.9148). However, there was statistical significance between age and survival (P= 0.0017).

ECG results showed that where ventricular tachycardia was recorded, survival was 21% for male patients, and 25% for female patients. Where

ventricular fibrillation was recorded, survival was 13.5% for males, and 11.7% for females. Pulseless electrical activity had a lower incidence of survival for males (2.5%), than females (7.8%). There were no survivors of asystole in either males or females on their second and final ECG recording. There was extreme statistical significance between survival and dysrhythmia on both initial and final ECG recordings ($P = <0.0001$). However, there was no significance between death and dysrhythmia on the first ECG recording ($P = 0.0623$), but there was on final ECG recording ($P = <0.0001$).

**Conclusions**

This present study's findings suggest that patients in prolonged asystolic arrests do not survive to leave hospital. Therefore, the transport of the asystolic patient to hospital by ambulance services may under particular circumstances be inappropriate.

# DECLARATION

I certify that this thesis does not, to the best of my knowledge and belief

i. incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher education;

ii. contain any material previously published or written by another person except where due reference is made in the text; or

iii. contain any defamatory material

Signature________________________________

Date____________________________________

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# TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# ABBREVIATIONS

| | |
|---|---|
| ALS | Advanced life support |
| AMI | Acute myocardial infarction |
| BLS | Basic life support |
| CAD | Coronary artery disease |
| CPR | Cardiopulmonary resuscitation |
| ECG | Electrocardiogram |
| NSR | Normal sinus rhythm |
| PEA | Pulseless electrical activity |
| ROSC | Return of spontaneous circulation |
| VEB | Ventricular ectopic beats |
| VF | Ventricular fibrillation |
| VT | Ventricular tachycardia |

# CHAPTER 1

# INTRODUCTION

# 1.0 INTRODUCTION

## 1.1 Background to the Study

Paramedics worldwide are trained in cardiopulmonary resuscitation (CPR). CPR is the combined action of compressing the heart between the sternum and vertebrae to simulate the pumping action of the heart, and the ventilation of the patient via an external source. Research continues to seek the most effective method of CPR and the ultimate relationship between compressions and ventilations. However, a majority of Resuscitation Councils around the world have agreed on a "Universal Algorithm" resuscitation algorithm (Handley, 2005). This is based on current evidence of resuscitation and includes CPR rates, appropriate drug therapy and approved treatment options for various cardiac dysrhythmias. This evidence is reviewed regularly, and best practice protocols are applied accordingly.

## 1.1 Significance of the Study

The aim of this study is to evaluate whether a patient in a prolonged state of asystolic cardiac arrest should be transported to hospital. The purpose of this present study is to review current practice advocated by St John Ambulance Service WA, by analysis of patient transport records for the years 1996 to 2004. At present, those patients who convert to asystole following treatment are transported to hospital irrespective of the time/distance involved.

In order to evaluate the appropriateness of the WA management of cardiac arrest dysrhythmia (asystole), current knowledge of cardiac anatomy, physiology and treatment options used by other ambulance services and hospitals for common cardiac conditions is presented. Current literature relevant to the appropriateness of treating cardiac arrest patients in asystole is evaluated.

Where there are survivors, then the time in asystole will be evaluated so that a recommendation can be made for a cut off time where resuscitation attempts are terminated and thus the need for unnecessary transportation to hospital is avoided.

The results of this study may indicate a change in current practice and understanding with regard to the treatment of asystolic cardiac arrest

presently advocated by St John Ambulance WA is necessary. The significance of this study could in turn impact on the workload of receiving emergency departments and hospital staff.

## 1.3 Research Question

Is the Treatment and Transport of Asystolic Cardiac Arrest Patients to Hospital by Ambulance Services Appropriate?

## 1.4 Hypotheses

The Hypothesis for this study will be:

Null Hypothesis ($H_o$)

*The treatment and transport of the asystolic cardiac arrest patient to hospital by Ambulance Services is appropriate.*

Alternate Hypotheses ($H_1$)

*The treatment and transport of the asystolic cardiac arrest patient to hospital by Ambulance Services is not appropriate.*

# CHAPTER 2

# LITERATURE REVIEW

# 2.0 LITERATURE REVIEW

## 2.1 Cardiac arrest

Cardiac arrest is defined as the 'cessation of normal circulation of the blood due to failure of the ventricles of the heart to contract effectively during systole' (Hampton, 2003). The resulting lack of blood supply results in cell death from oxygen starvation (anoxia). Cerebral hypoxia, or lack of oxygen supply to the brain, causes victims to immediately lose consciousness and stop breathing (Porth, 2002). In emergency treatment emphasis is placed on investing finance and time in training the public, prehospital and hospital health care professionals in the skills to be proficient in CPR.

CPR produces blood flow through the body via the compression of the heart between the sternum and vertebrae and the resultant increased intrathoracic pressure that is transmitted to all intrathoracic vascular structures (Nolan, Greenwood & Mackintosh, 1998). However, even when CPR is applied flawlessly, the effectiveness of this action is only approximately 20% to 30% that of the normal heart (Resuscitation Council (UK) & ERC 2000). The major concern in cardiac arrest is the rapid and irrevocable effects of tissue anoxia. Figures vary, but tissue anoxia has been shown to result in irreversible brain damage in as little as four to six minutes (Resuscitation Council (UK) 2002). Mistovich, Benner, & Margolis (2004), state that the primary goal of CPR is to 'restart the heart

to restore the brain'. Survival from cardiac arrest can be seen to diminish 10% for every minute that passes (Handley, 2005).

At the forefront of the "Universal Algorithm" cardiac arrest guidelines is the notion of "chain of survival" (Resuscitation Council (UK) & ERC 2000). This concept aims to identify and improve the outcomes in patients suffering from cardiac arrest. The basis is recognising cardiac arrest early and calling for 'expert help', early application of CPR, early defibrillation of shockable cardiac arrest dysrhythmias, and early advanced life support skills such as intubation and cardiac arrest medications (Handley, 2005).

The concept of 'chain of survival' has been advocated for over twenty years. Stratton and Niemann (1998) compared the outcomes of prehospital cardiac arrest in 1975 and 1995. Their study evaluated cardiac arrest resuscitation successes in 1975 when the concept of 'chain of survival' was unknown, and those of 1995 when the concept was frequently advocated. Stratton and Niemann found that in fact survival rates dramatically decreased during the twenty-year period. However, they surmised that additional factors such as the 'high incidence of chronic disease, the greater frequency of asystole and pulseless electrical activity', along with the inclusion of "end of life" arrest would have a major effect on results' (Stratton and Niemann, 1998).

At present, the 'chain of survival' still plays an important role in cardiac management. The 'chain' is said to be only as strong as its weakest link (Resuscitation Council (UK) 2002). Therefore, a successful resuscitation relies on many different interrelated factors.

## 2.2 Cardiac Anatomy & Physiology

In order to grasp some of the major concepts that may predict successful cardiac arrest resuscitation, it is important to review some basic cardiac anatomy and physiology. However, only general anatomy and physiology concepts are included within this paper, and as such more complex principles can be found in literature such as Tintinalli, Kelen, & Stapczynski, 2004.

### 2.2.1 Anatomy of the Heart

The heart, arteries, veins, and blood make up the cardiovascular system, and together they are responsible for circulating blood throughout the body. The adult heart is a muscular pump about 12 cm long, 9 cm wide at its broadest point, and 6 cm thick, and weighs roughly 300 grams (Myers, Neighbors, & Tannehille-Jones, 2002). It sits in the thorax on the left side of the chest in front of the lungs, resting on the diaphragm within the mediastinum (Stratton & Niemann, 1998). The heart is oriented in the chest, rotated about 30 degrees to the left lateral side, the right ventricle is the most anterior structure of the heart (Tintinalli et al. 2004). This results

in approximately two thirds of the mass of the heart lying to the left of the body's midline. The location of the heart between the two rigid structures of the vertebrae and sternum enable the heart to be compressed between the two in CPR (Mistovich et al. 2004).

### 2.2.2 Electrical Conduction System

The heart is composed primarily of muscle tissue (Huff, 2002). This specialised muscle tissue has the capacity for spontaneous, rhythmic self-excitation (Porth, 2002). There are four specially adapted conducting pathways in the heart; they are the sinoatrial and atrioventricular nodes, the Bundle of His and the Purkinje fibres (Tintinalli et al. 2004). Each area may initiate electrical stimulation, but a coordinated response enables the heart muscle to contract efficiently and pump blood. A network of muscle fibres coordinates the contraction, which is followed by relaxation of the cardiac muscle tissue which facilitates an efficient, wave-like pumping action of the heart (Myers et al. 2002**).**

Contraction of cardiac muscle fibres occurs after depolarisation of the cell membrane. Under normal circumstances depolarisation is initiated from a group of specialised pacemaker cells situated close to the junction of the right atrium and superior vena cava. It is called the sinoatrial node (SA node) and is the pacemaker of the normal heart, responsible for setting the rate and rhythm. The depolarisation from the SA node spreads through the atria, prompting the cardiac muscle tissue to contract in a coordinated

manner, (Tintinalli et al. 2004). The depolarisation that originates from the sinoatrial node strikes the atrioventricular node (AV node), which is situated, in the lower portion of the right atrium (Tintinalli et al. 2004). The atrioventricular node in turn sends the depolarisation wave through the bundle of His and in the Purkinje fibres of the interventricular septum, resulting in the contraction of the ventricles (Figure 1) (Hampton, 2003). This regular cycle of atrial contractions, followed by ventricular contractions, pumps blood effectively out of the heart.

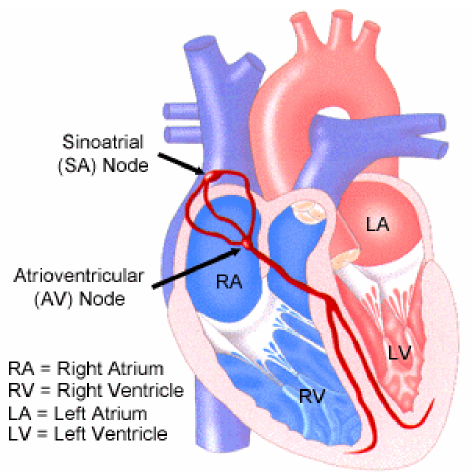


Figure 1 Electrical conduction system (Tintinalli, Kelen & Stapczynski, 2004)

### 2.2.3 Action potential

An action potential is a 'change in membrane potential in an excitable tissue that acts as an electrical signal and is propagated in an all-or-none fashion' (Mistovich et al. 2004). An action potential occurring at any point on the cell membrane acts as a stimulus to adjacent regions of the cell

membrane and other cell membranes, (Tintinalli et al. 2004). Once the excitation is in progress, propagation occurs along the length of the cell and on to adjacent cells.

Under resting circumstances the cardiac muscle cells are polarised. A potential difference of -90mV exists between the interior of the cell and the exterior of the extracellular space (Tintinalli et al. 2004). The inside of the cell is negative compared with the outside of the cell membrane and the resting membrane potential is therefore recorded as a negative (Sanders, 2005). Reversal of this charge is accompanied by a shift of sodium, potassium, and calcium ions and causes a change in the polarisation of the cells (Sanders, 2005). The cardiac action potential can be divided into five phases (Figure 2) (Hampton, 2003). Phase 0 is the rapid depolarisation phase, and represents the very rapid upward stroke of the action potential (Huszar, 2002). During this phase fast sodium channels open and sodium rapidly enters the cell. This results in a positive charge within the cell relative to the outside (Mistovich et al. 2004).

Phase 1 is known as the early rapid depolarisation phase, (Tintinalli et al. 2004). The sodium channels close, stopping further influx of sodium ions and the potassium continues to leak out of the cell. This results in a decrease in the number of positive ions inside the cell, and a drop in membrane potential that eventually leads to the cell membrane returning to its resting state (Sanders, 2005).

Phase 2 is the plateau stage where the action potential is prolonged (Tintinalli et al. 2004). During this phase, calcium enters the myocardial cells, triggering a large secondary release of calcium from intracellular storage sites and initiating contraction. The role of calcium in the action potential is to prolong depolarisation, which allows for completion of one muscle contraction before another depolarisation begins (Mistovich et al. 2004).

Phase 3 is the terminal phase of rapid repolarisation (Bledsoe, & Clayden, 2005). The inside of the cell becomes negative and the membrane potential returns to its resting state. Initiation of phase 3 occurs when calcium channels close and the outflow of potassium increases (Tintinalli et al. 2004).

Phase 4 represents the period between action potentials (Mistovich et. al., 2004). During this stage, the inside of the cell is negative relative to the outside, but there still remains an excess of sodium within the cell, and an excess of potassium outside the cell. The sodium-potassium pump is activated to transport sodium outside the cell and potassium inside the cell (Tintinalli et al. 2004).

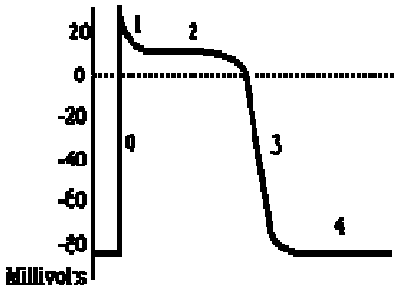


Figure 2 Action potential (Hampton, 2003)

### 2.2.4 Refractory period of cardiac muscle

Cardiac muscle is similar to all other excitable tissue and has a refractory period associated with the action potential (Figure 3) (Hampton, 2003). The absolute refractory period is defined as the period after effective stimulation during which 'excitable tissue fails to respond to a stimulus of threshold intensity' (Seidel, Ball, Dains, & Benedict, 1999). This refractory period ensures that the cardiac muscle is completely relaxed before another action potential can occur.

When repolarisation has returned the membrane potential to below threshold the cell is capable of responding to a greater-than-normal stimulus. This is referred to as the relative refractory period (Porth, 2002).

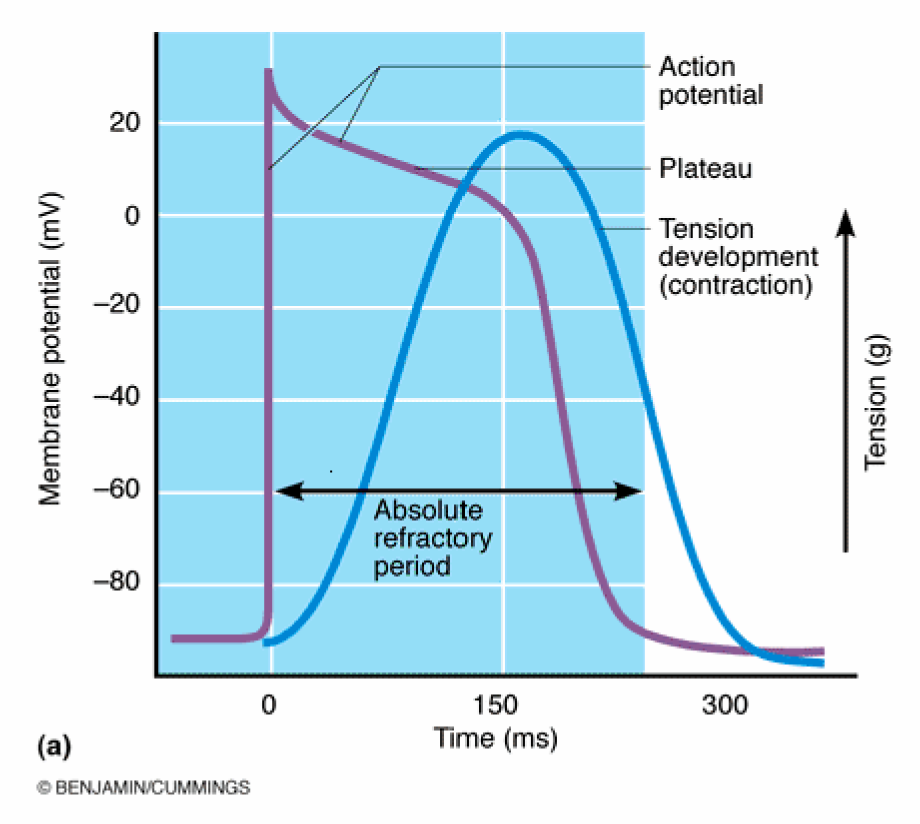


Figure 3 Refractory period of cardiac muscle (Merieb, 2004)

## 2.3 The Electrocardiogram

Recognition of cardiac arrest by medical personnel is verified by the patient's conscious state, along with the absence of cardiac output and respirations. Appropriate advanced life support is achieved by recognition of the electrical status of the heart, using the Electrocardiogram (ECG), whereby the electrical activity generated by the heart can be measured by a number of electrodes placed on the body surface (Seidel et al. 1999). The recorded tracing is called an ECG. The different waves that comprise the ECG represent the sequence of depolarisation and repolarisation of the atria and ventricles (Huszar, 2002).

The P wave represents the wave of depolarisation that spreads from the SA node throughout the atria (Figure 4) (Hampton, 2003). The brief isoelectric period after the P wave represents the time in which the impulse is travelling within the AV node where the conduction velocity is greatly slowed down. The period of time from the onset of the P wave to the beginning of the QRS complex is termed the P-R interval, which normally ranges from 0.11 to 0.20 seconds in duration (Sanders, 2005). This interval represents the time between the onset of atrial depolarisation and the onset of ventricular depolarisation (Huszar, 2002).

The QRS complex represents ventricular depolarisation. The duration of the QRS complex is normally 0.06 to 0.1 seconds (Hampton, 2003). This relatively short duration indicates that ventricular depolarisation normally occurs very rapidly. The isoelectric period following QRS is the time at which the entire ventricle is depolarised and roughly corresponds to the plateau phase of the ventricular action potential, which is represented by the ST segment (Huszar, 2002). The ST segment may be important in the diagnosis of ventricular ischaemia or hypoxia because under those conditions, the ST segment can become either depressed or elevated (Mistovich et al. 2004).

The T wave corresponds to the rapid ventricular repolarisation. The wave is normally rounded and positive. The T wave can become inverted,

peaked or flattened due to electrolyte imbalance, hyperventilation, CNS disease, ischemia or myocardial infarction (Sanders, 2005).

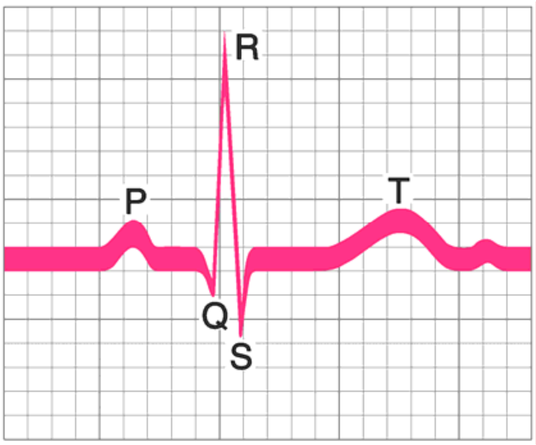


Figure 4 Normal ECG ( Huszar, 2002)

## 2.4 Causes of Cardiac Arrest

The causes of cardiac arrest are wide-ranging, with the majority occurring in people with pre-existing cardiac disease. Although the risk of cardiac arrest is greater in those patients with pre-existing cardiac conditions, most sudden cardiac arrests occur in people with unrecognised disease (Handley, 2005). As such, many of these patients will be within the prehospital arena when having their cardiac arrest.

A cardiac arrest may occur due to a primary airway, breathing or cardiovascular crisis (Nolan et al. 1998). Life threatening disease may cause secondary respiratory or cardiac compromise, which may result in

cardiac arrest. Primary airway problems include airway obstruction, often due to blood, vomit, foreign body, trauma, and pharyngeal swelling (Mistovich et al. 2004).

Breathing inadequacy may result from central nervous system depression that could ultimately affect respiratory drive, disruption of the main respiratory muscles such as diaphragm and intercostal muscles, and pulmonary disorders including asthma, pulmonary embolus, chronic obstructive pulmonary disease, lung contusion, acute respiratory distress syndrome, and pulmonary oedema (Nolan et al. 1998).

Cardiac abnormalities may also be primary or secondary (Sanders, 2005). Causes of primary cardiac arrest include ischaemia, myocardial infarction, hypertensive heart disease, valve disease, prescription and recreational drugs, abnormal electrolyte concentration, hypothermia and electrocution (Handley, 2005). A secondary cardiac abnormality is one where the heart is affected by pathology originating elsewhere (Mistovich et al. 2004). Examples of secondary cardiac abnormalities include airway obstruction, blunt and penetrating trauma, tension pneumothorax, and acute blood loss (Sanders, 2005).

### 2.4.1 Cardiac Arrest Rhythms

Primary and secondary causes of cardiac arrest display a recognisable ECG rhythm. The ECG rhythms associated with cardiac arrest are ventricular fibrillation, pulseless ventricular tachycardia, pulseless electrical activity and asystole (Handley, 2005). Each dysrhythmia has its own distinct ECG characteristics that make cardiac arrest rhythms relatively easy to identify.

### 2.4.2 Ventricular Fibrillation

Ventricular fibrillation (VF) presents with rapid chaotic electrical activity that leads to loss of coordinated ventricular contraction and cardiopulmonary arrest (Huszar, 2002). VF is a common cause of death in patients with acute myocardial infarction (MI), and may occur secondarily to antiarrhythmic drugs, prolonged QT syndromes, re-excitation syndromes, and systemic hypoxaemia (Brindley et al. 2002). The most successful treatment of VF is by electrical external defibrillation. Defibrillation depolarises a critical mass of the excitable myocardium. Successful defibrillation largely depends on the following two key factors: duration between onset of VF and defibrillation, and the metabolic condition of the myocardium (Handley, 2005).

Defibrillation success rates decrease 5-10% for each minute after onset of VF (Resuscitation Council (UK) & ERC 2000). In strictly monitored settings

where defibrillation was most rapid, success rates of 85% have been reported (Brindley et al. 2002). VF survival depends on the presence of witnesses who are competent in performing basic life support, the rapid availability or arrival of personnel and apparatus for defibrillation and advanced life support, and transfer to a hospital (Handley, 2005). Even under ideal circumstances, only an estimated 20% of patients who have out-of-hospital cardiac arrest survive to hospital discharge (Resuscitation Council (UK) & ERC 2000). In a study of out-of-hospital cardiac arrest survival in the United States, only 1.4% of patients survived to hospital discharge (Joyce et al. 1998). Other studies in suburban and rural areas have indicated survival rates up to 35% in paediatric patients (Pitetti et al. 2002). However, paediatric patients in cardiac arrest are generally as a result of secondary insult from hypoxia and/or hypovolaemia. Therefore, higher success rates are probably due to the correction of the underlying problem whereas with adult cardiac arrest, it is mainly due to a primary cardiac origin that may not always be responsive to treatment. However, irrespective of cause, the one accepted proven treatment for VF is its ECG recognition and early defibrillation (Resuscitation Council (UK) 2005).

Other conventional, but not absolutely proven adjuncts to defibrillation for the treatment of VF include adrenaline, amiodarone and other antiarrhythmics (Handley, 2005).

### 2.4.3 Ventricular Tachycardia

Ventricular tachycardia (VT) is defined as a 'dysrhythmia of three or more consecutive ventricular complexes occurring at a rate of more than 100 beats per minute' (Resuscitation Council (UK) 2005). However, during VT the atria and ventricles are asynchronous, 'causing profound loss of cardiac output and unconsciousness, particularly at high rates or in the presence of compromised left ventricular function' (Mistovich et al. 2004). The rapid rate associated with VT, along with the loss of atrial force results in compromised cardiac output, accompanied by decreased coronary artery and cerebral perfusion (Mistovich et al. 2004).

VT usually indicates significant underlying cardiovascular disease (Handley, 2005). VT with a perfusing rhythm is treated using antidysrhythmic drugs such as amiodarone, or synchronised cardioversion, whereas pulseless ventricular tachycardia is managed in the same way as VF, using defibrillation, adrenaline and antiarrhythmics (Resuscitation Council (UK) & ERC 2000).

### 2.4.4 Pulseless Electrical Activity

Pulseless electrical activity (PEA) is most frequently the end result of a major cardiac insult and is commonly caused by respiratory failure with hypoxia (Huff, 2002). PEA is caused by the inability of cardiac muscle to generate a sufficient force despite an electrical depolarisation (Huszar, 2002). Hypoxia secondary to respiratory failure is probably the most

common cause of PEA, comprising 20-53% of cases (Resuscitation Council (UK) & ERC 2000). The overall mortality rate is high in patients in whom PEA is the initial rhythm during cardiac arrest (Handley, 2005).

Treatment of PEA consists of cardiopulmonary resuscitation and the administration of adrenaline. However, if the PEA is bradycardiac, i.e. below 60 beats per minute, then atropine is additionally given. In all cases of PEA the diagnosis and correction of conditions that commonly cause PEA dysrhythmias are considered (Huff, 2002) These conditions are sometimes referred to as the four H's and four T's which include hypoxia, hypovolaemia, hypothermia, hypo/hyperkalaemia and metabolic disturbances, tension pneumothorax, tamponade (cardiac), toxic and therapeutic disorders, and thrombo-embolic and mechanical obstruction (Handley, 2005). These conditions are deemed as reversible and as such PEA is considered a 'rhythm of survival' (Resuscitation Council (UK) & ERC 2000).

### 2.4.5 Asystole

Asystole can be primary or secondary (Resuscitation Council (UK) & ERC 2000). Primary asystole occurs when the heart's electrical system intrinsically fails to generate a ventricular depolarisation (Seidel et al. 1999). This may result from ischaemia or from deterioration of the SA node or AV conducting system (Huszar, 2002). Secondary asystole occurs when factors outside the heart's electrical conduction system result in a

failure to generate any electrical depolarisation. Common causes of secondary asystole result from severe tissue hypoxia, and metabolic acidosis, near drowning, CVA, massive pulmonary embolus, hyperkalaemia, narcotic overdoses and hypothermia (Handley, 2005). Hypothermia is a special circumstance, since asystole can be tolerated for a longer period of time under such conditions and can be reversed with rapid rewarming while CPR is being performed (Resuscitation Council (UK) & ERC 2000).

Asystole follows untreated VF and commonly occurs after unsuccessful attempts at defibrillation (Sanders, 2005). Asystole is associated with a poor outcome regardless of its initial cause (Handley, 2005). Resuscitation is likely to be successful only if it is secondary to an event that can be corrected immediately, such as a cardiac arrest or airway obstruction, (Brindley et al. 2002). Occasionally, primary asystole can be reversed if it is due to SA node failure, which could be either intrinsic or extrinsic, and this is corrected immediately by external pacing (Mistovich et al. 2004).

The "Universal Algorithm" treatment for asystole is CPR and the administration of 1mg of adrenaline every three-five minutes, and a single 3mg dose of Atropine until the cardiac arrest is stopped (Handley, 2005). Generally, it is accepted practice that patients in asystolic cardiac arrest of twenty minutes or more have a minimal chance of survival. As such,

termination of resuscitation stops after twenty minutes irrespective of previous arrhythmias such as VF, pulseless VT or PEA (Resuscitation Council (UK) & ERC 2000). St John Ambulance (WA) current clinical practice guidelines advocate that if a patient reverts to asystole from VF or pulseless VT CPR must be given continually to the hospital even where the twenty-minute timeline of asystole is reached (Resuscitation Council (UK) & ERC 2000). St John Ambulance (WA) also does not advocate the use of adrenaline in any of their resuscitation clinical guidelines.

### 2.4.6 Prognostication

The aim of Prognostication is to predict, at the earliest opportunity, those patients who will not survive despite a return of spontaneous circulation (Resuscitation Council (UK) 2006). Resuscitation Council (UK) states there 'are no neurological signs that can predict outcome in the comatose patient in the first hours after return of spontaneous circulation (ROSC)'. However, 'the absence of pupil light reflexes on day three, and an absence of motor response to pain on day three, are both predictive of a poor outcome (death or vegitative state) with very high specifity' (Resuscitation Council (UK) 2006).

## 2.5 Analysis of Survival Rates

The risk of cardiac arrest in the prehospital phase is common, (Demaio et al. 2001). In the United States, 900,000 people experience acute myocardial infarction each year. Of this number, approximately 20% die before reaching the hospital and 30% die within 30 days (American College of Cardiology, 1996).

Research aims to find the best practice for the management of patients suffering with cardiac conditions, and those presenting in cardiac arrest (Handley, 2005). Although research studies are numerous, and many newer theories have been advocated through the years, Brindley et al. (2002) state that the 'overall survival following cardiopulmonary resuscitation in hospital does not appear to have changed markedly in 40 years'. This argument is based on a comparative study of adult cardiopulmonary arrest records between 1997 and 1999, and the abstracted data from inpatient medical records of arrest and survival details. It was concluded that 'similarities were shown on survival rates of cardiac pathology; showing survival was highest after primary respiratory arrest and lowest after pulseless electrical activity or asystole' (Brindley et al. 2002).

Patients presenting in VF, VT and PEA have treatment options that may improve patient outcome (Resuscitation Council (UK) 2005). Conversely, international studies have shown that the survival rate of out of hospital cardiac arrests presenting as asystole is very poor (Resuscitation Council (UK) & ERC 2000). In a twelve-month period, Melbourne Ambulance Service (MAS) investigated survival rates of 778 patients that met the entry criteria of asystole (Meyer et al. 2000). Results showed that resuscitation was commenced on 37% of these patients and there was just one survivor (0.12%). They concluded that adult victims of out of hospital cardiac arrest that present as asystole should 'not receive treatment' (Meyer et al. 2000). However, it should be noted that MAS follow the Universal Algorithm and additionally administer adrenaline and atropine in the treatment of Asystole.

Evidence has also shown that there have been a number of survivors that have presented in asystolic cardiac arrest. However, some of these survivors had suffered accidental hypothermia when their core body temperature was less than 28°C (Southwick & Dalglish, 1980). Southwick & Dalglish showed that even after two hours of persistent asystole, it did not represent 'irreversible cardiac compromise'. This research compared two randomised groups; one group of one hundred and thirty-eight patients that were kept normothermic, and one group of one hundred and thirty-seven patients that were cooled within four to eight hours to maintain a bladder temperature between 32 and 34°C for 24 hours.

Results showed that in the patients 'with witnessed cardiac arrest due to a ventricular arrhythmia, induced hypothermia to 32–34°C for 24 hours significantly improves both survival and favourable neurologic outcome'. However, this process has not been identified as useful if the patient is in asystole as a presenting dysrhythmia.

Nonetheless, there have been several characteristics common to patients who survive asystole. Petrie et al. (2000) identified several important predictors of survival. In their study they identified a subgroup in which resuscitation efforts are futile. As a result, this study identified 'potential field criteria for predicting 100% non-survival when the presenting rhythm is asystole'. During 1991 and 1997, 9,899 consecutive cardiac arrest cases were evaluated. Of the 3,888 patients presenting in asystole, only 9 (0.2%) survived to discharge. Importantly, there were no survivors when the patient's asystole exceeded 8 minutes. Recommendations were to improve 'specificity in prehospital termination guidelines that could lead to more efficient resource utilisation and less exposure to occupational risk' (Petrie et al. 2000). Although adrenaline and atropine were inclusive treatments in this study, Petrie et al. do not include use of these drugs as common characteristics for survival.

Demaio et al. (2000) evaluated the prehospital factors associated with 'optimal quality of life for survivors of out-of-hospital cardiac arrest'. Results from this study indicated that unless the arrest cardiac arrest is

witnessed and the patient receives immediate CPR the chances of survival are low. This conclusion was further reinforced by another study by Demaio et al. (2001) highlighting the importance of bystander CPR. They confirmed that of 9,218 out-of-hospital cardiac arrest cases treated, 15.2% were treated by bystanders, and concluded that 'improved community bystander CPR rates are associated with dramatically increased out-of-hospital arrest survival in a predictable fashion'.

There have been other studies that investigated alternative indicators of asystole survival. Denny et al. (2004) investigated whether there was a link between cardiac arrest and low socio-economic status. Although there was 'higher mortality among patients with acute myocardial infarction treated in-hospital', socio-economic status was 'not a predictor of survival to hospital admission after out-of-hospital cardiac arrest' (Denny et al. 2004).

A number of studies have reviewed hospital and prehospital drug therapy interventions that may improve survival from asystolic arrest (Mader and Gibson, 1997; Myerburg, Estes, Zaman, Luceri, Kessler, Trohman, & Castellanos, 1984). Mader and Gibson (1997) investigated whether adenosine receptor antagonism had any beneficial impact on victims of asystolic cardiac arrest. Their results showed positives in half of the patients in the treatment group, but concluded that this was too small a pilot study to be conclusive. They concluded that 'further research needs

to be conducted before accurate analysis can be made' (Mader & Gibson, 1997).

Myerburg et al. (1984) compared results of asystole from 1975 to 1978 to results from 1980 to 1982. Their results showed that there was an improved survival rate of those in the later years. However, the numbers were still very low, with only two survivors of the twenty-four patients presenting in asystole. They concluded that 'survivors within this subgroup tended to have a prompt response to prehospital pharmacologic interventions that were not available to the 1975 to 1978' group. Additionally, Myerburg et al. (1984) concluded that 'outcome has improved for a specific subgroup of victims of prehospital cardiac arrest with bradyarrhythmia or asystole; the improved outcome may relate to field interventions by rescue personnel at the scene of arrest but the mortality rate is still high' (Myerburg et al., 1984).

Additional studies have looked at survival outcome from prehospital cardiac arrest. A retrospective analysis was made of 115 patient care records of prehospital cardiac arrests with attempted resuscitation between July 1996 and September 1999 (Vukmir, 2004). Of the patients who survived to the emergency department, six had initially presented in pulseless electrical activity and 16 presented with ventricular fibrillation. However, the results of this study showed that none of the survivors presented in asystole. Results also showed that the median response interval from time of call to arrival of ambulance personnel at the patient's

side was 9 minutes, and that 'no patients survived when response interval was greater than 14 minutes'. They concluded therefore, that 'decreasing time delays in accessing the patient is crucial to improving outcome in out-of-hospital cardiac arrest' (Vukmir, 2004).

In view of the overwhelming evidence presented within this paper, many ambulance services have adopted termination of resuscitation policies for cardiac arrest. Demaio et al. (2000) studied 'the futility of transport after unsuccessful advanced life support measures in the field'. They looked at 978 prehospital cardiac arrest terminations from 1995 and 1999. The overall survival rates were 5.0%. Non-survival was associated with; age more than eighty years, unwitnessed arrest, no citizen CPR, and a non-VF/VT rhythm. Their study demonstrated that field termination occurs frequently for 'unwitnessed arrests in elderly patients with non-VF/VT rhythms' (Demaio et al. 2001).

Perhaps another aspect of cardiac resuscitation that may have a bearing on this discussion is how the general public perceives the effectiveness of CPR. Diem et al. (1996) reviewed CPR on fictitious medical television shows. They reviewed sixty occurrences of CPR during ninety-seven television episodes. The resuscitation attempts showed success in seventy-five percent of resuscitations during the 'immediate arrest phase' and sixty-seven percent of patients survived to hospital discharge. During one episode, Diem et al. discuss a patient who obtained full recovery after

being in an asystolic dysrhythmia for more than 30 minutes. They concluded that the television programs researched gave a 'misleading impression about the kind of people most commonly given CPR', 'CPR succeeded more frequently on television than in the real world' and 'misrepresentations of CPR on television may lead patients to generalise their impressions to CPR in real life' (Diem et al. 1996). Consequently, there may exist a misguided impression by the general public that all cardiac arrest victims have an excellent chance of survival.

## 2.6 Conclusions

Research investigating cardiac arrest points to a systematic approach to its management. Importantly, there seems to be growing evidence that suggests a number of cardiac arrest patients should not be resuscitated due to the low likelihood of their survival to hospital discharge.

Primary asystolic cardiac arrest seems to be one cardiac arrest condition that needs careful consideration. There are a number of precise guidelines used by medical practitioners that encourage needless and unrealistic cardiac arrest resuscitation attempts. Where the patient meets the criteria of unwitnessed arrest, no bystander CPR, non VF/VT rhythm or when asystole exceeds 8 minutes, the appropriateness of transferring that patient to hospital requires investigation.

Many medical services have in place a system to selectively withhold resuscitation attempts where commencement of CPR is plainly futile. Other professional bodies have resuscitation guidelines that advocate resuscitation of asystole for a limited time (Faine et al. 1997). Presently, St John Ambulance Service (WA) does not use adrenaline in any of their resuscitations. The rationale behind this decision lies in company policy that supports current 'Evidence Based Medicine'. At present there is 'only limited scientific evidence' supporting the drugs used in the immediate management of cardiac arrest (Resuscitation Council (UK) 2006). Additionally, current practice advocates that all patients who revert to asystole from VF and pulseless VT are transferred to hospital irrespective of the initial cardiac arrest insult. Also the overall time spent in this dysrythmia is not taken into account, even when prolonged for more than the twenty minute guidelines (Resuscitation Council (UK) & ERC 2000). It therefore seems important to evaluate the results of this practice to see if this is appropriate, or whether any of those patients transported have indeed survived to hospital discharge. Results may also indicate whether adrenaline and atropine have any effect on survival as research undertaken in the study of asystole seems to advocate their use.

Future study needs to be directed at reviewing the number and survival to discharge of patients transferred in asystole to hospital by St John Ambulance Service (WA). Firstly, what is the number of patients that have been in asystole and transferred to hospital? Are the numbers

significantly great to be an area of concern? That is, are a large number of patients being taken to hospital in asystole, or are the numbers few, not justifying the change or review of any clinical practice guidelines.

Additionally, there are recognised factors that include 'downtime'. 'Downtime' is the time that a patient is in cardiac arrest before any interventions are administered. As seen, bystander CPR intervention has a distinct positive bearing on survival, as does early access to medical care. Research has shown an eight minute window optimises cardiac arrest survival (Resuscitation Council (UK) 2005). Whereas no bystander CPR and prolonged resuscitation have been shown to contribute to futile resuscitation attempts. Are these factors prevalent within those patients transported within the WA system? It is therefore important to investigate response times, on scene times and transfer to hospital times for those indicated patients.

Finally, and probably the most important point; of those patients that are transferred to hospital in asystole, are there any survivors, and if so how many? Indeed, if there are significant survivors, it is imperative to carry on current practice and as such this may provide important data for other ambulance services that do not transfer their asystolic patients. However, if there is no evidence to suggest this practice is warranted, then it is questionable whether it is appropriate to transfer a patient in asystole to hospital.

This research study aims to review all 9505 adult cardiac arrests cases attended by St John Ambulance Service (WA) between January 1996 and November 2004. The initial dysrythmia will be categorised into VF, VT, PEA and asystole cardiac arrests. Following this, the data will be evaluated against the 219 patients who went on to survive and be discharged from hospital.

# CHAPTER 3

# MATERIALS AND METHODS

# 3.0 MATERIALS AND METHODS

## 3.1 Subjects

Retrospective data from St John Ambulance (WA) Patient Care Record Forms from January 1996 to November 2004 was collected and electronically placed onto a spreadsheet. Permission had been granted as the investigator is a senior member of St John Ambulance WA. Relevant patient information was extracted so that analysis could be undertaken. All patient identities were removed (de-identified) and are recognised by a code number. Ethical approval was obtained from the Human Ethics Committee, Edith Cowan University.

Data relating to asystolic and other dysrhythmic cardiac arrest patients were extracted and analysed utilising SPSS statistical package for quantitative analysis. Statistical analyses involved the normal measures of mean and standard deviation, followed by Chi-square (where appropriate**).** Chi-square analysis was determined for a P= <0.05 as a minimum level of significance. Observed and expected values were determined and the differences calculated using the formula;

$(\text{Observed} - \text{Expected})^2 / \text{Expected} = \chi 2.$

The sum of all values equals the total Chi-square value for each table. The degrees of freedom (df), were determined by the number of columns and rows in each table, i.e. df1, df4, and df8. These results were entered into a Chi-square calculator and cross checked with Chi—square tables to

determine the P values. Following analysis, results will be presented to St John Ambulance WA to allow for re-evaluation of treatment and transportation protocols.

Initial data showed 9881 patients who suffered cardiac arrest within the period 1996-2004. Patients were subsequently removed from the database if there was insufficient data, e.g. less than two ECG recordings, or if they were less than eighteen years of age. As a result 9505 patients were suitable for analysis.

### 3.2 Limitations of study

The limitation of this study is the retrospective data collection and analysis. Only two ECG recordings are attributed to each patient due to inconsistencies and incomplete patient record forms. Additionally, there are no timings attributed to the ECG which means that the time in each dysrhythmia can only be estimated. Therefore, the timings of the first ECG are estimated when the ambulance officer first attaches the defibrillator to the patient on arrival at scene. Where patients have been transported to hospital, the combined time of commencing treatment when arriving on scene to the arrival to hospital is estimated as a minimum 20 minutes. These are very conservative timings and the reality is that the time to hospital would be significantly longer to due to factors

such as removing the patient from the scene to the ambulance, followed by the subsequent transfer time to hospital. Therefore, ECG2 is estimated as being the patient's final ECG dysrhythmia on arrival at hospital. Consequently, those patients that remain in asystole between ECG1 and ECG2 are reviewed as being in asystole for at least 20 minutes.

This study also included all cardiac arrest patients irrespective of aetiology. However, it was accepted that survival of cardiac arrest due to trauma was extremely unlikely.

The length of time in cardiac arrest (downtime), and/or the time from cardiac arrest to the arrival of the ambulance have not been taken into account for all cardiac arrest patients. It was realised that this was a major risk factor in surviving out-of-hospital cardiac arrest (Jennings et al. 2006).

# CHAPTER 4

# RESULTS

# 4.0 RESULTS

## 4.1 Mortality analysis

A total 9505 patient care records were statistically analysed using a variety of tests including mean and standard deviation and Chi-square analysis. Table 1 shows that of this number, 9286 patients died and 219 patients survived. Therefore, 97.7% of all cardiac arrest patients subsequently died and survivors accounted for just 2.3%.

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | survived | 219 | 2.3 | 2.3 | 2.3 |
| | died | 9286 | 97.7 | 97.7 | 100.0 |
| | Total | 9505 | 100.0 | 100.0 | |

Table 1 Breakdown of all cardiac arrest patients

Table 2 shows a breakdown of the number and the percentage of patients (of all 9505 patients) into those that died at scene, those that were transported to hospital and those that survived. Of all 9505 patients, 7382 patients were classified as deceased on scene and as a result were not transported to hospital. This accounted for 75.4% of all cardiac arrest patients. The remaining 2123 patients were subsequently transported to hospital. This figure relates to 22.3% of all cardiac arrest patients. Of

these 2123 patients, 219 patients (2.3% of total) survived to leave hospital by 28 days post cardiac arrest.

| Category | Number | Percentage |
|---|---|---|
| All patients | 9505 | 100 |
| Died on Scene | 7382 | 75.4 |
| Transported to Hospital | 2123 | 22.3 |
| Survived | 219 | 2.3 |

Table 2 Breakdown of all patient categories, including patients that died on scene, the number of patients transferred to hospital, and the number of patients that subsequently survived

### 4.2 Gender analysis

Of all 9505 patients in this present study, analysis showed that the gender breakdown was 6456 male patients and 3039 female patients. This equated to 67.9% male and 32.1% female patients (Table 3).

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | male | 6456 | 67.9 | 67.9 | 67.9 |
| | female | 3049 | 32.1 | 32.1 | 100.0 |
| | Total | 9505 | 100.0 | 100.0 | |

Table 3 Breakdown of gender in all cardiac arrest patients

Of the 2123 patients transported to hospital, further analysis showed that the gender breakdown was 1488 male patients (70.1%) against 635 female patients (29.9%) (Table 4).

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | male | 1488 | 70.1 | 70.1 | 70.1 |
| | female | 635 | 29.9 | 29.9 | 100.0 |
| | Total | 2123 | 100.0 | 100.0 | |

Table 4 Breakdown of gender in all cardiac arrest patients transferred to hospital

Of the 2123 patients transported to hospital, 219 patients survived to leave hospital by 28 days post cardiac arrest. Further analysis showed that the gender breakdown of the survivors was 163 male patients against 56 female patients. This equated to 74.4% male and 25.6% female patients (Table 5).

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | male | 163 | 74.4 | 74.4 | 74.4 |
| | female | 56 | 25.6 | 25.6 | 100.0 |
| | Total | 219 | 100.0 | 100.0 | |

Table 5 Breakdown of gender in all cardiac arrest survivors to leave hospital.

Further analysis was made using Chi-Square for statistical analysis of all 2123 cardiac arrest patients transferred to hospital (Table 6 and Table 7).

| | Died | Died Expected | O - E | Diff Squared | χ2 | probability |
|---|---|---|---|---|---|---|
| Male | 1325 | 1335 | -10 | 100 | 0.075 | |
| Female | 579 | 569 | 10 | 100 | 0.175 | |
| Total | 1904 | 1904 | | | 0.25 | 0.6171 |

Table 6 Chi-square gender analysis of patients transferred to hospital that subsequently died

| | Survived | Survived expected | O - E | Diff Squared | χ2 | probability |
|---|---|---|---|---|---|---|
| Male | 163 | 154 | 9 | 81 | 0.525 | |
| Female | 56 | 65 | -9 | 81 | 1.246 | |
| Total | 219 | 219 | | | 1.771 | 0.1833 |

Table 7 Chi-square gender analysis of patients transferred to hospital and survived to leave hospital

Chi-square results explored any statistical significance of gender survival. There were expectations that 1335 males would die. However, the actual death rate of males was in fact fewer with 1325 male cardiac arrest patients. Additionally, there were more male survivors than expected, with 163 survivors compared to 154 expected survivors.

Female results showed that more females died than statistically expected. Female deaths accounted for 579 cardiac arrest patients, and this was more than the expected 569 patients. Additionally, there were fewer survivors than expected, with 56 female survivors compared to 65 expected survivors.

However, Chi-square analysis showed that there was no significant statistical difference in male and female death rates, and indicated a probability value of 0.6171 (Table 6). Although more males died than females, the overall percentages of patient death rates in relation to those transported were very similar, with 89% males patients dying compared to 91.2% female patients (Table 8).

| Gender | Survived % | Died % |
|---|---|---|
| Male | 11 | 89 |
| Female | 8.8 | 91.2 |
| Male & Female | 10.3 | 89.7 |

Table 8 Survival percentages of males and females transported to hospital

In addition, Chi-square analysis showed that there were no significant statistical differences in male and female survival rates, with a probability value of 0.1833 (Table 7). Results showed that males had a survival rate of 11% of all patients transported to hospital whereas female survival rate accounted for 8.8% of this patient group. The combined survival rate of all patients transported to hospital was 10.3% (Table 8).

### 4.3 Age analysis

Further analysis was undertaken to evaluate the age groups of all cardiac arrest patient categories. Table 9 shows the age groups of all 9505 cardiac arrest patients. This data showed that the majority of these patients fell into the 70-79 years of age category (25.5%), followed by 80-89 (18.2%), 60-69 (16.9%), 50-59 (11.5%), 40-49 (8.6%), 18-29 (7.9%), 30-39 (7.5%) and the minority 90+ (3.8%). Figure 5 is a Bar Chart representation showing the trend in these results.

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 18-29 | 752 | 7.9 | 7.9 | 7.9 |
| | 30-39 | 712 | 7.5 | 7.5 | 15.4 |
| | 40-49 | 821 | 8.6 | 8.6 | 24.0 |
| | 50-59 | 1096 | 11.5 | 11.5 | 35.6 |
| | 60-69 | 1611 | 16.9 | 16.9 | 52.5 |
| | 70-79 | 2426 | 25.5 | 25.5 | 78.0 |
| | 80-89 | 1728 | 18.2 | 18.2 | 96.2 |
| | 90+ | 359 | 3.8 | 3.8 | 100.0 |
| | Total | 9505 | 100.0 | 100.0 | |

Table 9 Age groups of all cardiac arrest patients

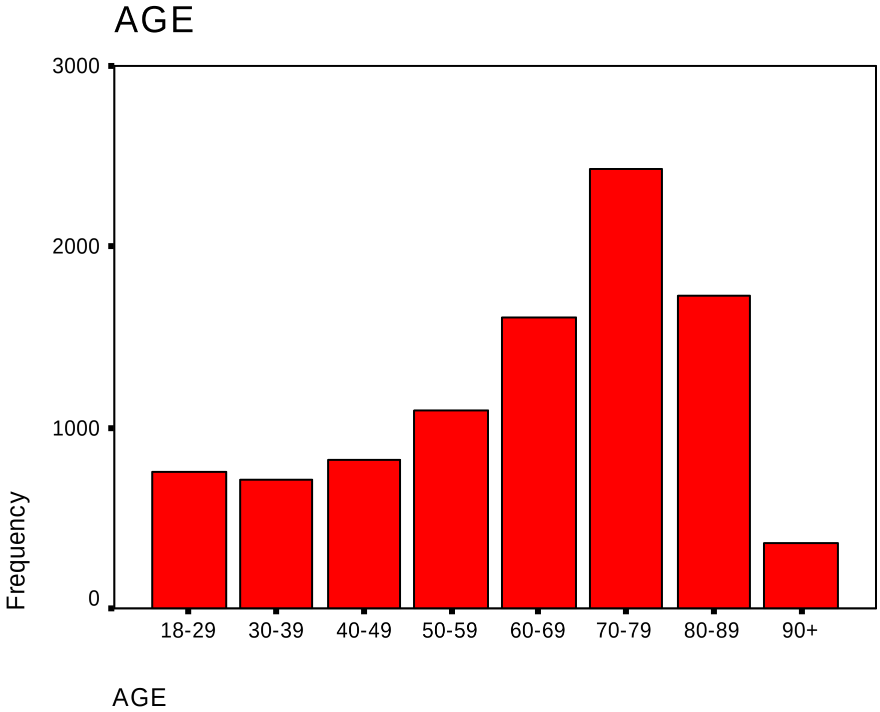


Figure 5 Bar chart showing age groups of all cardiac arrest patients

Of those 2123 cardiac arrest patients transferred to hospital the majority of patients fell into the 70-79 years of age category (26.3%), followed by 60-69 (20.6%), 80-89 (15.3%), 50-59 (14.2%), 40-49 (8.7%), 18-29 (5.9%), 30-39 (5.6%) and the minority 90+ (3.5%) (Table 10). Figure 6 is a Bar Chart representation of these results.

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 18-29 | 125 | 5.9 | 5.9 | 5.9 |
| | 30-39 | 118 | 5.6 | 5.6 | 11.4 |
| | 40-49 | 184 | 8.7 | 8.7 | 20.1 |
| | 50-59 | 301 | 14.2 | 14.2 | 34.3 |
| | 60-69 | 438 | 20.6 | 20.6 | 54.9 |
| | 70-79 | 559 | 26.3 | 26.3 | 81.3 |
| | 80-89 | 324 | 15.3 | 15.3 | 96.5 |
| | 90+ | 74 | 3.5 | 3.5 | 100.0 |
| | Total | 2123 | 100.0 | 100.0 | |

Table 10  Age groups of all cardiac arrest patients transported to hospital

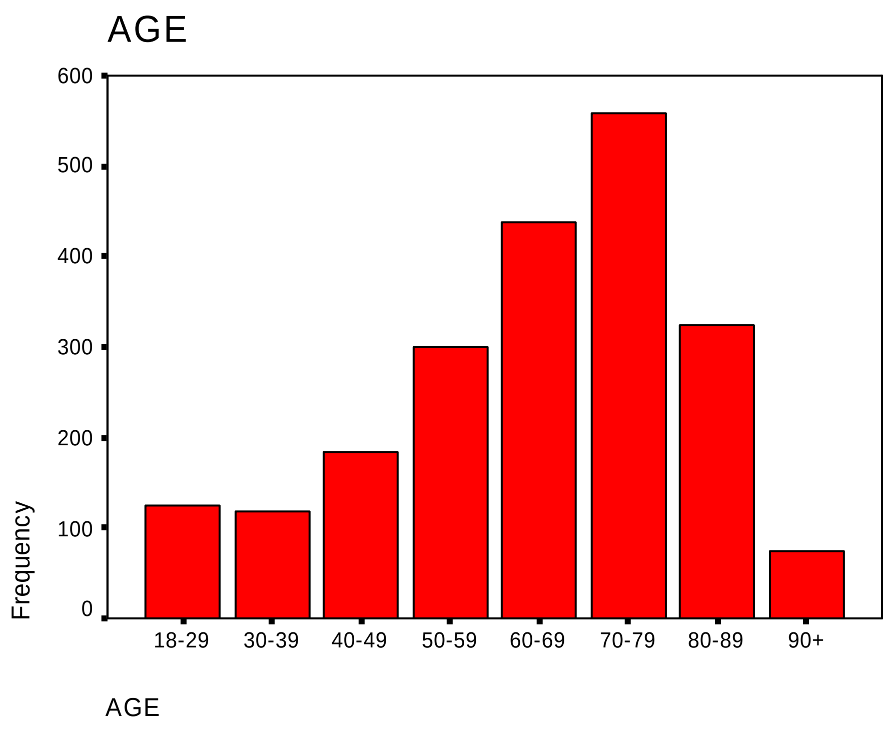


Figure 6  Bar chart showing all age groups of patients transferred to hospital

Of the 219 cardiac arrest patients who survived to leave hospital (Table 11), the majority of patients fell into the 70-79 years of age category (27.9%), followed by 60-69 (26.5%), 50-59 (19.2%), 40-49 (10.0%), 80-89 (9.1%), 18-29 and 30-39 equal (2.7%) and the minority 90+ (1.8%). Figure 7 is a Bar Chart representation of these results

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 18-29 | 6 | 2.7 | 2.7 | 2.7 |
| | 30-39 | 6 | 2.7 | 2.7 | 5.5 |
| | 40-49 | 22 | 10.0 | 10.0 | 15.5 |
| | 50-59 | 42 | 19.2 | 19.2 | 34.7 |
| | 60-69 | 58 | 26.5 | 26.5 | 61.2 |
| | 70-79 | 61 | 27.9 | 27.9 | 89.0 |
| | 80-89 | 20 | 9.1 | 9.1 | 98.2 |
| | 90+ | 4 | 1.8 | 1.8 | 100.0 |
| | Total | 219 | 100.0 | 100.0 | |

Table 11 Age groups of cardiac arrest survivors

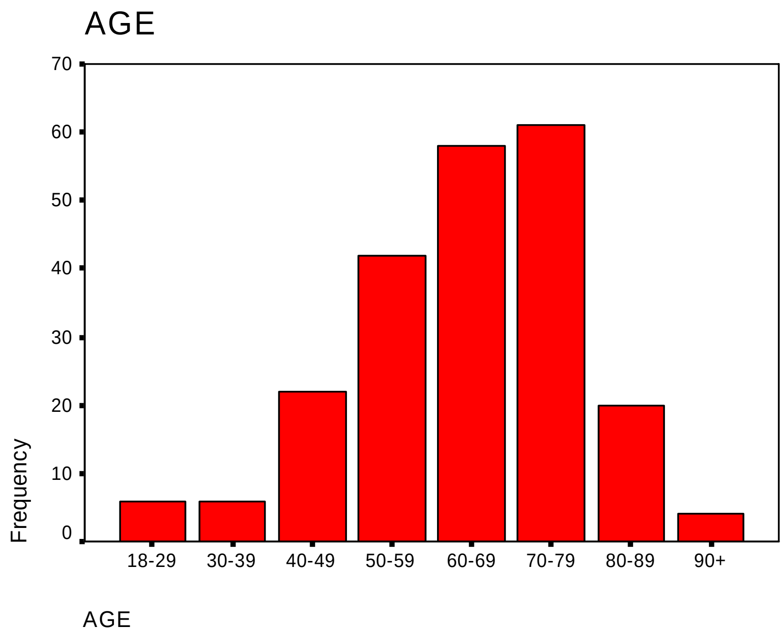


Figure 7 Bar chart showing all age groups of survivors of cardiac arrest

Chi-Square analysis was undertaken on all 2123 cardiac arrest patients transferred to hospital (Table 12 and Table 13). Table 12 shows that of those patients aged 40 – 79, the expected deaths are greater than those observed. In age groups 18-39 and 80+, the expected deaths are less than observed, whereas, the reverse is seen in age groups 18-39 and 80+. However, results suggest no statistically significant chance of death relating to patient age, with a P-value of 0.9148 (Table 12).

| Age | Died | Expected No. Died | O - E | Diff Squared | $\chi 2$ | probability |
|---|---|---|---|---|---|---|
| 18-29 | 119 | 112 | 7 | 49 | 0.437 | |
| 30-39 | 112 | 106 | 6 | 36 | 0.339 | |
| 40-49 | 162 | 165 | -3 | 9 | 0.054 | |
| 50-59 | 259 | 270 | -11 | 121 | 0.448 | |
| 60-69 | 380 | 393 | -13 | 169 | 0.430 | |
| 70-79 | 498 | 502 | -4 | 16 | 0.032 | |
| 80-89 | 304 | 290 | 14 | 196 | 0.675 | |
| 90+ | 70 | 66 | 4 | 16 | 0.242 | |
| Total | 1904 | 1904 | | | 2.657 | 0.9148 |

Table 12 Chi-square age group analysis of patients transported to hospital that subsequently died

Table 13 shows that within all age groups 40-79, there were more survivors observed than statistically expected. Analysis also indicated that there were a greater number of patients transported who survived within age groups 40-79, than age groups 18-39 and 80+. Chi-square

analysis showed that patient survival rates were related to age, with a P-value of 0.0017.

| Age | Survive | Expected No. Survived | O - E | Diff Squared | $\chi 2$ | probability |
|---|---|---|---|---|---|---|
| 18-29 | 6 | 13 | -7 | 49 | 3.769 | |
| 30-39 | 6 | 12 | -6 | 36 | 3.000 | |
| 40-49 | 22 | 19 | 3 | 9 | 0.473 | |
| 50-59 | 42 | 31 | 11 | 121 | 3.903 | |
| 60-69 | 58 | 45 | 13 | 169 | 3.755 | |
| 70-79 | 61 | 57 | 4 | 16 | 0.280 | |
| 80-89 | 20 | 34 | -14 | 196 | 5.764 | |
| 90+ | 4 | 8 | -4 | 16 | 2.000 | |
| Total | 219 | 219 | | | 22.944 | 0.0017 |

Table 13 Chi-square age group analysis of all survivors of cardiac arrest patients

Table 14 indicates the survival rate of the age groups 40-79. The highest rate of survival lies within the age group 50-59 with 13.9% of those patients transferred to hospital. Patients aged 60-69 had a survival rate of 13.2%, followed by age group 40-49, and lastly age group 70-79 at 10.9%. The combined survival rate of all patients transported to hospital aged 40-79 was 12.35%.

| Age | Percentage |
|---|---|
| 40-49 | 11.9 |
| 50-59 | 13.9 |
| 60-69 | 13.2 |
| 70-79 | 10.9 |
| All patients 40-79 | 12.35 |

Table 14 Survival percentage rates within age groups of all patients

Table 15 shows a further breakdown of male and female survivors. Analysis shows that of all males transported to hospital, patients aged 50-59 had the greatest survival rate of 15%. Of those aged 40-49 the survival rate was slightly lower at 14.8%. Other survival rates were 13% for those aged 60-69 and 12% for those aged 70-79. The combined survival rate for males aged 40-79 was 13.4%.

Female survival rates showed different results. The female patients aged 60-69 showed best survival rates at 13.7%. This was followed by patients aged 70-79 at 8.5%, patients aged 50-59 at 7.8% and patients aged 40-49 at just 4%. The combined survival rate of all female patients aged 40-79 was 9.2%.

| Age | Male Percentage | Female Percentage |
|---|---|---|
| 40-49 | 14.8 | 4 |
| 50-59 | 15 | 7.8 |
| 60-69 | 13 | 13.7 |
| 70-79 | 12 | 8.5 |
| All patients 40-79 | 13.4 | 9.2 |

Table 15 Survival percentages of male and females within the age range of 40-79

### 4.4 ECG analysis

Analysis was undertaken to review the initial ECG dysrhythmia (ECG1) and a subsequent ECG dysrhythmia (ECG2). Of all cardiac arrest patients, 6953 patient ECG's displayed asystole (73.3%), 1212 were in VF (12.8%) and 459 patients (4.8%) were described as being 'another' rhythm (unrecognisable by the ambulance officer as any other rhythm listed on Patient Care Record form). 408 patients (4.3%) were in PEA, 192 patients (2.0%) were classed as bradycardic, 136 patients (1.4%) were in NSR, 110 patients (1.2%) were tachycardic, 26 patients (0.3%) were in VT, and the remaining 9 patients (0.1%) were reported as VEB (Table 16). This information in represented in a Bar Chart (Figure 8).

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | NSR | 136 | 1.4 | 1.4 | 1.4 |
| | asystole | 6953 | 73.2 | 73.2 | 74.6 |
| | tachycardia | 110 | 1.2 | 1.2 | 75.7 |
| | bradycardia | 192 | 2.0 | 2.0 | 77.8 |
| | VT | 26 | .3 | .3 | 78.0 |
| | VF | 1212 | 12.8 | 12.8 | 90.8 |
| | VEB | 9 | .1 | .1 | 90.9 |
| | PEA | 408 | 4.3 | 4.3 | 95.2 |
| | other | 459 | 4.8 | 4.8 | 100.0 |
| | Total | 9505 | 100.0 | 100.0 | |

Table 16 ECG1 breakdown of all cardiac arrest patients

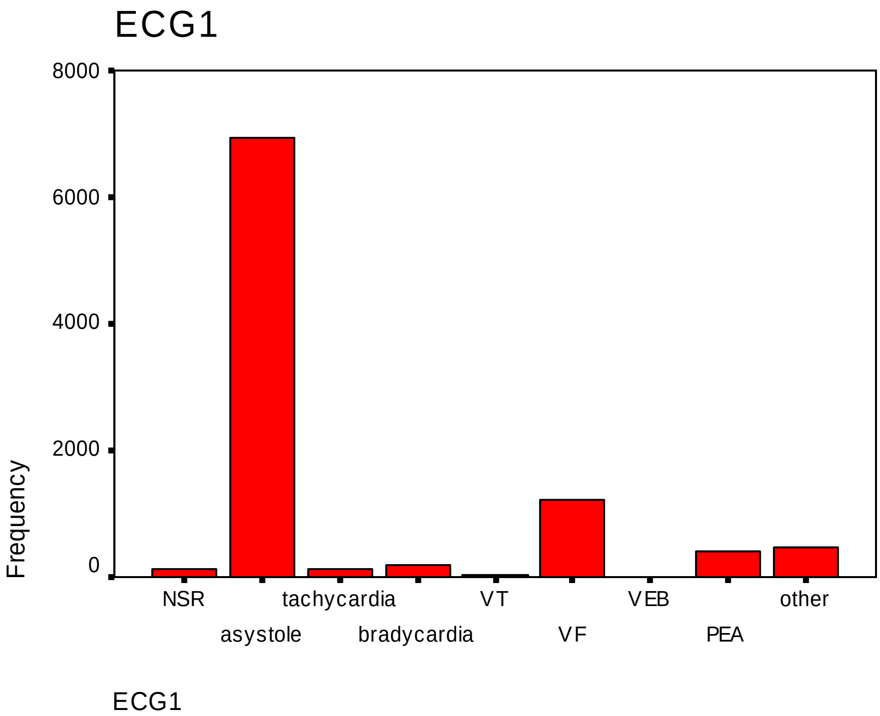


Figure 8 Bar chart showing ECG1 of all cardiac arrest patients

Of the 2123 patients transported to hospital, the ECG1 of 792 patients was VF (37.2%). The remaining results showed 425 patients were in asystole (20.0%), 310 patients (14.6%) were in PEA, 168 patients (7.9%) were classed as bradycardic, 165 patients (7.8%) were described as being in 'another' rhythm, 126 patients (5.9%) were in NSR, 106 patients (5.0%) were tachycardic, 23 patients (1.1%) were in VT, and the remaining 8 patients (0.4%) were reported as VEB (Table 17). Figure 9 displays this information in a Bar Chart.

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | NSR | 126 | 5.9 | 5.9 | 5.9 |
| | asystole | 425 | 20.0 | 20.0 | 26.0 |
| | tachycardia | 106 | 5.0 | 5.0 | 30.9 |
| | bradycardia | 168 | 7.9 | 7.9 | 38.9 |
| | VT | 23 | 1.1 | 1.1 | 39.9 |
| | VF | 792 | 37.3 | 37.3 | 77.2 |
| | VEB | 8 | .4 | .4 | 77.6 |
| | PEA | 310 | 14.6 | 14.6 | 92.2 |
| | other | 165 | 7.8 | 7.8 | 100.0 |
| | Total | 2123 | 100.0 | 100.0 | |

Table 17 ECG1 breakdown of all patients transferred to hospital

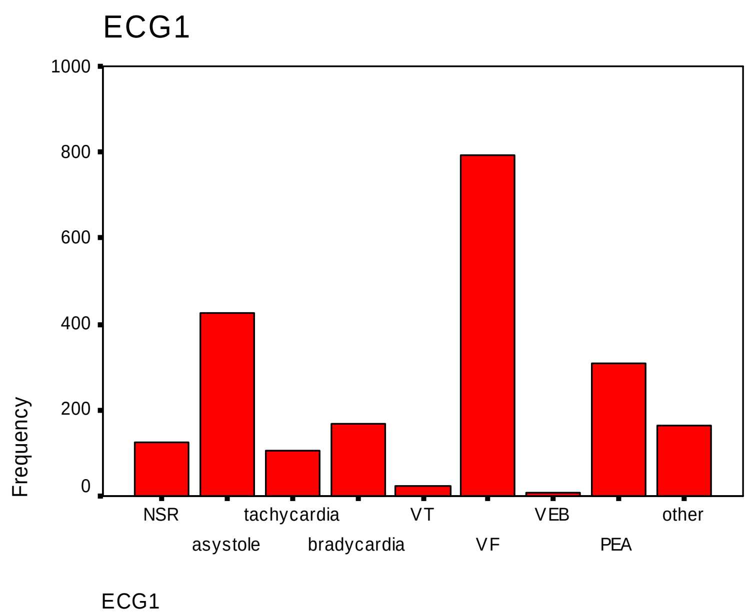


Figure 9 Bar chart showing ECG1 of all patients transferred to hospital

Table 18 shows the ECG1 breakdown of all cardiac arrests survivors. Of the 219 patients who survived, the initial ECG of 105 patients was VF (47.9%). The remaining results showed 43 patients were in NSR (19.6%), 19 patients (8.7%) were described as being in 'another' rhythm, 16 patients (7.3%) were tachycardic, 14 patients (6.4%) were in PEA, 10 patients (4.6%) were bradycardic, 6 patients (2.7%) were reported as VEB, 5 patients (2.3%) were in VT and the remaining 1 patient (0.5%) was in asystole. Figure 10 displays this information in a Bar Chart.

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | NSR | 43 | 19.6 | 19.6 | 19.6 |
| | asystole | 1 | .5 | .5 | 20.1 |
| | tachycardia | 16 | 7.3 | 7.3 | 27.4 |
| | bradycardia | 10 | 4.6 | 4.6 | 32.0 |
| | VT | 5 | 2.3 | 2.3 | 34.2 |
| | VF | 105 | 47.9 | 47.9 | 82.2 |
| | VEB | 6 | 2.7 | 2.7 | 84.9 |
| | PEA | 14 | 6.4 | 6.4 | 91.3 |
| | other | 19 | 8.7 | 8.7 | 100.0 |
| | Total | 219 | 100.0 | 100.0 | |

Table 18 ECG1 breakdown of all survivors of cardiac arrest

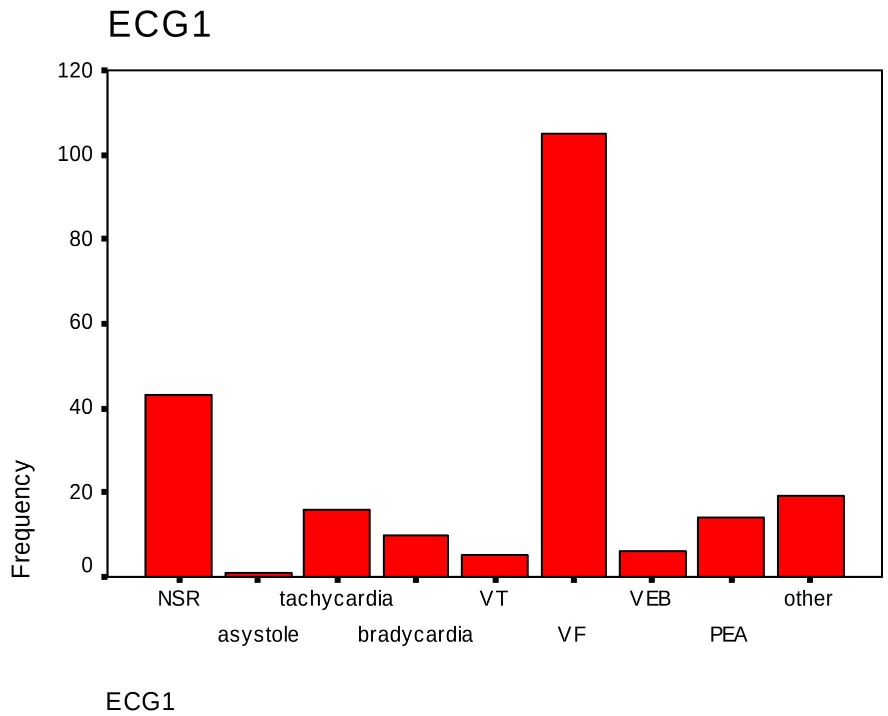


Figure 10 Bar chart of ECG1 of survivors of cardiac arrest

A subsequent ECG was taken for analysis of all dysrhythmias. The results showed that of all 9505 cardiac arrest patients, 7818 patients (82.3%) were in asystole, 495 patients (5.2%) were in VF, 421 patients (4.4%) were in PEA, 383 patients (4.0%) were described as being in 'another' rhythm, 165 patients (1.7%) were bradycardic, 90 patients were in NSR (0.9%), 79 patients (0.8%) were tachycardic, 37 patients (0.4%) were in VT and the remaining 17 patients (0.2%) were reported as VEB (Table 19). Figure 11 displays this information in a Bar Chart.

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | NSR | 90 | .9 | .9 | .9 |
| | asystole | 7818 | 82.3 | 82.3 | 83.2 |
| | tachycardia | 79 | .8 | .8 | 84.0 |
| | bradycardia | 165 | 1.7 | 1.7 | 85.8 |
| | VT | 37 | .4 | .4 | 86.2 |
| | VF | 495 | 5.2 | 5.2 | 91.4 |
| | VEB | 17 | .2 | .2 | 91.5 |
| | PEA | 421 | 4.4 | 4.4 | 96.0 |
| | other | 383 | 4.0 | 4.0 | 100.0 |
| | Total | 9505 | 100.0 | 100.0 | |

Table 19 ECG2 breakdown of all cardiac arrest patients

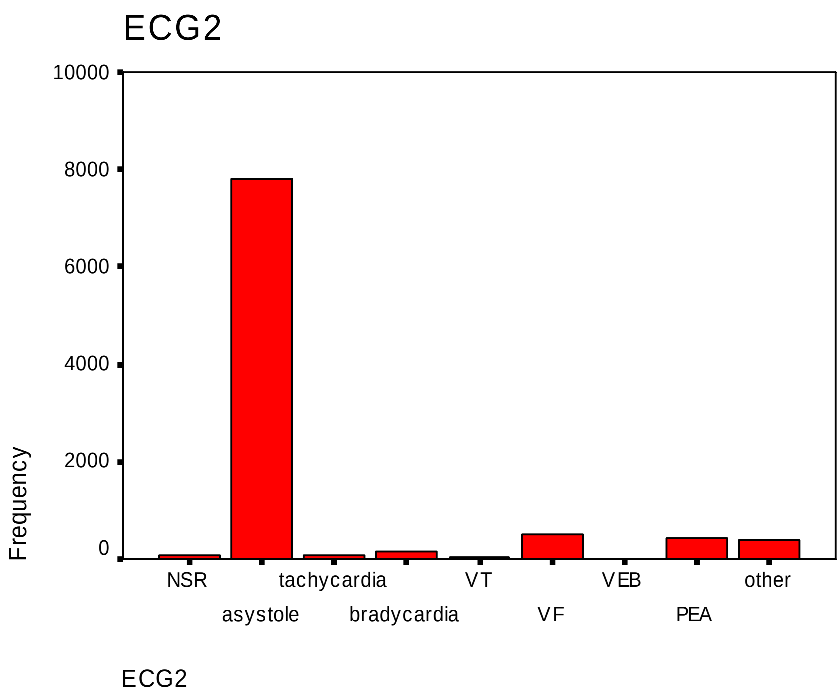


Figure 11 Bar chart showing ECG2 of all cardiac arrest patients

The analysis of ECG2 of the 2123 patients transported to hospital showed 766 patients (36.1%) were in asystole, 410 patients (19.3%) were in VF, 368 patients (17.3%) were in PEA, 205 patients (9.7%) were described as being in 'another' rhythm, 157 patients (7.4%) were bradycardic, 89 patients (4.2%) were in NSR, 77 patients (3.6%) were tachycardic, 34 patients (1.6%) were in VT, and the remaining 17 patients (0.8%) were reported as VEB (Table 20). Figure 12 displays this information in a Bar Chart.

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | NSR | 89 | 4.2 | 4.2 | 4.2 |
| | asystole | 766 | 36.1 | 36.1 | 40.3 |
| | tachycardia | 77 | 3.6 | 3.6 | 43.9 |
| | bradycardia | 157 | 7.4 | 7.4 | 51.3 |
| | VT | 34 | 1.6 | 1.6 | 52.9 |
| | VF | 410 | 19.3 | 19.3 | 72.2 |
| | VEB | 17 | .8 | .8 | 73.0 |
| | PEA | 368 | 17.3 | 17.3 | 90.3 |
| | other | 205 | 9.7 | 9.7 | 100.0 |
| | Total | 2123 | 100.0 | 100.0 | |

Table 20 ECG2 breakdown of all cardiac arrest patients transferred to hospital

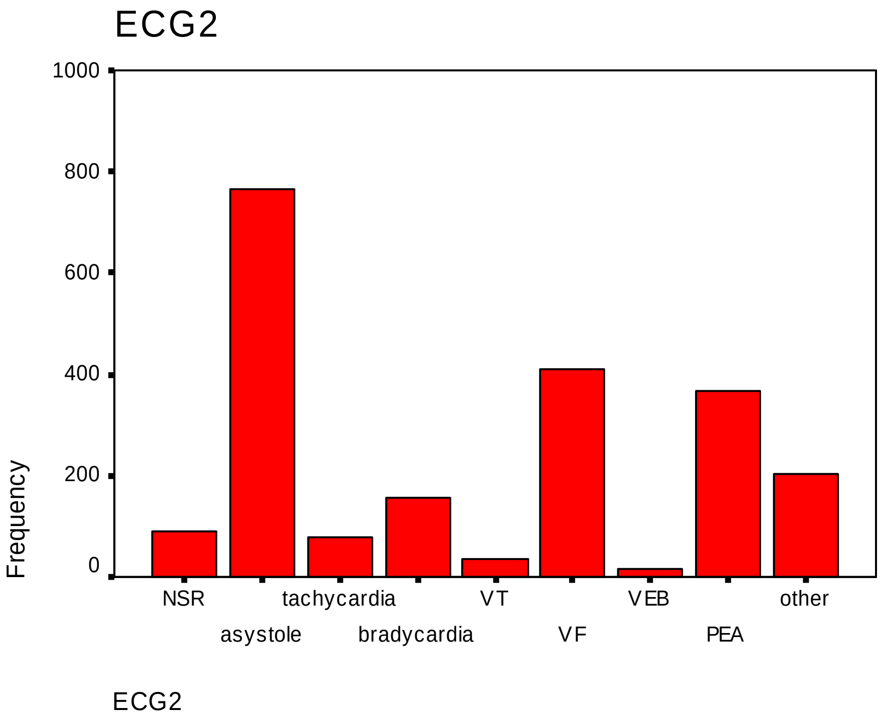


Figure 12 Bar chart showing ECG2 of cardiac arrest patients transferred to hospital

The results of ECG2 of the patients who survived to leave hospital showed that 62 patients (28.3%) were in VF, 45 patients (20.5%) were described as being in 'another' rhythm, 38 patients (17.4%) were in NSR, 20 patients (9.1%) were bradycardic, 20 patients (9.1%) were tachycardic, 14 patients (6.4%) were in PEA, 11 patients (5.0%) were in VT, and the remaining 9 patients (4.1%) were reported as VEB (Table 21). Figure 13 displays this information in a Bar Chart.

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | NSR | 38 | 17.4 | 17.4 | 17.4 |
| | Asystole | 0 | 0.0 | 0.0 | 0.0 |
| | tachycardia | 20 | 9.1 | 9.1 | 26.5 |
| | bradycardia | 20 | 9.1 | 9.1 | 35.6 |
| | VT | 11 | 5.0 | 5.0 | 40.6 |
| | VF | 62 | 28.3 | 28.3 | 68.9 |
| | VEB | 9 | 4.1 | 4.1 | 73.1 |
| | PEA | 14 | 6.4 | 6.4 | 79.5 |
| | other | 45 | 20.5 | 20.5 | 100.0 |
| | Total | 219 | 100.0 | 100.0 | |

Table 21 ECG2 breakdown of all cardiac arrest survivors

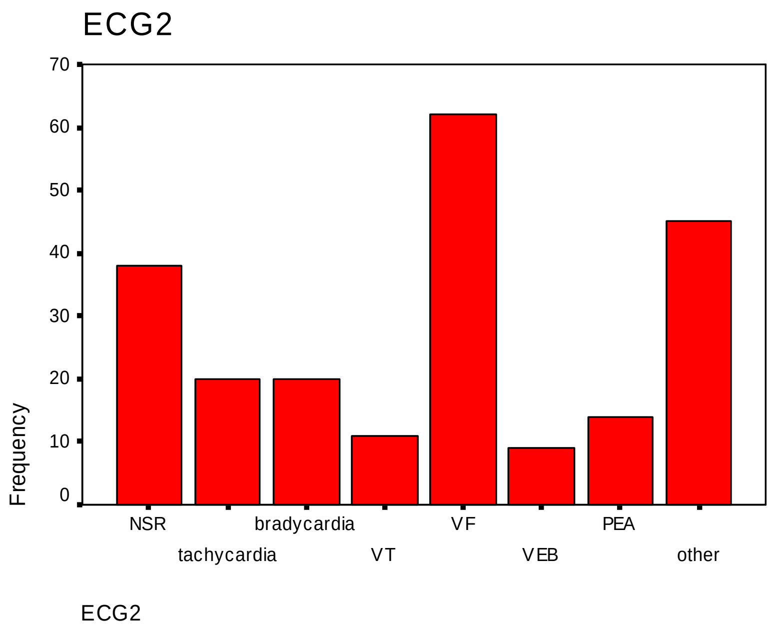


Figure 13 Bar chart showing ECG2 of all cardiac arrest survivors

Chi-Square test analysis was undertaken to examine the ECG recordings of all 2123 cardiac arrest patients transferred to hospital. Table 22 shows a breakdown of the initial ECG of all cardiac arrest patients that subsequently died (1904 patients).

These results showed that there were fewer patients that died when they initially presented in NSR than was expected. Of the expected 113 patients, 83 actually died. Analysis of asystole showed that more cardiac arrest patients died than were statistically expected. Results indicated that although 381 asystolic patients were expected to die, the numbers that actually died were 424 patients.

Where patients were seen to have tachycardia as a dysrhythmia, fewer died than was statistically expected. Analysis showed that 90 cardiac arrest patients died, compared to the expected 95 patients. Patients who experienced bradycardia as their presenting rhythm were seen to have more than the statistically expected death rates. Results indicated that 158 bradycardic patients died compared to the expected 150 cardiac arrest patients.

There were slightly less than expected death rates for patients in VT. Statistically, 20 patients were expected to die, though results showed 18 cardiac arrest patients actually died. Patients with VF showed significantly lower death rates than expected. Results indicated that 687

cardiac arrest patients died when presenting in VF compared to the expected 710 patients.

Of those patients that had VEB as their presenting rhythm, 7 cardiac arrest patients were expected to die. However, results indicated that only 2 patients actually died. Patients with PEA as their presenting rhythm showed an increase in actual deaths compared to expected deaths. Statistically, 278 PEA cardiac arrest patients were expected to die, but results showed that in fact 296 patients died. Where the presenting rhythm was 'other', there were very similar results seen in the actual and expected death rates. The expected death rate was 148 compared to 146 patients that died.

Chi-square analysis of ECG1 of the patients transported to hospital showed that there was no statistical significance between the initial dysrythmia and the patients who subsequently die. Analysis of results gave a P-value of 0.0623.

| | Died | Died Expected | O - E | Diff Squared | $\chi2$ | probability |
|---|---|---|---|---|---|---|
| NSR | 83 | 113 | -30 | 900 | 7.964 | |
| Asystole | 424 | 381 | 43 | 1849 | 0.482 | |
| Tachy | 90 | 95 | -5 | 25 | 0.263 | |
| Brady | 158 | 150 | 8 | 64 | 0.426 | |
| VT | 18 | 20 | -2 | 4 | 0.200 | |
| VF | 687 | 710 | -23 | 529 | 0.745 | |
| VEB | 2 | 7 | -5 | 25 | 3.571 | |
| PEA | 296 | 278 | 18 | 324 | 1.165 | |
| Other | 146 | 148 | -2 | 4 | 0.027 | |
| total | 1904 | 1904 | | | 14.843 | 0.0623 |

Table 22 ECG1 Chi-square dysrhythmia analysis of all patients transferred to hospital that subsequently died

Table 23 shows Chi-square analysis of the initial ECG of all survivors of cardiac arrest (219 patients). Where NSR was seen on the patients first ECG, the expected survival rate was significantly less than that observed. Survivors accounted for 43 patients in contrast to the expected 13 survivors.

Analysis of patients that presented in asystole showed that although 44 patients were expected to survive, only 1 patient survived. However, survival rates for patients who experienced tachycardia were better than

expected. There were 16 tachycardic cardiac arrest patients that survived compared to the expected 11 patients.

Where patients were observed to have bradycardia as their dysrythmia, there were fewer survivors than expected. Results showed that only 10 patients survived compared to the expected 17 cardiac arrest patients. Survival rates for patients in VT showed 5 cardiac arrest patients surviving compared to the expected 2 surviving patients.

Analysis of VF survival rates was extremely different than expected. The number of VF survivors was 105 cardiac arrest patients, compared to the expected 82 patients. Patients that had indicated VEB on their initial dysrythmia showed an increase from that statistically expected with 6 patients surviving compared to 1 expected survivor.

Additionally, less PEA cardiac arrest patients survived than was expected. Results showed that 14 PEA patients survived compared to the expected 32 patients. Patients that were recorded as 'other' showed similar survival rates to those expected,, with 19 patients surviving, compared to 17 expected patient survivals.

Chi-square analysis of all dysrhythmias seen in ECG1 of all survivors of cardiac arrest showed that there was extreme statistical significance when

relating the initial ECG with those patients that survive cardiac arrest. These results showed a P-value of <0.0001.

| | Survived | Survived expected | O - E | Diff Squared | $\chi 2$ | probability |
|---|---|---|---|---|---|---|
| NSR | 43 | 13 | 30 | 900 | 69.230 | |
| Asystole | 1 | 44 | -43 | 1849 | 42.022 | |
| Tachy | 16 | 11 | 5 | 25 | 2.272 | |
| Brady | 10 | 17 | -7 | 49 | 2.882 | |
| VT | 5 | 2 | 3 | 9 | 4.500 | |
| VF | 105 | 82 | 23 | 529 | 6.451 | |
| VEB | 6 | 1 | 5 | 25 | 25.000 | |
| PEA | 14 | 32 | -18 | 324 | 10.125 | |
| Other | 19 | 17 | 2 | 4 | 0.235 | |
| total | 219 | 219 | | | 162.717 | <0.0001 |

Table 23 ECG1 Chi-square dysrhythmia analysis of all survivors of cardiac arrest

Chi-Square test analysis was undertaken on the second ECG recordings of the 2123 cardiac arrest patients transferred to hospital. Table 24 shows a break down of dysrhythmias of all patients that subsequently died (1904 cardiac arrest patients).

The results indicated that where NSR was seen, slightly more patients died than were actually expected. The statistically expected death rate

was 46 cardiac arrest patients, but 51 patients actually died. Where a patient was in asystole, there were far more deaths than expected. Analysis showed that there were 689 expected asystolic patient deaths, but in fact this was greatly increased to 766 deaths.

Where patients were seen to have tachycardia as a dysrhythmia, fewer died than was statistically expected. There were 57 tachycardic cardiac arrest patients that died, compared to the expected 69 patient deaths. Patients who experienced bradycardia as their presenting rhythm were seen to have less than expected deaths. Results showed that 137 bradycardic patients died compared to the expected 140 cardiac arrest patients.

Patients in VT showed less than expected rates of death, with 23 patient deaths compared to 30 expected deaths. Patients with VF showed significantly lower death rates than expected. Death rates indicated that 348 VF cardiac arrest patients died compared to the expected 367 patients. Of those patients that had VEB as their dysrythmia, analysis suggested 15 cardiac arrest patients were expected to die. However, results showed that only 8 VEB patients died.

Patients recorded as having PEA showed an increase in deaths compared to expected deaths. Statistically, 330 PEA cardiac arrest patients were expected to die. However, results showed that 354 PEA cardiac arrest

patients died. Finally, where the ECG recording was 'other', less cardiac arrest patients died than expected. Statistically, 184 'other' patients were expected to die. However, results showed that 160 'other' cardiac patients actually died.

Chi-square analysis of all dysrhythmias seen in ECG2 of those patients transported to hospital showed that there was statistical significance when relating the ECG recordings with those patients who will subsequently die. These results gave a P-value of 0.0084

| | Died | Died Expected | O - E | Diff Squared | $\chi 2$ | probability |
|---|---|---|---|---|---|---|
| NSR | 51 | 46 | 5 | 25 | 0.543 | |
| Asystole | 766 | 689 | -77 | 5929 | 8.603 | |
| Tachy | 57 | 69 | -12 | 144 | 2.086 | |
| Brady | 137 | 140 | -3 | 9 | 0.064 | |
| VT | 23 | 30 | -7 | 49 | 0.133 | |
| VF | 348 | 367 | -19 | 361 | 0.983 | |
| VEB | 8 | 15 | -7 | 49 | 3.266 | |
| PEA | 354 | 330 | 24 | 576 | 1.745 | |
| Other | 160 | 184 | -24 | 576 | 3.130 | |
| total | 1904 | 1904 | | | 20.553 | 0.0084 |

Table 24 ECG2 Chi-square analysis of all patients transported to hospital that subsequently died

Chi-square analysis was undertaken on the ECG2 of all 219 patients that survived (Table 25). Where NSR was recorded, the expected survival rate was only 9 patients, but results showed that a significant 38 patients actually survived. Asystolic patient results also varied significantly from those statistically expected. There were 79 asystolic patients expected to survive, but in reality there were nil survivors.

Survival for patients recorded as tachycardic was significantly better than expected, with 20 cardiac arrest survivors compared to 8 expected patients. Survival for patients recorded as bradycardic was also better than expected; with 20 patients surviving compared to the expected 16 cardiac arrest patients.

Survival rates for patients with VT increased with 11 surviving compared to the expected 4 patients. Additionally, patient survival rates of VF were very different than statistically expected, with 62 survivors compared to the expected 42 patients.

Where VEB was seen on ECG2, cardiac arrest survivors increased compared to that expected, with 9 patients surviving compared to 2 expected survivors. In addition, patients with recorded PEA survived less often than expected, with 14 patients surviving compared to the expected 37 patients. Finally, of those patients that were recorded as 'other', more

patients survived than expected. There were 21 expected survivors, but in fact 45 patients survived.

Chi-square analysis of all dysrhythmias seen in ECG2 of all survivors of cardiac arrest showed that there was extreme statistical significance when relating the initial ECG with those patients that survive cardiac arrest. These results showed a P-value of <0.0001

| | Survived | Survived expected | O - E | Diff Squared | $\chi 2$ | probability |
|---|---|---|---|---|---|---|
| NSR | 38 | 9 | 29 | 841 | 93.440 | |
| Asystole | 0 | 79 | -79 | 6241 | 79.000 | |
| Tachy | 20 | 8 | 12 | 144 | 18.000 | |
| Brady | 20 | 16 | 4 | 16 | 1.000 | |
| VT | 11 | 4 | 7 | 49 | 12.250 | |
| VF | 62 | 42 | 20 | 400 | 9.523 | |
| VEB | 9 | 2 | 7 | 49 | 24.500 | |
| PEA | 14 | 37 | -23 | 529 | 14.290 | |
| Other | 45 | 21 | 24 | 576 | 27.428 | |
| total | 219 | 219 | | | 279.431 | <0.0001 |

Table 25 ECG2 Chi-square analysis of all survivors of cardiac arrest

Further analysis was used to investigate the rate of survival from different cardiac dysrhythmias (Table 26). These were divided into two areas; those dysrhythmias that are seen prior or post cardiac arrest (peri-dysrhythmias) and those rhythms associated with cardiac arrest.

Table 26 shows ECG1 recordings of dysrhythmias recognised as peri-arrest dysrhythmias. Survival rates of patients with tachycardia were 15%, patients with bradycardia were 6%, and patients with VEB were 75%.

| Dysrhythmia | Percent |
| --- | --- |
| Tachycardia | 15 |
| Bradycardia | 6 |
| VEB | 75 |

Table 26 ECG1 percentages of survivors that presented in peri-arrest dysrhythmias

Table 27 shows ECG2 recordings of dysrhythmias recognised as peri-arrest dysrhythmias. Survival rates had increased from the previous ECG1 recordings of patients with tachycardia to 26% and bradycardia to 6%. However, patients in VEB had decreased to 53%.

| Dysrhythmia | Percent |
| --- | --- |
| Tachycardia | 26 |
| Bradycardia | 12.7 |
| VEB | 53 |

Table 27 ECG2 percentages of survivors that presented in peri-arrest dysrhythmias

Table 28 shows the survival rates of cardiac arrest dysrhythmias of ECG1. Results showed that 21.7% of VT patients that were transported to hospital survived. Of the other patients transported, 13.25% of VF patients, 4.5% of PEA patients, and 11.5% of 'other' dysrhythmias survived. Only 0.23% of asystolic patients were classed as surviving on their first ECG rhythm.

| Dysrhythmia | Percent |
|---|---|
| VT | 21.7 |
| VF | 13.25 |
| PEA | 4.5 |
| Other | 11.5 |
| Asystole | 0.23 |

Table 28 ECG1 percentages of survivors of VT, VF, PEA, 'other', and asystole

Table 29 shows the ECG2 survival rates of the patients transported to hospital. VT patients had a survival rate of 32%, VF patients 15%, PEA patients 3.7% and 'other' patients 22%. There were no survivors of asystole on ECG2 recording; therefore the survival rate was 0%.

| Dysrhythmia | Percent |
|---|---|
| VT | 32 |
| VF | 15 |
| PEA | 3.8 |
| Other | 22 |
| Asystole | 0 |

Table 29 ECG2 percentages of survivors of VT, VF, PEA, 'other', and asystole

All cardiac patients transferred to hospital with an ECG of VT, VF, PEA and 'other' dysrhythmias were analysed to detect the percentage of survivors in ECG1 in both male and female patients (Table 30).

For male patients, the most successful dysrhythmia was VT, and 21% of male patients transferred to hospital survived. 13.5% of all male patients transferred to hospital survived when in VF, followed by 14% when presented as 'other', and only 2.5% of males survived when in PEA.

For female patients transported to hospital, most survivors were seen when recorded in VT with 25% surviving. This was followed by VF, with a survival rate of 11.7%, PEA at 7.8% and 'other' at 6.9%.

| Dysrhythmia | Male Percentage | Female Percentage |
|---|---|---|
| VT | 21 | 25 |
| VF | 13.5 | 11.7 |
| PEA | 2.5 | 7.8 |
| Other | 14 | 6.9 |

Table 30 ECG1 breakdown of male and female survivors of VT, VF, PEA, and 'other' dysrhythmias

Chi-square analysis of all ECG1 survivors is shown in Table 31. Where all cardiac arrest dysrhythmias are analysed there is an extremely high statistical significance with a P-value of <0.0001, indicating survival is dependent on presenting cardiac arrest dysrhythmias.

| | Survived | Survived expected | O - E | Diff Squared | $\chi 2$ | probability |
|---|---|---|---|---|---|---|
| Asystole | 1 | 44 | -43 | 1849 | 42.022 | |
| VT | 5 | 2 | 3 | 9 | 4.500 | |
| VF | 105 | 82 | 23 | 529 | 6.451 | |
| PEA | 14 | 32 | -18 | 324 | 10.125 | |
| Other | 19 | 17 | 2 | 4 | 0.235 | |
| total | | | | | 63.333 | <0.0001 |

Table 31 ECG1 Chi-square analysis of survivors that initially presented in the dysrhythmias asystole, VT, VF, PEA and 'other' dysrhythmias.

ECG2 of all cardiac patients transferred to hospital recorded as VT, VF, PEA, and 'other' dysrhythmias were analysed to detect the percentage of survivors in both male and female patients (Table 32). Of all male patients transferred to hospital, a significant 32% survived when in VT. This was followed by 26% when in a dysrhythmia described as 'other', 14.7% when in VF and 3.7% when in PEA. For all females transported to hospital, their second ECG showed that most survivors occurred when VT was present (33%). Patients in VF had the second highest survival rate at 16%, followed by 'other' at 14% and PEA at 4%.

| Dysrhythmia | Male Percentage | Female Percentage |
|---|---|---|
| VT | 32 | 33 |
| VF | 14.7 | 16 |
| PEA | 3.7 | 4 |
| Other | 26 | 14 |

Table 32 ECG2 breakdown of male and female survivors of VT, VF, PEA, and 'other' dysrhythmias

Chi-square analysis of all ECG2 survivors is shown in Table 33. Where all cardiac arrest dysrhythmias are analysed there is an extremely high statistical significance with a P-value of <0.0001, indicating survival is dependent on presenting cardiac arrest dysrhythmias. An analysis and discussion of these results will be performed in the next chapter.

| | Survived | Survived expected | O - E | Diff Squared | $\chi 2$ | probability |
|---|---|---|---|---|---|---|
| Asystole | 0 | 79 | -79 | 6241 | 79.000 | |
| VT | 11 | 4 | 7 | 49 | 12.250 | |
| VF | 62 | 42 | 20 | 400 | 9.523 | |
| PEA | 14 | 37 | -23 | 529 | 14.290 | |
| Other | 45 | 21 | | | 27.428 | |
| total | | | | | 142.491 | <0.0001 |

Table 33 ECG2 Chi-square analysis of survivors that presented in asystole, VT, VF, PEA, and ‘other’ dysrhythmias on their final ECG recording

# CHAPTER 5

# DISCUSSION AND CONCLUSION

# 5.0 DISCUSSION AND CONCLUSION

## 5.1 Overview

This study initially examined 9881 cardiac arrest histories of patients from January 1996 to November 2004. Cardiac arrest was due to both primary and secondary causes. Some of the primary causes of cardiac arrest included acute myocardial infarction (AMI) and ischaemia. Secondary causes included respiratory conditions, blunt and penetrating trauma, and self harm.

Within the 9881 cardiac arrest patients, all ages were included. Evidence suggests that risk and survival factors for paediatric cardiac arrest differ from those of adult cardiac arrest. Nadkarni et al. (2006) recognised in their study that paediatric cases had far better survival rates for all cardiac arrest showing PEA, asystole, VF or VT. Therefore, it was appropriate to remove all patients under the age of eighteen from this present study, thus reducing the number of patient records analysed to 9505.

Out-of-hospital cardiac arrest is a leading cause of death in first world countries (Meyer et al. 2000). Research suggests there are a number of risk factors that contribute to cardiac arrest. Thogeirsson et al. (2005) states that a 'major risk factor is MI and coronary heart disease (CAD)', and this significantly increases risk. Thomas et al. (2002) further developed terms in their study that describe age and gender as 'fate factors', and the

provision of early CPR, defibrillation, and advanced life support as 'program factors'.

### 5.2 Survivors v Deceased

This present study determined that of the 9505 cardiac arrest patients, 9286 patients died and 219 patients survived. This study highlighted that only 2.3% of all cardiac arrest patients survived to leave hospital. This finding mirrors those of Meyer et al. (2000) and Jennings et al. (2006) who reported that the incidence of cardiac arrest survival rates may be as low as 3% in Australia. Herlitz et al. (1997) reported survival rates in Sweden at just 1.2% surviving to hospital discharge.

Jennings and Pasco (2001) suggest survival rates of 4.3%. However, they also stated that 19.1% of patients were admitted to hospital alive. This statement reflects the fact that 19.1% of patients were transferred to hospital, but whether they were actually clinically alive, or in a state of cardiac arrest and receiving CPR, is not clarified. If these patients were merely in transit to hospital, then these findings would be comparable to this present study, where 22.3% of patients were transported to hospital.

Our study also showed that of all cardiac arrest patients 75.4% were declared dead on scene. This illustrated that 7382 people died from cardiac arrest at the time of, or during a short period after they initially collapsed. Similar findings were observed in other studies which showed

extremely high percentages of patients dying on scene from cardiac arrest, (Thorgeisson et al. 2005; Stiell et al. 2004).

De Maio et al. (2001) examined the termination of treatment for out-of-hospital cardiac arrests. In their study they found 52% of cardiac arrest patients were terminated on scene. However, although this figure is significantly lower than found in the present study, only those patients with cardiac aetiology were included in their study and therefore it is not possible to compare significance.

### 5.3 Gender

It was reported here that males accounted for 67.9% of all cardiac arrest patients and females accounted for the remaining 32.1%. This suggests that there is a greater risk of males suffering out-of-hospital cardiac arrest. Albert et al. (1996) reported that gender differences in out-of-hospital cardiac arrest were males 76.3% and females 23.7%. Their findings suggested that this ratio related to risk factors such as coronary artery disease (CAD) being higher in males than females. In fact, 80% of those males studied had CAD, and the remaining 20% had primarily cardiomyopathy (10%) and valvular heart disease (Albert et al. 1996). These results would suggest that perhaps similar risk factors in males were prevalent within this present study. In actual figures, 6456 cardiac arrest patients were male, compared to 3049 female patients.

Of the 9505 patients, 2123 were transported to hospital. The gender ratios

were only slightly different to the total cardiac arrest figures. Males accounted for 70.1% versus 29.9% of females. Of the total surviving patients (219), 74% were males (163 patients) and 25.6% were females (56 patients). There are only minor percentage changes within these categories. Therefore, these results reflect the same underlying risk factors that account for the gender statistics seen in the Albert et al. (1996) study, namely coronary artery disease.

Chi-square analysis showed that of those patients transferred to hospital, fewer males died than was statistically expected. Results indicated that 1335 males were expected to die, but a slightly lower figure of 1325 died. Analysis also showed that more females died than was statistically expected. Results showed that 563 female patients were expected to die, but there were actually 579 cardiac arrest deaths. However, Chi-square analysis showed that although the expected deaths were different among gender, there was no statistical significance between gender differences and death (P= 0.6171). These results showed that the death rate percentages of both genders were very similar, with 89% of male patients compared to 91.2% of female patients dying.

Chi-square analysis indicated that more males survived than was statistically expected, with 163 cardiac arrest survivors compared to the expected 154 patients. Additionally, fewer females survived than was statistically expected, with only 56 survivors compared to the expected 65

patients. However, although these expected values differ, there was no statistical significance in relation to gender difference and survival of cardiac arrest (P=0.1833). These results showed that the survival rate percentages of both genders transferred to hospital was similar, with an overall survival rate of 10.3%, of which 11% were male patients compared to 8.8% of female patients surviving cardiac arrest.

## 5.4 Age

The ages of all patients were analysed within this study to identify any age group significance in surviving cardiac arrest. Swor et al. (2000) investigated whether age is an 'independent predictor of survival' in patients sustaining an out-of-hospital cardiac arrest. Overall, they found that patients aged 40-49 and 50-59 experienced the best survival rate to hospital discharge at 10%. Other results from the study by Swor et al. (2000) showed a decline in successful resuscitation with increasing age; 8.1% for ages 60-69, 7.1% for ages 70-79, and 3.3% for ages 80+. They concluded that there was a 'two fold decrease in survival with patients ages 80+'.

Within this present study, the initial group containing all cardiac arrest patients recognised the largest numbers of cardiac arrest patients were seen in the age group 70-79 years of age. This was 2426 individuals and represented 25.5% of all patients. The next significant age group was 80-89 years of age with 18.2% (1728 patients), followed by 60-69 years of age

with 16.9% (1611 patients) and 50-59 years of age with 11.5% (1096 patients). Younger age groups showed similar results to the study by Swor et al. (2000), but the least represented group was the age group 90+ with 3.8% (359 patients). These results would concur with recognised high risk groups of patients (Swor et al. 2000)

Where patients were transferred to hospital, similar ratios were identified to the results found by Swor et al. (2000). The highest age group noted was again 70-79 years of age with 26% (559 patients), followed by 60-69 years of age 20.6%, (438 patients) 80-89 years of age with 15.3% (324 patients) and 50-59 years of age 14.2% (301 patients). The remaining age groups also showed similar results to the study by Swor et al. (2000). Therefore, it seems that patients aged 70-79 remain consistent, with those that die on scene and those that are transported to hospital changing little and as such show no age predictors of survival. There were changes seen in the age group 60-69 years of age with an increased percentage of patients transported to hospital from 16.9% to 20.6% of initial cardiac arrests. This means that of this age group, there was an increased chance of transportation to hospital, and as such chance of survival.

There was a reduction from 18.2% of patients initially arresting to 15.3% of patients in the age bracket of 80-89 years of age transported. This may indicate that of all calls to this age group, fewer numbers will be transported to hospital because they have died on scene. Similar results

were seen with the remaining age groups. However, Chi-square analysis showed that there was no statistical significance between age and death from cardiac arrest (P=0.9148) in this study.

Of the survivors, 27.9% were in the age group of 70-79 years of age. Again this is consistent with categories already discussed. There was a significant increase of survivors aged 60-69 and 50-59 years of age with 26.5% (58 patients) and 19.2% (42 patients) respectively. However, there is a decline in the age group 80-89 years of age with 9.1% (4 patients) surviving.

Although this study showed different survival rates to the study by Swor et al. (2000), it did show that all age groups of 40-49, 50-59, 60-69, 70-79, and 80-89 had a reasonable chance of survival. Therefore, age alone is an unlikely predictor of survival. However, it is shown that age is a significant contributor to high numbers of cardiac arrests, with the majority being in the 70-79 age brackets and the minority being in the 30-39 years of age bracket. Swor et al. (2000) concluded that although their study showed survival rates more prevalent with 40-59 year olds, they indicated that resuscitation for 60+ was not futile.

This present study indicated through Chi-square analysis that there were a greater number than expected of patients transported who survived within the age group 40-79. Analysis also showed that those survivors

transported in the 18-39 and 80+ age groups were fewer in number than statistically expected to live. These figures are consistent with the Swor et al. (2000) findings.

This present study also explored the survival rates of both males and females aged 40-49. Of all males transported to hospital, those aged 50-59, 15% survived compared with those aged 40-49 who had a survival rate of 14.8%. This would certainly mirror Swor et al. (2000) findings. Additionally, there were similar results in those patients aged 60-69 (13%), and 70-79 (12%).

Of those females transported to hospital, those patients aged 60-69 had the best survival rate at 13.7%. However, other age group results were different to those of male patients transferred to hospital. Female patients aged 70-79 showed a survival rate of 8.5%, followed by patients aged 50-59 at 7.8% and patients aged 40-49 at just 4%.

The combined survival rate for male patients transferred to hospital aged 40-79 was 13.4%, and for female patients was 9.2%. Of all male and female patients aged 40-79 the survival rate was 12.35%. Chi-square analysis showed that there was high statistical significance that indicated survival was related to age ($P= <0.0001$). Therefore, our study would certainly agree with Swor et al. (2000) that resuscitation attempts for all age groups are not futile, where the viable patient is transferred to hospital.

The results of this study may reflect the conclusions found by Vaccarino et al. (1999) which indicated age and survival of cardiac arrest was directly related to the risk factors of MI. In addition, they also found that among patients less than 50 years of age, the mortality rate for the women was more than twice that for the men.

### 5.6 Cardiac Arrest Dysrhymias

It is recognised that the chances of successful resuscitation deteriorates with each passing minute (Resuscitation (UK) 2006). Where a patient is in a shockable ECG rhythm, i.e. pulseless VT and VF, then early defibrillation is the definitive treatment (Meyer et al. 2000). Therefore, it was seen as important to review presenting primary and secondary cardiac dysrhymias in this study.

#### 5.6.1 Normal Sinus Rhythm

Normal sinus rhythm (NSR) represented relatively low numbers of cardiac arrest patients. At the first ECG, 136 patients were recorded with NSR. This represented 1.4% of the total cardiac arrest patients. Of those transported 126 patients were in NSR on their first recording, and of those survivors, 43 were in NSR.

The second recorded ECG, showed 0.9% (90 patients) of all cardiac arrest patients presented in NSR. Of those patients transported to hospital, 89 patients (4.2%) were in NSR. Finally, of the survivors, 17% (38 patients) where recorded as having a NSR at some stage during their cardiac arrest.

As such, this suggests rapid intervention by ambulance officers with ALS at some time during their treatment.

Chi-square analysis indicated that in the first recorded ECG, fewer cardiac arrest patients (NSR) died than was statistically expected whereas in the second recorded ECG, statistically more patients died than expected. However, the difference between the expected and actual deaths in ECG2 varied only very slightly (51 died, 46 expected). In both ECG1 and ECG2 survival rates were higher than expected. All patients identified as being in NSR would have been alive. These patients would have reverted to cardiac arrest dysrhythmias. The cardiac arrest may have followed NSR, or the patient may have reverted to NSR following treatment. Therefore, where survival of cardiac arrest occurs after or before NSR, it would suggest that early intervention of ALS and defibrillation was critical to survival.

### 5.6.2 Tachycardia

A low number of patients were seen to be tachycardic at some point in their cardiac arrest. In ECG1, 1.2% of all patients were tachycardic (110 patients). As a percentage of those patients transferred to hospital, this increased to 5.0% (106 patients). Of those that survived, 7.3% of patients were shown to have tachycardia at some stage. This represented 16 patients.

Results of all cardiac arrest patients, at their second ECG recording, showed that just 0.8% (79 patients) were tachycardic. Of those transferred to hospital, 77 patients were transported, representing 3.6% and 20 patients (9.1%) survived. As with NSR these patients would have at some time been in another cardiac arrest rhythm. These results suggest that few patients are recorded as having tachycardia prior to or after cardiac arrest.

In ECG1, Chi-square analysis indicated that survival rates were slightly fewer than that expected. However, the second recorded ECG showed significantly fewer patients died than expected. This would suggest survival where tachycardia is present is relatively good. This is additionally supported by Chi-square analysis of survival rates. In both ECG1 and ECG2 survival was dramatically increased from that expected.

### 5.6.3 Bradycardia

Of all cardiac arrest patients, 2% (192 patients) were recorded as being bradycardic on their first ECG. Of those transferred to hospital, 168 patients represented 7.9%. This decreased to 4.6% (10 patients) of those patients that later survived to leave hospital.

The second recorded ECG showed that 0.8% (165 patients) of all cardiac arrest patients were bradycardic. Of those transferred to hospital, 7.4% (157 patients) were bradycardic, and 9.1% (20 patients) were among those listed as survivors.

Chi-square analysis of ECG1 showed that more patients died than expected and with ECG2 only marginally fewer patients died. Survival rates however, showed that on ECG1 fewer patients survived, but on ECG2 more patients survived than expected. This suggests that survival is possible where symptomatic bradycardia is present after or before cardiac arrest.

However, these results would suggest that only a small number of cardiac arrest patients are recorded as bradycardic. Similar to tachycardia, these dysrhythmias cannot be ruled out as a pre-warning, or a peri-dysrythmia of cardiac arrest (Resuscitation Council (UK) 2006).

### 5.6.4 Ventricular Ectopic Beats

Ventricular ectopic beats (VEB) were rarely recorded throughout all ECG recordings. VEB were seen in only 0.1% (9 patients) of all cardiac arrests. Similar low numbers of patients (8 patients) were transported to hospital and this represented just 0.4%. Of those that survived, only 6 patients had recorded VEB on their first ECG, and 9 patients had VEB on their second ECG.

Chi-square analysis showed that at both ECG1 and ECG2 there were significantly fewer patients who died than was expected. Additionally, both ECG recordings showed that survival rates were significantly higher

than expected. These results suggest that VEB, although rarely recorded in the cardiac arrest setting, has an excellent prognosis. However, VEB may accompany other dysrhythmias, which may vary from the occasional one seen on the ECG, to many VEB. The "Universal Algorithm" acknowledges that increasing VEB may be a warning of possible cardiac arrest, especially in the setting of symptomatic bradycardia, (Resuscitation Council (UK) 2006)

### 5.6.5 Ventricular Fibrillation

VF is recognised as a shockable rhythm (Handley, 2005), and as such, early defibrillation is the key to successful resuscitation. Of all patients, VF was seen in 1212 patients (12.8%) on their first ECG recording. Of those cardiac arrest patients transported to hospital, 792 patients (37.3%) were at some point in VF. Of all survivors of cardiac arrest, 105 patients were recorded as having VF, and this accounted for a massive 47.9%.

The second ECG recordings showed that of all cardiac arrest patients, 5.2% (495 patients) were in VF. It was seen that the number of patients in VF had declined from the number seen in ECG1. This would have been as a result of VF changing into other dysrhythmias such as asystole. For those that were transported to hospital, 19.3% (368 patients) were in VF, and of the survivors, 28.3% (62 patients) were in VF.

Chi-square analysis recorded significantly fewer patients died than expected on both ECG1 and ECG2. Additionally, significantly more patients survived than statistically expected. These results indicate excellent survival chances where the patient is in VF.

This present study has presented evidence that VF was a major factor in survival of a cardiac arrest. The first recorded ECG of those that survived accounted for 47.9% of all survivors. Further analysis also showed that of those males transported to hospital, 13.5% survived on ECG1 and 14.7% survived on ECG2. Additionally, female survival rate was good with a survival rate of 11.7% on ECG1 and a survival rate of 16% on ECG2. This would suggest that early treatment of VF with ALS/BLS and defibrillation has an extremely good outcome.

This study has shown that survival of VF depends on the early appropriate treatment. This has been recognised and demonstrated in many studies (De Maio et al. 2005; Thorgeisson et al. 2005; Absalom et al. 1999). Stiell et al. (2004) go further and stress that 'in order to save lives, health care planners should make CPR by citizens and rapid defibrillation responses a priority for the resources of emergency medical services systems'. In addition, White et al. (1996) concluded that 'when shocks resulted in ROSC, the overwhelming majority of patients survived (96%)'. This present study also recognised the importance to early access to medical assistance and the recognition and appropriate treatment of VF.

#### 5.6.6 Ventricular Tachycardia

VT was recorded on only a few occasions. With all cardiac arrest patients, the first and second ECG recordings reported 0.3% and 0.4% respectively (26 and 37 patients). Of those cardiac arrest patients transferred to hospital, the first ECG showed 1.1% (23 patients) and the second 1.6% (34 patients) were in VT. For those that survived, 2.3% were in VT at the first ECG recording and the second ECG recording showed 5.0% in VT (11 patients).

Chi-square analysis suggests similar results for those patients that died and those that were expected to die. However, analysis also indicated that survival rates were better than expected. Where patients were taken to hospital, it was seen that males had a survival rate of 21% on their first ECG, and a significant 32% on their second ECG. Female patients showed equally good survival rates at 25% on ECG1 and 33% on ECG2. Therefore where VT is present, and although not often recorded, it has a reasonable outcome.

This present study suggests that VT is rarely seen in the out-of-hospital cardiac arrest setting. Jennings et al. (2006) also documented similar findings in their study, suggesting VT is extremely rare as the presenting cardiac rhythm.

### 5.6.7 Pulseless Electrical Activity

PEA was recorded in 4.3% of all cardiac arrest patients on their first ECG. This accounted for 408 patients out of all cardiac arrest patients. Similar figures were seen on second ECG recording, which resulted in 421 patients in PEA (4.4%). Of those transferred to hospital, 14.6% (310 patients) were in PEA and the second ECG recording reported 17.3% (368 patients) in PEA.

Of the survivors, the number of patients with PEA remained constant at 6.4% (14 patients) with PEA seen in both ECG recordings. Jennings et al. (2006) recorded a much higher incidence of PEA, quoting 27.8% of all cardiac arrest patients. Differences between these results and those found in this present study may be due to differences in ambulance activation/response times, and/or the standard procedure of sending two or more ambulances to the incident in the metro area of Melbourne. Additionally, ambulance officer recognition of PEA may differ and this would account for higher percentages found in the study by Jennings et al. (2006).

Chi-square analysis showed that in both ECG1 and ECG2 recordings more patients died than was statistically expected. In addition, both recordings showed that fewer patients survived than expected. When further analysis was undertaken, male patients that were transferred to hospital

showed only a 2.5% survival rate on their first ECG, and only slightly better on the second ECG with a survival rate of 3.7%. Female patients had better results, and their survival rate was 7.8% on the first ECG recording, dropping to 4% on ECG2.

Results suggest that although PEA is classified as a survivable dysrhythmia, survival prognosis is not good. Patients in PEA, often have 'some mechanical myocardial contraction but are too weak to produce a detectable pulse or blood pressure', (Resuscitation Council (UK), 2006). Rapid and early intervention may make a difference to survival to correct the underlying cause of PEA. Therefore, the results seen in our study are reasonable, and may largely be due to ambulance activation times, and transfer distances, thus delaying essential time required for definitive care.

#### 5.6.8 Other Dysrhythmias

Other dysrhythmias are those ECG recordings that the ambulance officer is unable to recognise or categorise. There were a number of 'other' dysrhythmias noted on both the initial and subsequent ECGs. 459 patients represented 4.8% of the total number of cardiac arrest patients on the first ECG. 383 patients on the second ECG represented 4.4% of all patients.

Of those transported to hospital, 165 patients (7.8%) were categorised as 'other' and this increased to 205 patients (9.7%) on the subsequent ECG. Of the survivors, 'other' was recorded on 19 patients (8.7%) on the first ECG and 45 patients (20.5%) on their second.

Chi-square analysis of ECG1 showed the expected numbers of patients that died, and similar expected survival rates. However, on ECG2 significantly fewer patients died than was expected. Additionally, significantly more patients survived than was expected. Analysis also showed that 14% of male patients on ECG1 and 25% of male patients on ECG2 survived when transported to hospital. Female patient survival rates were less, but they still had a survival rate of 6.9% on ECG1 and 14% on ECG2. These results would suggest that some of these unrecognisable cardiac rhythms may have actually been the rhythms associated with good outcome, i.e. VF (47.9% of survivors, 105 patients) and VT (2.3% of survivors, 5 patients).

It seems that ambulance officers recorded a fairly substantial number of cardiac dysrhythmias that they were unable to categorise. Many of those patients who later survived to leave hospital had been placed into this category. Perhaps, those dysrhythmias that were seen on the ECG monitors were a number of different arrhythmias and very hard to categorise with certainty. This would certainly suggest that there needs to be an emphasis on ambulance officer education and training to adequately recognise and diagnose ECG dysrhythmias. However, for the purpose of this study, it was assumed that if the patient had an ECG recording of PEA or 'other' dysrythmia, then some electrical activity was seen on the ECG monitor. Therefore, this could not be classed as asystole, and thus not reflect any bias in the overall hypotheses.

### 5.6.9 Asystole

The results showed that asystole accounted for 73.2% of all cardiac arrest patients. This meant that of 9505 cardiac arrest patients, 6953 were recorded as asystolic on arrival of the ambulance officer and declared deceased on scene. These patients were recognised as having no chance of survival after receiving a period of CPR if appropriate, i.e. not obviously dead. Of the asystolic patients, 425 were transported to hospital. The clinical practice guidelines of St John Ambulance (WA) would suggest that these 425 patients would have been in another initial dysrythmia associated with survival before reverting into asystole, i.e. VF or VT. Therefore, the 425 asystolic patients represented 20% of all patients transferred to hospital. However, of the total number of patients this figure represents only 6% of all asystolic patients that eventually get transferred to hospital. That is, only 425 patients of the total 9505 patients. Of possible significance, of all survivors, only one patient was recorded as being in asystole (0.1%).

The patient's second ECG of all patients showed an increase to 82.3% being asystolic. Therefore, indicating an increase in number of patients from 6853 to 7818. This meant that there was a change in ECGs from the first to the second that would have converted from other dysrhythmias to asystole. This may have resulted from ALS treatments, such as defibrillation, that may have changed a previous dysrythmia to asystole.

Of those patients transferred to hospital there was a further increase in asystole shown on the second ECG recordings. This present study showed a rise in asystolic cardiac arrest patients transferred to hospital from 425 to 766 (20% to 36.1%). However, of the total number of patients, this figure represents only 9.7% of all asystolic patients transferred to hospital, i.e. 766 patients of the total 9505 patients. In addition, the increase in asystolic patients in ECG 2 is due to other dysrhythmias changing to asystole as the resuscitation attempts fail, i.e. VF reverting to asystole following defibrillation. Comparative figures from other studies differ from those found in this study due to different treatment options of the asystolic patient at the scene by ambulance officers. This results in many officers terminating resuscitation attempts at the scene and therefore the asystolic patient does not get transferred to hospital.

In this study, of those patients that survived, no patient had a second ECG reading of asystole. This would suggest that the initial cardiac dysrhythmias of asystole were reverted by early intervention, or that asystole was transient such as seen in myocardial stunning shown after defibrillation (Resuscitation Council (UK), 2006). These results would also suggest that no patient survived extended periods of asystole.

Chi-square analysis showed that on both ECG1 and ECG2 there were significantly more patients that died than statistically expected. Additionally there were significantly fewer patients surviving than

statistically expected. ECG1 showed that 424 patients died with only 1 shown as surviving. However, ECG2 shows that 766 patients died and there were no survivors. This indicates that the one asystolic patient that was recorded as alive, eventually had died in ECG2, or had reverted to another dysrythmia. Therefore, not one patient (0%) survived to leave hospital where their ECG recording remained in asystole for a prolonged period of time.

A study by Engdahl et al. (2000) studied the survival chances of patients in asystolic out-of-hospital arrests in Sweden. In their study of 4662 cardiac arrest patients, they reported 35% of patients 'were judged as having asystole as the first-recorded arrhythmia'. This figure is higher than the 20% recorded in this present study. There is no obvious reason why this is so, as similar to our study, Engdahl et al. (2000) combined all cardiac arrest cases regardless of aetiology or age. Additionally, both countries have almost identical rates of cardiac disease with 110.9 per 100 000 people in Australia suffering CAD compared to 110.1 per 100 000 people in Sweden (WHO, 2006). However, of the 35% of cardiac arrest patients, 10% were transferred 'alive' to hospital and 2% were discharged from hospital alive. Their final results mirror those found in this present study where the survival rate from all cardiac arrests was 2.3%.

### 5.6.10 Chi-square analysis of dysrhythmias

Chi-square analysis indicated patient expected survival and death rates for each dysrythmia. Of all patients transferred to hospital, there was no statistical significance in the initial dysrythmia seen in ECG1 and death (P=0.0623). Therefore, this study showed that the presenting rhythm was not an accurate indicator of patient outcome. However, analysis of ECG2 showed that there was statistical significance in predicting those patients that died and their final (ECG2) recording (P= 0.0084). These results would suggest that where patients remain or revert to a subsequent dysrythmia after initial treatment, their survival is more predictable.

Analysis of ECG1 and ECG2 on all survivors showed that survival was related to the presenting dysrythmia. Chi-square results showed this analysis to be highly statistically significant with both results showing P= <0.0001. In addition, there was also statistical significance where analysis was undertaken on all patients transferred to hospital with asystole, VF, VT, PEA, and 'other'. Both ECG1 and ECG2 results showed P= <0.0001. These results confirm that survival is related to patient dysrythmia.

### 5.6.11 Conclusion

This present study has shown that irrespective of gender, cardiac arrest was reported in all age groups whether young or old. It has also shown that statistically men are approximately twice as likely to have a cardiac arrest as women (67.9% male, 32.1% female). However, analysis shows

that there is no statistical significance in the number of deaths of male patients over female patients (P= 0.6171). Additionally, analysis indicates that there is no statistical significance in survival of female patients over male patients (P= 0.1933).

Our study has indicated that females in the age group of 60-69 had the greatest chance of survival from cardiac arrest. For male patients, our study has shown those aged 40-79 had good survival rates from cardiac arrest. However, the age of the patient was not an indicator for predicting death. This study showed no significance in ages of those patients transferred to hospital that subsequently died (P= 0.9148). However, there was statistical significance of patients survival and age (P= 0.0017), which suggests survival may be related to the age of the patient.

ECGs were recorded twice on each patient. Analysis showed that there were many different cardiac arrest and peri-arrest dysrhythmias recorded. Chi-square analysis showed that survival was dependent on the initial ECG and subsequent ECG dysrythmia (P= <0.001). However, analysis comparing death and dysrhythmias was not as conclusive. On ECG1, P= 0.0623, indicated that death was not related to the first recorded dysrythmia. These results may occur because initial recorded dysrhythmias such as VF and VT may have reverted quickly after definitive treatment, e.g. defibrillation. However Chi-square analysis showed that subsequent ECG recordings were highly significant in

predicting death (P= <0.001). These results would indicate that death is related to prolonged dysrhythmias and is associated with poor outcome.

Where individual dysrhythmias were reviewed, VF was seen in a large number of patients that later went on to survive their cardiac arrest. Both male and female patients survived equally well when presenting in this dysrythmia. This supports evidence that early treatment such as BLS, ALS and defibrillation of VF has a reasonable outcome if it is a witnessed arrest, or if the time of collapse to arrival of CPR or defibrillator is not delayed.

Results also indicated that although VT is rarely recorded in cardiac arrest, both male and female survival rates were significant. However, there were few survivors of PEA, although evidence suggests that transport to hospital is appropriate. This present study also highlighted a large number of cardiac rhythms that the ambulance officer was unable to accurately identify, and so was titled 'other'. Survival rates from this group was also significant and therefore, we can conclude where the ECG is unrecognisable by the officer, transportation to hospital is appropriate.

Asystole was seen in large numbers of patients in cardiac arrest. Over 75% were not transported and reported as being in asystole. Of those transported, 20-36% were at some stage in asystole. Of all survivors no patient (0%) was seen to be in asystole on arrival at hospital. Studies such

as by Engdahl et al. (2000) reported that survivors of asystole were young (<58 years of age), had a witnessed arrest, had shorter intervals between collapse and the arrival of an ambulance, and were less likely to have non-cardiac aetiology of cardiac arrest.

This present study's findings suggest that patients in long term asystolic arrests (20 minutes+) do not survive to leave hospital. Therefore, the transport of the asystolic patient to hospital for this patient group appears to be inappropriate. Treatments at the scene by by-stander CPR and ambulance officers will often determine whether a patient is likely to survive their cardiac arrest. This is certainly reiterated by other ambulance services around the world that treat the asystolic patient using the "Universal Algorithm" at the scene and transfer only those patients who have a real chance of survival.

# CHAPTER 6

# FUTURE RESEARCH

# 6.0 FUTURE RESEARCH

This study reviewed current practice in the treatment of asystolic cardiac arrest by St John Ambulance (WA). It is important that evidence based medicine is conducted in the prehospital field. This study has questioned just one area of patient management.

However, it is vital that other areas are reviewed. It is seen that cardiac arrest has a poor outcome and further research is required to increase patient survival and/or understand risk factors. Areas of future study include reviewing whether there is a connection between the number of deaths/survivors to the day of the week, the importance of arrival at the scene and to the hospital in relation to survival, the implementation of cardiac arrest drugs, and if there is any connection between patient's residence and survival.

# CHAPTER 7

# REFERENCES

## 7.0 REFERENCES


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