# CHAPTER 1: INTRODUCTION

## 1.1 BACKGROUND

This study focuses on medical flight crew working on a fixed-wing air ambulance service that operates out of South Africa into sub-Saharan Africa.

To join an air medical service, medical personnel are expected to be competent in numerous life-saving skills. The minimum skills required are set by the relevant program and guided by their set standards (Davidoff, 2006).

Within the specific air medical service in which the study was conducted, standards and therefore skills are guided by the Commission on Accreditation of Medical Transport Systems (CAMTS). CAMTS is a consortium of professional organizations whose goal is to offer a voluntary evaluation of compliance to set accreditation standards.

These standards demonstrate the ability to deliver patient care of the highest quality in a safe transport environment (Davidoff, 2006). CAMTS requires that all medical flight crew remain current in certain courses. These courses include the American Heart Association's Advanced Cardiac Life Support (ACLS) and Paediatric Advanced Life Support (PALS) (CAMTS, 2006).

Medical flight crew need training and skills to manage complications that may arise during transport. They should not only be able to continue existing care but have the skills and authority to alter treatment protocols. The aim is to attempt to at least match the level of management the patient will require at the receiving facility. In additional to their medical training, the crew should also be trained in acute care medicine, aviation physiology and have experience in resuscitating patients within a confined space. (Munford, Roby & Xavier, 2006).

As in any medical field, patient safety is a priority. One of the factors that ensure patient safety is the clinical skill and judgment of the medical personnel. Clinical judgment is directly related to training, knowledge and experience. (Lasater, 2007).

The author has a personal interest in the process of the training of medical flight crew in South Africa, in particular, the specific air ambulance service. Presently it is assumed that because medical personnel are certified to perform certain skills, they have the ability to perform these life-saving skills within the air medical environment. However, the air medical environment is a unique environment with its own set of challenges that may influence the efficiency and safety of the performance of certain skills (Martin, 2003; Holleran & Houlston, 2010). In the author's personal experience, the various reasons include the fact that the air medical environment provides medical crew with its own unique set of challenges like limited space and equipment, stressors of flight, additional safety concerns, etc (Martin, 2003). Secondly it may be because the training that the medical crew receive does not reflect the real world of aviation medicine.

There may be value in providing simulation based learning so that medical flight crew remain proficient in the necessary skills required.

### 1.1.1 Simulation

Simulation has had a major impact on training in diverse fields such as aviation, space flight, locomotive driving, ship handling, fire fighting, combat and operation of nuclear power plants (Eaves & Flagg, 2001). The earliest description of simulation is in the sixth century AD, where the game of chess was used to simulate battlefield tactics (Perkins, 2007).

The earliest evidence of medical simulation is in the physical models of anatomy and disease that were constructed long before the development of modern plastic. Medical education developed through the 1900s from a simple apprenticeship to demanding objective measures of competence in domains of knowledge, skills and behavior. However the concept of deliberate practice to acquire and retain skills was a recent development and human patient simulation was introduced at the end of the $20^{th}$ century. The innovations in resuscitation, technology and plastic have been synonymous with the development of medical simulation. Despite the fact that many simulation modalities were already described almost 50 years ago, standardized patients, virtual reality and mannequins have only been widely accepted in the past decade. (Rosen, 2008).

Simulation is an educational process that can be used to evaluate the professional competencies regardless of the level e.g. student, new graduate or seasoned professional (Decker, Sportsman, Puetz & Billings, 2008). There is an increasing appreciation of the role of simulation in the teaching and assessment of clinical skills (Stamper, Jones & Thompson, 2008).

## 1.2 IMPORTANCE OF THE STUDY

One of the life-saving skills that air medical crew are expected to perform is synchronized cardioversion. It is one of the skills that both the ACLS and PALS courses expect students to be competent in. In the author's personal experience it is, however, a skill very seldom performed or practised within the normal medical environment and even less in the air medical environment.

Because the air medical environment has its own unique set of challenges, the proficiency of medical flight crew performing this skill within the specific aviation environment may be inadequate. The value of simulation-based learning (in contrast to the traditional orientation offered) will be assessed, with the aim of improving and/or maintaining proficiency within the air medical environment.

In this specific air ambulance service, training of air medical crew takes the form of theoretical courses, practical observation missions and orientation and training towards specific equipment and logistics. However, medical flight crew are not afforded the opportunity of practising life saving skills and/or medical intervention skills within the aviation environment.

The author hopes through this research to introduce the concepts of simulation based learning in the air medical environment to a leading air ambulance provider in South Africa.

## 1.3 PURPOSE

The purpose of this study is to assess the value of simulation based learning for medical flight crew in performing synchronized cardioversion efficiently, effectively and safely within the air medical environment.

## 1.4 PROBLEM STATEMENT

Medical crew may have difficulty in efficiently applying certain clinical skills in the air medical environment because they are not afforded the opportunity to practice these skills within this unique environment.

## 1.5 RESEARCH OBJECTIVES

1.5.1 To evaluate the skills in performing electrical synchronized cardioversion of the medical flight crew who have not been exposed to simulation based learning with reference to the specific skill within the air medical service.

1.5.2 To evaluate the skills in performing electrical synchronized cardioversion of the medical flight crew who have been exposed to simulation based learning within the air medical service.

1.5.3 To compare scene management by the medical flight crew who have experienced simulation based learning in relation to the crew who received standard orientation and training.

## 1.6 DEFINITIONS

### 1.6.1 Simulation

"Simulation is the imitation of some real thing, state of affairs, or process. The act of simulating something generally entails representing certain key characteristics or behaviours of a selected physical or abstract system" (http://en.wikipedia.org/wiki/Simulation, 2007).

### 1.6.2 Electrical Synchronized Cardioversion

Synchronized cardioversion is the delivery if an electrical shock that is synchronized with the QRS complex of the electrocardiogram. It is indicated for the treatment of unstable tachyarrhythmia when there is a perfusing rhythm (pulse). An unstable patient demonstrates signs of poor perfusion that includes decreased level of consciousness, hypotension, ongoing chest pain or other signs of shock. (AHA guidelines for CPR, 2005). Will also be referred to a synchronized cardioversion in the text.

### 1.6.3 Medical Flight Crew

For the purposes of this study, medical flight crew refers to Medical Doctors, Registered Nurses and Advanced Life Support Paramedics that actively work as health care practitioners in the air medical environment. In addition to their basic medical training they have all received additional training in amongst others, aviation physiology, ACLS and PALS. May also be referred to as Medical Crew in the text.

### 1.6.4 Aeromedical environment

For the purpose of this study, the aeromedical environment is the environment in which medical care is provided. The environment of this particular air ambulance service is pressurized cabins of fixed wing jets that cruise at altitudes of 35 000ft to 41 000ft. May also be referred to as the air medical environment.

### 1.6.5 Scene management

In this study, scene management refers to performing the needed skill whilst maintaining the safety of the patient and fellow crew members. This includes using multifunction pads instead of paddles to deliver the cardioversion shock and clearing the patient before the shock is delivered.

### 1.6.6 Multifunction pads

In this study, these are specific adhesive pads that are applied to the patient's chest through which electrical shocks are delivered when performing defibrillation and synchronized cardioversion. They form part of standard equipment supplied on this specific air ambulance. Also referred to as pads in the text.

# CHAPTER TWO: LITERATURE SURVEY

## 2.1 INTRODUCTION

Aviation, like medicine, may be considered a high-risk area, where even the smallest human error may cause significant incidents and accidents. In acute and emergency medicine, with its time constraints, it is vital to be able to immediately recognize critical situations, make the right decisions and react to sudden changes in a situation - and do so with zero error tolerance (4Rescue, 2009, editorial).

According to Bradley (2006), aviation and medicine require a high degree of technical proficiency. The field of aviation long ago recognized the hazards of an airborne trainee pilot who has not yet reached a certain level of familiarity and experience with the controls of the aircraft. Flight simulation has developed to such an extent that its cost rivals that of its real-life counterpart because of the importance given by the aviation industry to high-fidelity simulation in the training of pilots (Bradley, 2006).

In the literature review the author introduces the reader to the role that simulation plays in training of health care providers, how simulation based training contributes to patient safety and the advantages and challenges of simulation. There is also a brief discussion of some of the theoretical principles that are the foundation of simulation based learning.

## 2.2 SIMULATION IN TRAINING

Matveevskii and Gravenstein (2008) summarized the role that simulators play in training: it can be used to measure doctors' advanced diagnostic and therapeutic skills as well as their ability to integrate knowledge, clinical judgment, communication and team work. On review of the literature they drew the conclusion that simulation is better than traditional means of medical training in that it provides a safe environment for teaching and learning potentially risky procedures. It also allows for the opportunity to plan training opportunities as certain clinical events may be rare and unlimited exposure can therefore be planned. According to Perkins (2007), junior doctors' inability to recognize and manage critically ill patients is due to the reduction in clinical exposure, and simulation allows for controlled clinical practice without putting patients at risk.

### 2.2.1 Development of simulation in medical training

In 1963, a neurologist from the University of Southern California, started using patient actors to portray different patient conditions. This was however, not widely accepted as it was said to be too expensive and unscientific. In the 1970s there was the introduction of patient instructors who were patients with chronic stable conditions used to teach physical examination and diagnostic skills. This prompted a name change to the current standardized patients (SPs). Over the next few decades, the use of SPs was researched and developed to the extent that in 1993 the Medical Council of Canada was the first to incorporate SP examination into licensure. (Rosen, 2008).

The birth of medical simulation training in resuscitation was the creation of "Resusci-Anne" in 1960. This mannequin allowed trainees to practise airway opening, ventilations and chest compression. (Perkins, 2007; Rosen, 2008). Over the next few decades, simple plastic models were built to practice resuscitation, physical examination and procedural skills but it was not until the 1990s that advanced task training systems were developed (Rosen, 2008).

Simulation within the medical environment has, however to date, developed significantly, and the widespread acceptance of simulation in medical education has been because of the ability to demonstrate multiple patient problems, the consistency of the reproducibility of content and the ease of simulating a critical event, all within a safe environment (Bryson & Levine, 2008).

### 2.2.2 Types of simulation / simulators

There are many types of simulators in the medical field, all serving various functions. These vary from standard patients (SPs), where actors are used to evaluate skills like history taking, physical examination and communication skills, to procedural or part-task trainers, which are simple anatomical models of body parts used to demonstrate normal anatomy or disease processes and to develop basic psychomotor skills like intravenous cannulation, tracheal intubation and other simple surgical skills. Then there are computer and electronic patients. Computer patients are interactive, using software or internet virtual worlds that give visual, auditory and haptic feedback. Electronic patients are either mannequin or virtual reality based, but with replication of the clinical environment. These are often termed Full Environment Simulators (FES). (Perkin, 2007; Rosen, 2008).

The actual mannequin can also be classified from low to high fidelity, which refers to the degree of accuracy portrayed by the mannequin compared to the real phenomenon (Eaves, et al., 2001)

FES simulators attempt to immerse the student in the experience by ensuring that equipment, environmental and psychological realism is maximized (Brindley, Suen & Drummond, 2007). This replication of the environment, includes a patient, other health care professionals, ancillary equipment and supplies (Bryson et al., 2008). In addition to practising procedures, FES gives educators the ability to stage realistic scenarios in which human behavior and interaction may be the focus. Participants can make mistakes and the scenarios can have bad outcomes without actual patient harm. An adverse outcome may generate negative emotions and no health care professional wants to contribute to patient harm through a bad clinical outcome. (Bryson et al., 2008).

Bryson et al., (2008), looked at the use of FES in anaesthesia, and two approaches gained the most attention. The first was crisis resource management, which focused on human factors. In these staged scenarios, actors played roles of various operation room personnel and the principal issues were communication and leadership. The second used the mannequins more directly and actors were not required. The focus was the response to physiology and skill development.

## 2.3 SIMULATION AS AN EDUCATIONAL TOOL

"Patient simulators offer an exciting new frontier in transport crew education.... The ability for providers to rapidly assess a patient, initiate specific therapy, visualize response to therapy, and address complications in a controlled situation using a coordinated team approach, is what is unique about patient simulators." (Hutchinson & Stocking, 2006, p. 319).

Simulation is also an educational process that can be used to evaluate the professional competencies regardless of the level e.g. student, new graduate or seasoned professional The health care community has embraced simulation as a component of continuing education to master skills and provide training. Specific certification courses, e.g. Advanced Trauma Life Support and Advanced Cardiac Life Support, use simulation extensively in their standard curriculums. (Decker, et al., 2008).

### 2.3.1 Patient safety

As in any medical field, patient safety is a priority. In aviation medicine the safety of the transport team is essential but the safety of the patient being transported must be assured. The culture of safe practice in the aeromedical environment also includes the patient care. (Holleran et al., 2010).

The cramped quarters and proximity to sensitive electrical equipment has generated concerns about the safety of defibrillation (or synchronized cardioversion) in this environment. However, whether the aircraft is on the ground or in flight, defibrillation can be carried out without hesitation, provided that standard defibrillation precautions are observed. These standard precautions are that air medical personnel should follow the ACLS defibrillation standards for selection of energy levels (joules) and use self-adhesive monitor/defibrillation pads. The medical flight crew must also inform the pilot before defibrillation and stand clear of the patient and stretcher when discharging the current. (Holleran, 2003).

#### 2.3.2.1 Simulation and clinical skill and judgment

Another aspect that ensures patient safety is the clinical skill and judgment of the medical personnel. "In dealing with increasing patient complexity and technological advancement, transport nurses must rely on sound decision–making skills to deliver up-to-date evidence based care and help to facilitate positive patient outcomes." (Holleran, et al., 2010, p.16). As already mentioned, clinical judgment is directly related to training, knowledge and experience (Lasater, 2007).

According to Benner, Tanner & Chesla., (2006) in Lasater (2007, p.497), "Clinical judgment refers to the ways in which nurses come to understand the problems, issues, or concerns of clients / patients, to attend to the salient information and to respond in concerned and involved ways." The advances in high-fidelity simulation are now providing ideal arenas for clinical practice learning and an arena to develop the skill of clinical judgment (Lasater, 2007).

There is an increasing appreciation of the role of simulation in the teaching and assessment of clinical skills within the field of medicine. Clinical skill proficiency is essential for the safe delivery of health care. Medical simulation is increasingly being recognized as a valuable mechanism for training and assessing these skills. (Stamper, et al., 2008).

A patient's safety and well-being also depends on the health care practitioner's familiarity and experience with the instruments and equipment used in the health care setting, and the use of simulation can enhance proficiency and training while maximizing safety and minimizing risk (Stamper, et al., 2008).

### 2.3.2 Characteristics of simulation

Gredler (1994), in Eaves et al., (2001), describe simulation as having five major characteristics:

- It is problem-based learning;
- The subject matter, settings and issues presented are not usually textbook problems that have cut-and-dried answers;
- The participants perform functions associated with their specific roles and settings that they would usually find themselves in;
- Participants will realize the outcomes of the simulation are the consequences of their own actions; and

- Participants experience the reality of their roles and functions in that all roles are performed conscientiously, in a professional manner and with the associated responsibilities.

By providing a simulated learning experience that imitates the working environment, elements of the real world are integrated and the learner is required to demonstrate procedural techniques, decision-making and critical thinking skills to achieve specific goals. The scenario used must include all the critical elements necessary to validate competency. (Decker, et al., 2008).

## 2.4 ADVANTAGES OF SIMULATION

With simulation based learning, situations that are difficult to predict, and which large numbers of learners therefore rarely experience, can be created. This gives learners the opportunity to react on a scheduled basis to high-risk patient situations without concern for patient safety. This is particularly true where real-life experiences are discouraged due to the high risk to others. In certain situations, simulation may therefore be the only possible learning approach. (Decker, et al., 2008).

Stamper, et al., (2008) looked at the utilization and overall satisfaction among the users of a Trauma Simulation Training Centre located within the Brooke Medical Centre. This centre is capable of a wide range of medical simulations, including physical examinations, primary response actions, complex trauma, etc. It also uses various modalities of simulation including model-driven, high-fidelity simulators, instructor-driven simulators and even role-playing with simulated patients. The primary aim of the simulator centre is to prepare military physicians for many of the trauma scenarios they may encounter. (Stamper, et al., 2008).

Results of the study showed that users favored the simulation based learning because of the realism of simulated scenarios. The skill set that was most commonly taught or tested was the Advanced Cardiac Life Support procedures followed by airway procedures, pre-deployment field medical skills and trauma procedures. (Stamper, et al., 2008). Simulation allows for training that targets the needs of the learner (Rosen, 2008).

Another advantage of simulation is that it may supplement the dwindling resources, which often include animals, cadavers and patients without consent, for the practice of medical skills (Rosen, 2008).

According to Weller (2004), medical students, value simulation based learning for various reasons. These include, the opportunity to apply theoretical knowledge in a safe and realistic setting. They also value it for developing teamwork skills and a systematic approach to a problem. Other medical students have cited advantages such as the opportunity to practise technical skills, sharpen critical thinking abilities and exercise delegation skills (Eaves et al., 2001).

Other advantages of simulation training include the instructor being able freeze the scenario and assist the student to make good decisions, i.e. take advantage of teachable moments. It allows for integrated feedback, debriefings and guided reflection, thereby facilitating the link between theory and practice. Algorithms, performance checklists and videotaping can be used to evaluate student performance. Serious problems / cases can be presented with active involvement in the learning process. All this is done with no threat to patient safety. (Eaves et al., 2001; Decker, et al., 2008).

## 2.5 CHALLENGES OF SIMULATION

Although simulation has come a long way there are still major barriers to its use in health education. Fidelity and validity issues as well, as the cost of the equipment and personnel, are what the sceptics use to justify the non-implementation of simulation (Rosen, 2008). Fidelity is the ability of the simulation to replicate reality, and one has to consider the mannequin, environment and psychological aspects (Brindley, et al., 2007). There is also debate over the value of the use of mannequin-simulation for competency testing even though specialities like surgery and anaesthesiology are including this to test competency (Rosen, 2008). Other challenges include, time commitments, developing of scoring systems and appropriate selection of simulation experiences (Decker, et al, 2008).

When considering these challenges, it is worthwhile looking at what Bryson and Levine (2008) concluded in their study. They stated that no clinical instructor would knowingly allow a student to make a mistake or medical error on an actual patient and, therefore, the simulation environment is a powerful learning experience as such mistakes can be made without harm to an actual patient. David Gaba (1992), in Rosen (2008, p. 159) stated, “No industry in which human lives depend on the skilled performance of responsible operators has waited for the unequivocal proof of the benefit of simulation before embracing it.”

## 2.6 THEORETICAL PRINCIPLES OF SIMULATION

Constructivism is the theory that learning is a constant effort to assimilate new experiences that either complement or challenge the learner’s existing cognitive structures. New experiences that fit in with existing beliefs are assimilated and the learner has a richer understanding of the concept. If the experience challenges existing beliefs they are either accommodated by the learner modifying his/her conceptual structures, or disengaged when the learner rejects the experience as flawed. The instructor needs to facilitate accommodation by exploring the learner’s pre-conceptions, challenging these where appropriate, and explaining how the new idea improves the learner’s previous model. (Perkins, 2007).

Problem-based learning, which is the principal format of constructivism, is when students develop their own understanding through active participation. The instructor / facilitator needs to facilitate this through positive ethos instruction. Simulation is built upon this principle and can vary from simple simulations to FES. The integration of psychomotor skill training and problem-based learning that occurs during simulation results in improved performance in comparison to classroom-delivered problem-based learning (Perkins, 2007; Bryson et al, 2008).

According to Tanner (2006), a nurse's perception of a situation is rooted in his /her theoretical knowledge, ethical perspectives and relationship with the patient, but is strongly shaped by the nurse's practical experience. High-fidelity simulation provides learners with the opportunity to practise their skills, and learn more if there are clear expectations and there is direct feedback on performance (Lasater, 2007). Decker et al., (2008) stated that simulation is important in acquiring critical and reflective thinking skills needed to provide competent patient care.

According to Tanner's Clinical Judgment Model, the four phases of clinical judgment are Noticing, Interpreting, Responding and Reflecting. The first three actions can be described as thinking-in-action skills . They occur during the situation and require clinical judgment. In other words there is cognition of the patient's needs through evidence that is presented, the data surrounding the event are understood and prioritized and a conclusion is then made about the best course of action. This is followed by an appropriate response. The fourth step is described as the thinking-on-action skill of reflection, after responding to the situation. Reflection is seen as the catalyst for clinical learning as it gives the learner the opportunity to understand their learning through an exploratory process. (Tanner, 2006; Lasater, 2007).

Simulation can provide multiple experiences that will allow for reflection-in-action during the simulation and reflection-on-action when there is critical review of one's own and others' experiences. It gives opportunity to practice individual skills or the integration of knowledge, attitudes and skills in a well defined arena with continual feedback on performance. (Perkins, 2007).

Reflection on the learning experiences in clinical decision-making enhances patient care delivery. It is an important strategy to engage continual learning and there is associated improvement in the quality of care, stimulation of personal and professional growth, and closing of the gap between theory and practice. (Pirret, 2007; Holleran et al., 2010).

Kolb's experiential learning model also describes a concrete experience followed by reflective observation during which there is assimilation of a concept into a theory and this theory is then tested in new situations through active experimentation (Perkins, 2007).

## 2.7 CONCLUSION

In conclusion it is worth while noting that according to literature, simulation based learning has become a valuable educational tool for training and assessment. Using the above mentioned as a guide the researcher designed a simulation exercise that allowed for active involvement of the student (participant). The simulation had clearly defined expectations, used a performance checklist as a guideline, and continual feedback on performance was provided. The intention was that with the integration of psychomotor skill training and problem-based learning that occurs in a simulation exercise, there would be improved performance of the skill of synchronized cardioversion.

Chapter three will show how the researcher implemented this simulation based learning experience in an aeromedical environment and then assessed if this aided in the correct performance of a specific life saving skill.

# CHAPTER THREE: RESEARCH METHODOLOGY

## 3.1 INTRODUCTION

The objectives were to identify if there is a difference in performance of electrical synchronized cardioversion between medical flight crew who had not been exposed to simulation-based learning and those who had.

The success in performing the skill was measured by the time to delivery of first successful shock and whether the correct steps were taken to perform the skill. These steps included:

- Checking the patient's pulse to see if it correlated with what was displayed on the monitor / defibrillator;
- Pressing the SYNC button to engage the synchronization mode;
- Checking the display to confirm synchronization; and
- Selecting the appropriate joules setting.

The next objective was to compare the scene management by the medical flight crew who participated in the simulation based learning exercise (experimental group) to that of those who did not (control group). Scene management is the safety with which the skill was performed. This was measured by:

- Use of multifunctional pads in preference to paddles; and

- Announcing to team members that the defibrillator is charging and clearing (standing clear of) the patient before delivering the shock.

Potential categorical variants within the sample groups that were considered that may have had an influence on the outcome were:

- Age of medical flight crew member;
- Years of experience as a medical flight crew member;
- Specific field of medicine, i.e. doctor, registered nurse or paramedic;
- Years of experience within the specific medical profession;
- Number of times that the medical crew member had performed synchronized cardioversion in flight;
- Number of times that the medical crew member had performed synchronized cardioversion in everyday medical practice within the last year; and
- Time since last ACLS course attended.

## 3.2 DESIGN

This study had a quasi-experimental design as possible variants prior the research were not know and therefore could not be controlled. The author was keenly aware that these variants may have equal or more influence than the treatment process (Polit & Beck, 2008).

No pretest was done. All crew were expected to retain their currency in an ACLS and PALS, which means they were currently certified as skilled in synchronized cardioversion.

The experimental group was exposed to a treatment process involving a simulation-based exercised in synchronized cardioversion. The participants in the control group were offered the routine orientation towards the specific piece of equipment required to perform the skill.

Both control and experimental groups underwent a post-test. All the participants were given a scenario and, in the cabin of an air ambulance, requested to perform synchronized cardioversion.

### 3.2.1 Data collection tools

Data was collected in two ways: direct observation of skill performance and self administered structured questionnaire used to collect demographic data (APPENDIX E).
For the observation of the skill performance a structured tick sheet was used with very clear objectives and actions to observe. This instrument is based on the technical skill tick sheet used in the ACLS course for teaching synchronized cardioversion. Refer to

APPENDIX D. As this instrument is ratified and used by the American Heart Association to teach the skill of synchronised cardioversion, it may be accepted that the tool is valid to be used measurement tool in the performance of the specific skill. Because the sample group is small and very limited there was no opportunity test the reliability of the tool. However as this tool is used in ACLS courses and the data collector is an ACLS instructor, reliability of the tool was accepted.

An independent observer did the observation in the post-test. This person is a member of the Resuscitation Council of South Africa, is an ACLS and PALS instructor and also has experience in aviation medicine.

## 3.3 POPULATION AND SAMPLE GROUP

The study population was the flight medical crew of an internationally accredited fixed-wing air ambulance service based in Johannesburg, South Africa.

There are thirty-six active (forty-one employed) flight medical crew in this service; these include registered nurses, paramedics and doctors. Of these crew 56% are doctors, 24% registered nurses and 20% paramedics.

With the idea of widening the population, additional medical flight crew were approached from a very similar air ambulance service but due to competitive reasons, the response was poor.

Inclusion criteria:

- Flight medical crew employed by an air ambulance service, or
- Medical personnel that may not presently be practising as aviation health care providers but have previous experience in the field;
- All must be current in ACLS.

### 3.3.1 Sampling

As the entire population meets the inclusion criteria all were approached to take part in the study. In allowing for refusal and sample mortality, the intention was to obtain a sample group of a minimum of 30 subjects.

Potential participants were e-mailed to request participation in the research project. Because the target population is so small, the author decided to afford all medical flight crew the opportunity to be participants. Thirty-two individuals agreed to participate in the study but for various reasons, including being on an air ambulance mission, the sample mortality was six, allowing for 26 (n=26) participants.

Stratified random sampling was done to divide the participants into the control and experimental groups using medical qualification as homogenous subsets. It was done by allocating numbers to each particpant within the subsets and then randomly allocating the required amount of participants from each qualification group (strata) to the sample groups. Each group needed to have similar amounts of personnel with the various qualifications of paramedic, doctor and registered nurse to reduce the effect of the possible variant of medical qualification. The random stratification also enhances the representation of the population (Polit et al., 2008).

## 3.4 DATA COLLECTION PROCESS

Participants were given specific time slots for participation in the research project. On arrival they were requested to sign the participant information and consent form if this had not already been submitted to the researcher. Research assistants were briefed prior the treatment process and the post- test (Refer to APPENDIX F).

### 3.4.1 Simulation-based learning exercise (treatment process).

This was held at Lanseria, Execujet Hangar, Air Rescue Africa Air Ambulance on 21 October 2009. The participants in the experimental group were exposed to the independent variable of the simulation based learning exercise (treatment process) in synchronized cardioversion.

The participants were given printouts of the expectations for the simulation based exercise as well as the guidelines for performing synchronized cardioversion prior to commencing the exercise. These printouts were returned after the exercise. The expectations for the simulation learning exercise were explained to each participant prior to commencing the exercise.

#### 3.4.1.1 Expectations for the simulation-based exercise in synchronized cardioversion.

The following expectations were explained to the participants before the session:

- The skill of synchronized cardioversion would be practised within the cabin of an air ambulance.
- There would be no practise in ECG interpretation.
- Safety of the patient / mannequin and fellow participants was a priority.
- Each mannequin was to be treated as if it were a real patient.
- Any disregard shown to the mannequin was considered a negative outcome of the exercise.
- The procedure of cardioversion was to meet the standards set out by the American Heart Association ACLS course.
- Peer review was encouraged.
- Continual feedback would be given.
- The standard monitor / defibrillator used in the air ambulance service would be utilized.
- Participants would be allowed to practise the skill of cardioversion multiple times until they felt efficient. However, there was a time consideration as the other participants needed to fulfil their allocated time slots. Any participants who still felt incompetent at the end of their allotted exercise session would be

allowed to repeat an exercise at the end of all the other participants' exercise sessions.

3.4.1.2 Steps in performing synchronized cardioversion

Participants were all given a copy of Table 3.1, which could be used as a reference during the simulation-based exercise.

**Table 3.1** Steps in performing synchronized cardioversion

| STEP | ACTION |
|---|---|
| 1 | Check patient's pulse to ensure correlation with the monitor |
| 2 | Ensure proper display of the patient's rhythm |
| 3 | Turn on the defibrillator mode |
| 4 | Position adhesive pads on the patient. |
| 5 | Press SYNC control button to engage synchronization mode. |
| 6 | Look for marker on the R wave indicating SYNC mode. Adjust monitor gain if necessary. |
| 7 | Select the appropriate energy level: 100J |
| 8 | Announce to the team members: "Charging defibrillator – stand clear!" |
| 9 | Press charge button. |
| 10 | Clear the patient when the defibrillator is charged. Use a strong and forceful voice. |
| 11 | Press shock button. |
| 12 | Check the monitor. |
| 13 | If tachycardia persists, increase the energy level appropriately: 120 / 150 J |
| 14 | Activate the SYNC button. |
| 12 | Deliver second shock (Always use steps 8, 9, 10, before delivering a shock) |

Based on the AHA ACLS technique list for synchronized cardioversion (Field, 2006, p. 95)

Two participants were allocated to each simulation session at a time - one to fulfil the role of the second team member who provided assisted ventilations to the mannequin / patient and the primary role player who practised performing synchronized cardioversion. Participants alternated roles so that both could have an opportunity to practise synchronized cardioversion and to observe and critique. Positive critique and feedback were encouraged among the participants while performing the skill.

A realistic patient scenario was presented of a case of unexpected unstable tachyarrhythmia. The participants had to perform electrical synchronized cardioversion on the mannequin within the confined space of the aircraft cabin with only the usual equipment taken on an air ambulance mission. Feedback and guidance were given by the simulation operator, who is also an ACLS instructor with experience in aviation medicine.

#### 3.4.1.3 Simulation set up

A full environment simulation was created. A computer patient was used, specifically a Skills Master mannequin that uses the Heartsim 4000™ software. The mannequin was set up in the aircraft, feet aft, as would be the case with most patients transported in this environment. It was secured to the stretcher with the harnesses provided, the monitor was connected and switched on, the blood pressure cuff in place on the right arm, intravenous line with administration set and pressure bag attached to the left arm and an oxygen nasal cannula put in place.

The monitor / defibrillator was the Zoll CCT M-series™ (standard to this particular air ambulance service). It was put in position on a LifePort™ stretcher, AeroSled arm and the monitor was connected to mannequin.

Emergency bags, equipment, drugs and other accessories were set up and available in the aircraft as is standard on air ambulance missions. Catering items were also put in place as on a usual mission. Additional equipment, like the HAZMAT bag, and fridge drug box , was also placed in the cabin of the aircraft.

The aircraft was connected to a ground power unit so there was power to the stretcher, air conditioning (although limited) and cabin lighting. The door of the aircraft was closed and only available lighting in the aircraft could be used. Head torches were available if requested by the crew.


**Figure 3.1** View of the simulation set up from the aft of the aircraft.


**Figure 3.2** Closer view of the mannequin with monitoring, IV line and supplemental oxygen in place.

**Figure 3.3** View from the head of the patient; the HeartSim 4000™ controls can be seen.

The medical flight crew who participated in the simulation based learning exercise were asked not to divulge what skill they practised with the participants in the control group.

### 3.4.2 Control group

The control group participants, who had also been allocated time slots, were given the routine training / orientation offered by the specific air ambulance service. This was done by the air ambulance service training officer, and involved orientation regarding the use of the Zoll CCT M-series as well as training in the steps to follow when performing various procedures, including defibrillation and synchronized cardioversion, with specific reference to this monitor. Participants were allowed to ask questions and practise the steps that could be performed on the actual monitor.

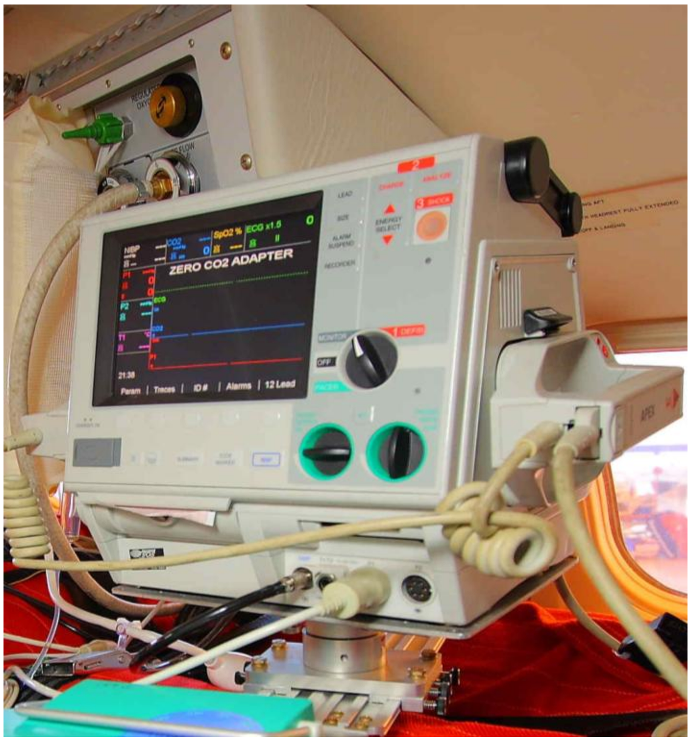


**Figure 3.4 The** Zoll CCT M-series

### 3.4.3 Post-test

This took place at the same place as the initial simulation exercise, Lanseria, Execujet Hangar, Air Rescue Africa Air Ambulance on 7 November 2009.

All participants randomly chose a number from a bottle on commencement of the post-test. This number was given by the participant to the persons doing the data collection which was recorded on the post-test sheet and demographic questionnaire.

Participants were requested to remain in designated holding areas. Once testing was done, the participants were not permitted to return to the holding areas and were requested not to discuss what skill was measured in the post-test.

The aircraft set-up and mannequin used were the same as during the simulation-based exercise. All participants were briefed in advance as to the expectations for the simulation exercise.

The post-test involved the same process as the treatment process with a few significant changes:

- The post-test was undertaken by both the experimental and control groups.
- The researcher of the simulation based learning project was not present or near the aircraft when participants were performing the skill.
- An independent expert from the Resuscitation Council of Southern Africa did the data collection together with a research assistant.
- No immediate feedback was given to individual participants.
- Each participant was given a time limit of 10 minutes to perform the skill.
- The participants were requested to complete a brief demographic questionnaire after performing the skill.
- Each participant performed the skill in isolation – no assistant, as additional interventions were not expected to be performed on the mannequin.

Observation was used to collect the data pertaining to the performance of the skill. The observer used a tick sheet to record observations. This data collection tool is based on the skills checklist for the performance of synchronized cardioversion as determined by the American Heart Association Advanced Cardiac Life support provider manual (Field, 2006). Refer to APPENDIX D.

Steps that were achieved were ticked. Time to first successful synchronized cardioversion shock was recorded and careful observation for potential threat to "patient" and crew safety observed and noted.

Variables were determined by all participants completing a structured self-administered demographic questionnaire. Refer to APPENDIX E

3.4.3.1 Expectations for the simulation based exercise in the post-test.

The following expectations were explained individually to all participants prior to commencing the post-test:

- Participants would be requested to perform a specific life-saving skill that requires the use of the Zoll CCT M-series monitor / defibrillator.
- This would occur within the cabin of an air ambulance.
- Participants have a maximum of 10 minutes to perform the skill after which the simulation would be stopped.

- Participants would not be expected to perform any additional skills like airway techniques, ECG interpretation and drug administration.
- Safety of the "patient" and fellow participants was priority.
- Each mannequin was to be treated as if it were a real patient.
- No feedback would be given.
- After completion of the exercise, participants would be requested to complete a demographic tick sheet.

## 3.5 ETHICAL ISSUES

Ethical clearance was obtained from the Human Research Ethics Committee (Medical) at the University of the Witwatersrand, Joahnnesburg. Refer to APPENDIX G.

### 3.5.1 Right to protection from exploitation

To ensure no victimization, the regional medical director of the air ambulance service wrote a letter to all medical flight crew assuring them that there would be no prejudice should individuals not want to take part in the study and that the outcome of the study would have no impact on their employment in the company (APPENDIX A).

### 3.5.2 Right to self-determination

Participation in this study was voluntary and participants could withdraw at any time.

As the researcher was in a management position (chief flight nurse) in relation to the medical flight crew, an independent party, with whom the crew had no association, was approached to ask crew if, on principle, they would participate in this study. The aim was to ensure that there was no coercion of potential participants. See attached correspondence in APPENDIX C.

### 3.5.3 Right to full disclosure

All participants were given an information leaflet and informed consent document that could be taken home with them and critically reviewed. See APPENDIX B. Only the signed consent form needed to be returned once the individual had agreed to become a participant.

All participants are entitled to a copy of the final outcomes of this study should they specifically request such in writing.

### 3.5.4 Right to privacy

All data collected, as well as results, were kept strictly confidential. No names of crew appear on the simulation evaluation form (data collection tool) or the demographic questionnaire. Numbers, randomly selected by participants, were used to correlate the simulation evaluation form and the demographic questionnaire. No information on either these documents contains any specific references to the respective study participant, or any identifying data. Allocated participant numbers ensured that participants' results remained anonymous.

Because synchronized cardioversion it is a life-saving skill, the final results of the performance of the group as a whole will be reported to the medical director of the concerned air ambulance service.

### 3.5.5 Beneficence

The skill undertaken in this study poses no safety or personal injury risks to any of the participants or examiners and therefore no indemnity and waiver of liability forms were completed. The intention ultimately was to produce benefits for patients transported by this air ambulance service, as there would hopefully be improved skill and safety in the practice of synchronized cardioversion.

# CHAPTER 4: STUDY FINDINGS

## 4.1 TESTS USED FOR DATA ANALYSIS

Because of the small sample size, the Mann-Whitney non-parametric test method was used to analyze the difference between the control and experimental groups with reference to:

- Time to first and second successful shocks;

The chi-square statistical analysis was used assess the performance of the two sample groups with regards to:

- the steps of synchronized cardioversion; and
- scene management.

The Fisher's exact test was also used to test the significance as there were cells with small frequencies.

The chi-square significance test was used to test for significance of categorical variants within the sample groups and the abovementioned variables. These variants included:

- Age of medical crew member;
- Years of experience as a flight crew member;
- Specific field of medicine;
- Years of experience within the specific medical profession;

- Number of times that the medical crew member had performed synchronized cardioversion in flight;
- Number of times that the medical crew member had performed synchronized cardioversion in everyday medical practice within the last year: and
- Time since last ACLS course.

The intention was to see if the performance of the participants in the control and experimental groups was due to the treatment process or by chance related to the variants listed above.

Kruskal-Wallis equality-of-populations rank test was used to analyze significance of any of the above mentioned variants on time to first and second shock delivery.

## 4.2 DATA ANALYSIS

### 4.2.1 Participant response

Thirty-two individuals agreed to participate in the research. However, there was a sample mortality of six. Four of the latter were participants who on the days of the research exercises could not attend due to work commitments (they were dispatched on air ambulance missions).

There were a total of 26 participants - experimental group (*n=13*) and the control group (*n=13*). Of the 26 participants, one did not complete the skill in the allocated 10 minutes during the post-test.

### 4.2.2 Participant background

As seen in Figure 4.1, ten (38%) were registered nurses, with six participants having more than ten years experience and only one having less than five years experience. Five (19%) were ALS paramedics all having more than five years experience and eleven (42%) were doctors of whom eight have more than five years experience. The majority of participants (42%) had 5 – 10 years experience within their respective medical professions.

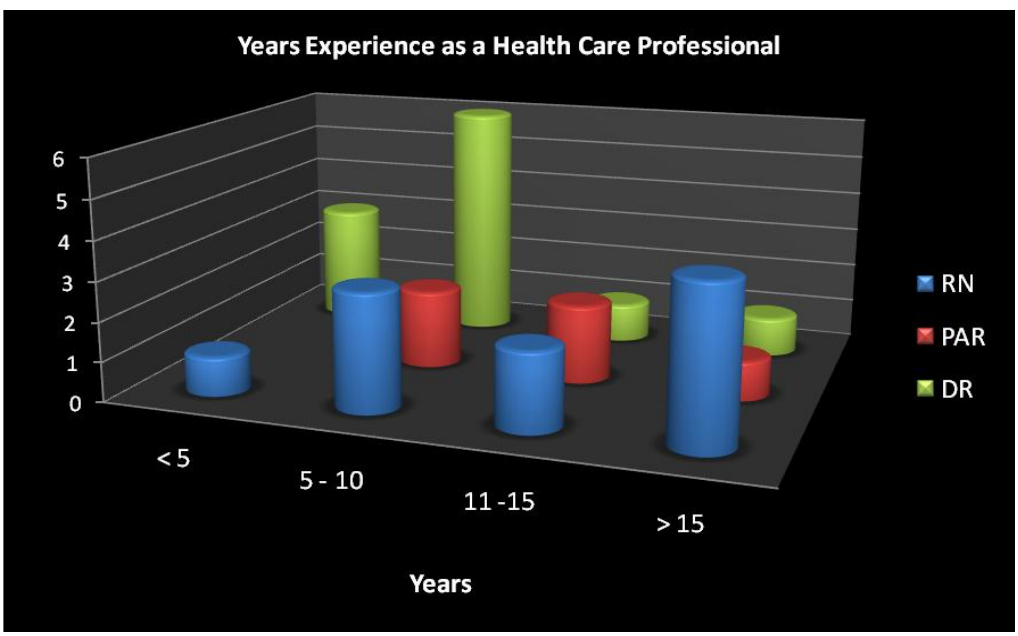


**Figure 4.1** Years of experience as health care professionals within the various qualifications of registered nurse, paramedic and doctor.

When looking at the distribution of subsets it was noted that the sample is fairly representative of the population. Doctors – 56% in the population, 42% in the sample group. Nurses – 24% in the population, 38% in the sample group. Paramedics – 20% in the population, 19% in the sample group. This contributes to construct validity (Polit, et al., 2008).

Figures 4.2 to 4.5 demonstrate the difference in years of experience in air medical care and experience within chosen medical profession. Experience within the aeromedical field as medical flight crew was less. Of the registered nurses, 70% had five or less years experience as medical flight crew. Sixty-four percent of the doctors and 60% of the paramedics had five or less years experience as medical flight crew. When looking at the average of years experience across the various qualifications, 42% had less than two years experience as medical flight crew.

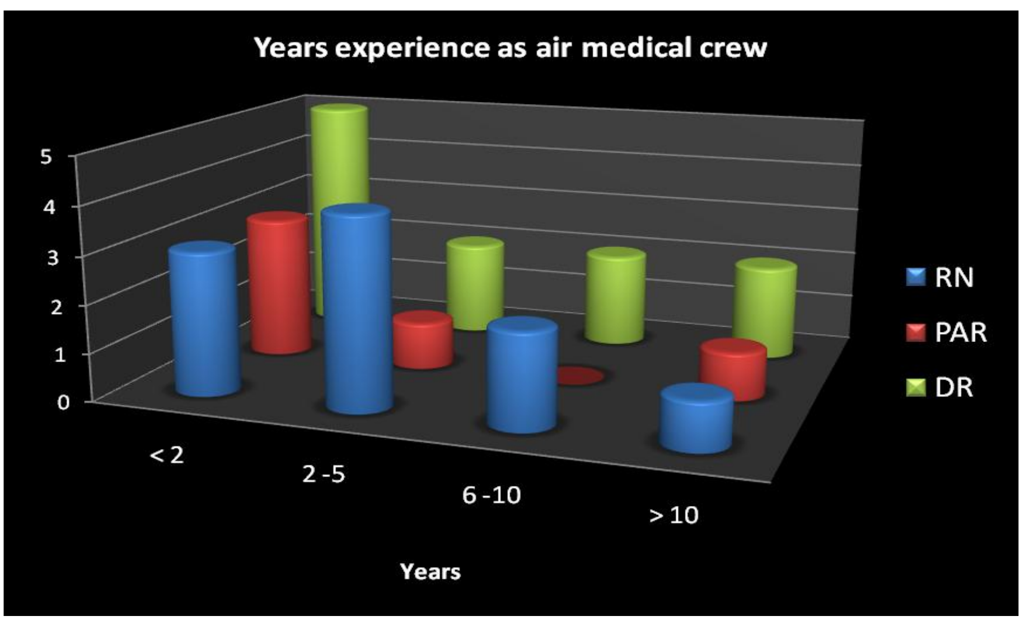


**Figure 4.2** Years of experience as medical flight crew within the various medical qualifications.

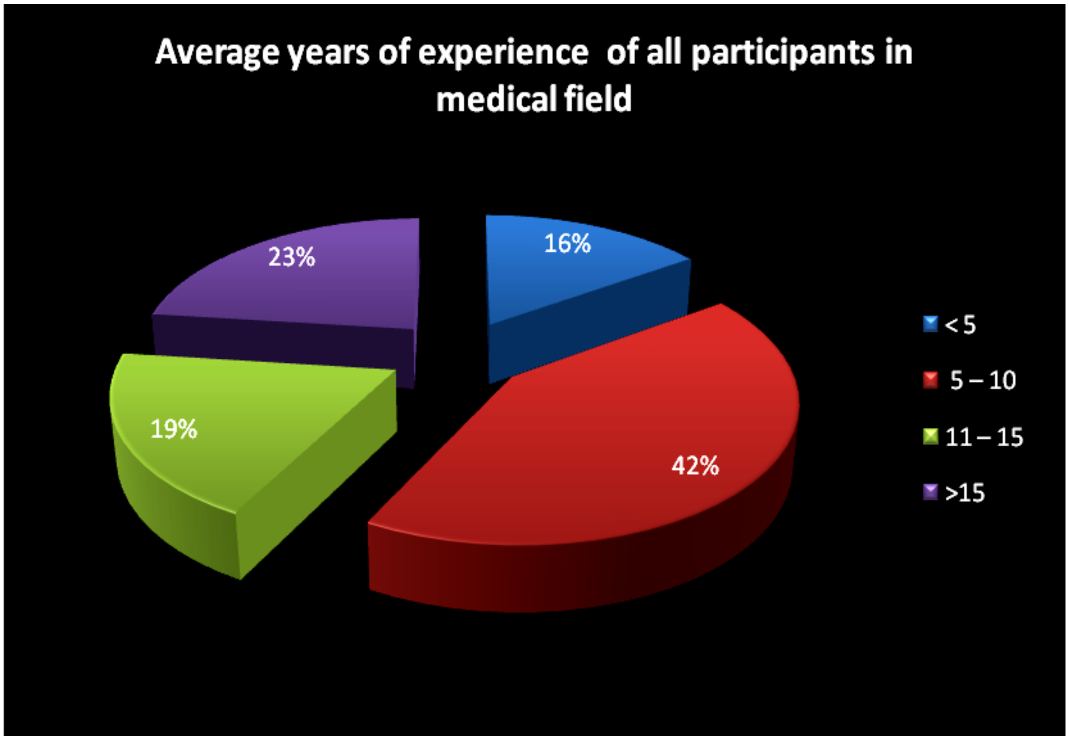


**Figure 4.3** Average years of experience of all participants in the medical field

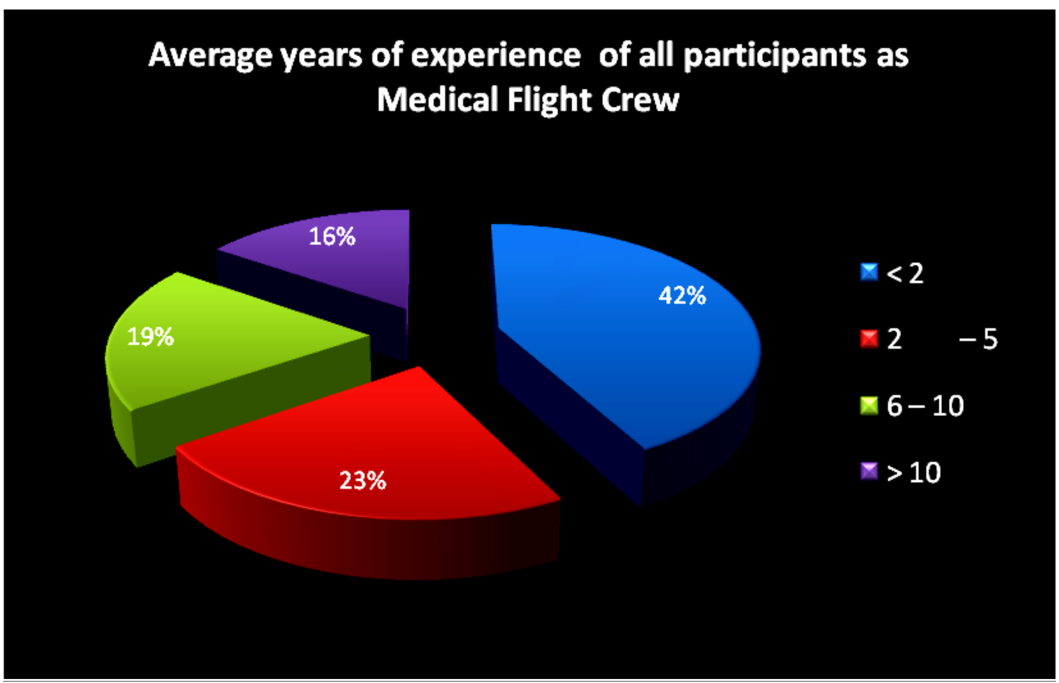


**Figure 4.4** Average years of experience of all participants as medical flight crew

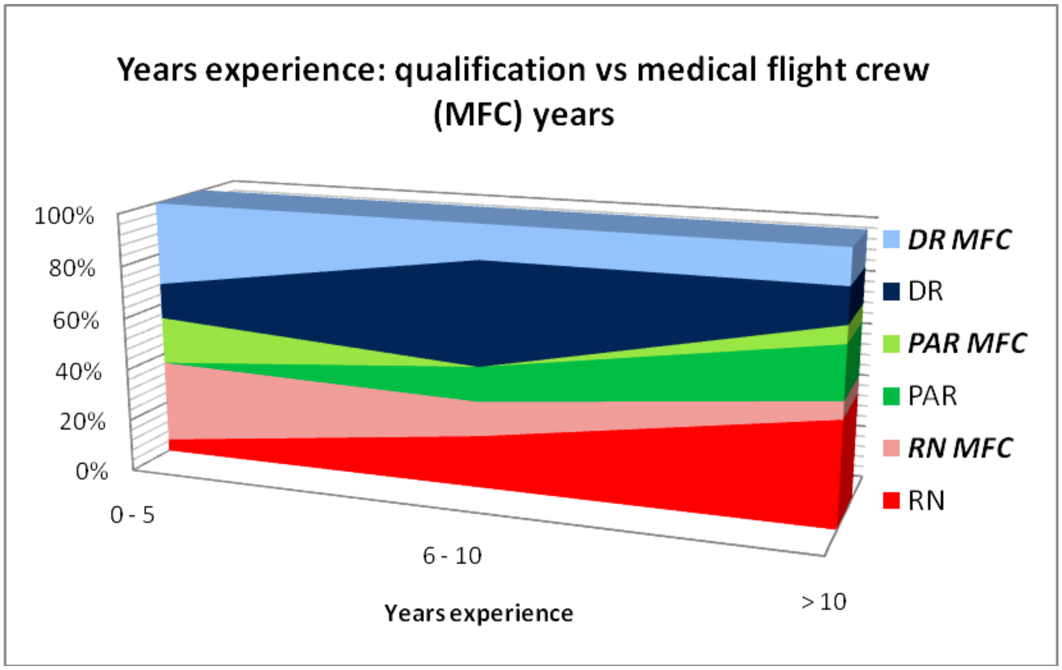


**Figure 4.5** Comparison of the average years of experience in the medical field vs those as medical flight crew

4.2.3 Additional demographic information

Just over half (54%) of the participants were aged 30 – 39 years.

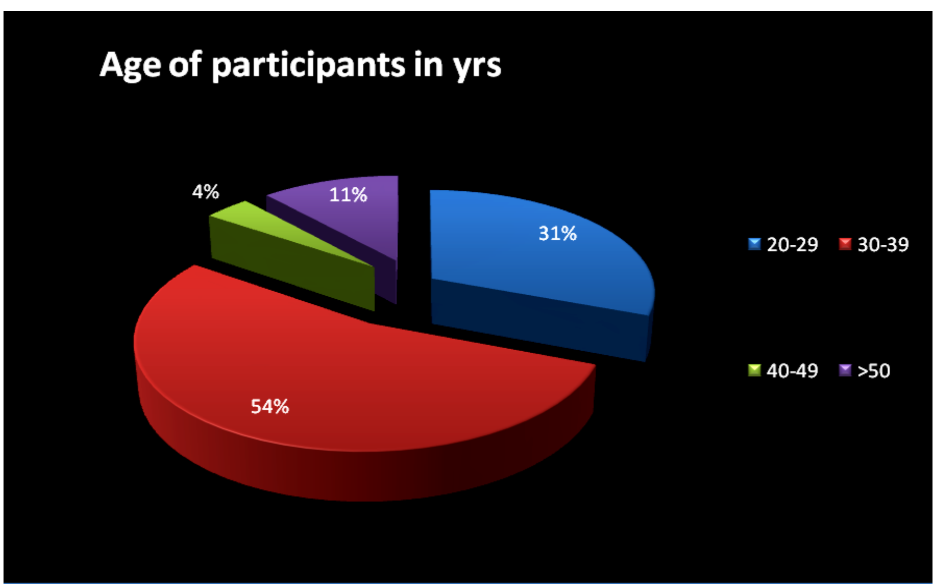


**Figure 4.6** Average age of participants

When looking at the period since participants did their last ACLS course, 50% had done it within the last 2–12 months and 42% within the last 13-24 months. None had done an ACLS course in the preceding two months and two participants had done the course over two years ago.

Another variant considered was the number of times that synchronized cardioversion had been performed in the various work environments. Eight-five percent of participants had never performed synchronized cardioversion on an air ambulance flight whereas 42% of participants had not performed this skill in their normal work environments within the last year.

### 4.2.4 Performance of the skill of synchronized cardioversion

In assessing the performance of synchronized cardioversion by both sample groups, following aspects were analyzed:

- Did the medical flight crew member check the patient’s (mannequin's) pulse? If the patient did not have a pulse, their resuscitation requires CPR, not synchronized cardioversion. (American Heart Association, 2005).
- The participant had to simultaneously check the monitor and the pulse rate to correlate what was seen on the monitor with what he / she was feeling. They also had to check that the rhythm display was adequate and adjust if needed.

- The next step was to turn the monitor to defibrillation mode. This was not analyzed, however, as synchronized cardioversion and defibrillation cannot be performed if this initial step is not done.
- However, the next step is to activate the synchronize (SYNC) button – which is essential to ensure that the shock delivered is synchronized with the QRS complex of the ECG rhythm to avoid the shock being delivered in the relative refractory portion of the cardiac cycle. (AHA, 2005).
- Confirmation of the synchronization was then done by checking if every R wave is marked.
- The selection of correct joules for first and second shocks was also analyzed.

Using the chi-square statistic it was found that there was a significant relationship between the experimental sample group and checking the patient's pulse ($p<0.05$), activating the SYNC button ($p<0.05$) and selecting of the correct joules for the second shock ($p<0.05$).

**Table 4.1** Results of the chi-square test in the various steps performed in synchronized cardioversion

| | |
|---|---|
| ***Check patient's pulse and correlate with monitor.*** | $X^2 = 5.6566$, *df* = 1, **p = 0.017**<br>Fisher's exact p-value = 0.034<br>1-sided Fisher's exact p-value = 0.029 |
| Check rhythm display on monitor | $X^2 = 0.5035$, *df* = 1, p = 0.478<br>Fisher's exact p-value = 0.649<br>1-sided Fisher's exact p-value = 0.410 |
| ***Activate SYNC (synchronize) button*** | $X^2 = 4.7273$, *df* = 1, **p = 0.030**<br>Fisher's exact p-value = 0.096<br>1-sided Fisher's exact p-value = 0.048 |
| Check R wave is marked (confirmation of synchronization) | $X^2 = 2.600$, *df* = 1, p = 0.107 |
| Selection of correct joules for first shock | $X^2 = 3.4361$, *df* = 1, p = 0.064<br>Fisher's exact p-value = 0.097<br>1-sided Fisher's exact p-value = 0.077 |
| ***Selection of correct joules for second shock*** | $X^2 = 11.9141$, *df* = 1, **p = 0.001**<br>Fisher's exact p-value = 0.001<br>1-sided Fisher's exact p-value = 0.001 |

### 4.2.5 Assessment of scene management by sample groups

To assess whether participants were safe in the performance of synchronized cardioversion, two aspects were considered:

- Use of pads vs paddles to deliver the shock; and
- Standing clear of the patient before delivering the shock.

#### 4.2.5.1 Use of pads vs paddles to deliver the shock

When it came to the use of paddles vs multifunction pads, twelve (92.31 %) participants in the experimental group vs one (7.69%) in the control group choose to use pads ($p < 0.001$). ($X^2 = 18.6151$, *df* = 1, $p = 0.000$) Fisher's exact p-value = 0.000.

#### 4.2.5.2 Clearing the patient before delivering the shock

All thirteen participants in the experimental group (100%), compared to the seven (53.85%) participants in the control group, gave the command to clear the patient prior to delivering the shock ($p < 0.05$). ($X^2 = 7.800$, *df* = 1, $p = 0.005$) Fisher's exact p-value = 0.015.

### 4.2.6 Comparison of time to first successful shock

**Table 4. 2** Summary of time to first and second shock

| Variable | N | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| Time to $1^{st}$ shock | 25 | 1.5068 | 1.223832 | .28 | 5.31 |
| Time to $2^{nd}$ shock | 25 | 2.0088 | 1.404319 | .41 | 6.15 |

The two-sample Wilcoxon rank-sum (Mann-Whitney) test was used to compare the two sample groups times to first and second shock.

**Table 4.3** Two-sample Wilcoxon rank-sum (Mann-Whitney) test for time to first shock

| | OBS | Rank Sum | Expected |
|---|---|---|---|
| Control group | 12 | 108.5 | 156 |
| Experimental group | 13 | 216.5 | 169 |
| Combined | 25 | 325 | 325 |
| Unadjusted variance 338.0 | | | |
| Adjustment for ties -0.39 | | | |
| Adjusted variance 337.61 | | | |

If a null hypothesis ($H_0$) was: Time to first shock for the control group = time to first shock for the experimental group ($z = -2.585$), because $z < -1.96$, the null hypothesis is rejected and the conclusion is that the two groups are not equal. There is a significant non-directional difference in time to first shock between the two sample groups ($p=0.009$). When looking at Table 4.3, it is noted that the control group were quicker to first shock.

4.2.6.1 Time to second successful shock

$H_0$: Time to second shock for the control group = time to second shock for the experimental group (z =-1.931). The null hypothesis is accepted and the groups are seen as equal. There is no significant difference (p=0.0534).

4.2.7 Significance of the categorical variants within the sample groups.

4.2.7.1 Influence of variants on performance of synchronized cardioversion.

**Table 4.4** Influence of categorical variants on the performance of synchronized Cardioversion

| | Age of the participant | Years experience as Medical Flight Crew | Qualification | Years experience in the specific medical field | Period since last ACLS course was done. |
|---|---|---|---|---|---|
| Check the patient's pulse | $X^2$=1.7778, *df* = 2,<br>p = 0.411<br>Fisher's exact = 0.712 | $X^2$=6.4323, *df* = 3,<br>p = 0.092<br>Fisher's exact = 0.093 | $X^2$=0.9725, *df* = 2,<br>p = 0.615<br>Fisher's exact = 0.647 | $X^2$=2.0364, *df* = 3,<br>p = 0.565<br>Fisher's exact = 0.584 | $X^2$=5.6566, *df* = 2,<br>p = 0.059<br>Fisher's exact = 0.093 |
| Check the rhythm display on the defibrillator / monitor | $X^2$=5.5565, *df* = 3,<br>P = 0.135<br>Fisher's exact = 0.116 | $X^2$=1.9636, *df* = 3,<br>P = 0.580<br>Fisher's exact = 0.837 | $X^2$=3.6148, *df* = 2,<br>P = 0.164<br>Fisher's exact = 0.188 | $X^2$=2.400, *df* = 3,<br>P = 0.494<br>Fisher's exact = 0.599 | $X^2$=1.8234, *df* = 2,<br>P = 0.402<br>Fisher's exact = 0.380 |
| Press the synchronization button | $X^2$=6.9884, *df* = 3,<br>p = 0.804<br>Fisher's exact = 0.635 | $X^2$=2.8382, *df* = 3,<br>p = 0.417<br>Fisher's exact = 0.639 | $X^2$=0.3707, *df* = 2,<br>p = 0.831<br>Fisher's exact = 1.000 | $X^2$=0.8828, *df* = 3,<br>p = 0.830 | $X^2$=0.4298, *df* = 2,<br>p = 0.807<br>Fisher's exact = 1.000 |
| Confirm the presence of markers on the R- wave | $X^2$=2.6619, *df* = 3,<br>p = 0.447 | $X^2$=6.2321, *df* = 3,<br>p = 0.101 | $X^2$=0.0355, *df* = 2,<br>p = 0.982 | $X^2$=0.3171, *df* = 3,<br>p = 0.957 | $X^2$=1.0193, *df* = 2,<br>p = 0.601 |
| Set appropriate joule level | $X^2$=0.9552, *df* = 3,<br>p = 0.812<br>Fisher's exact = 1.000 | $X^2$=1.669, *df* = 3,<br>p = 0.644<br>Fisher's exact = 0.680 | $X^2$=0.2674, *df* = 2,<br>p = 0.875<br>Fisher's exact = 1.000 | $X^2$=1.8549, *df* = 3,<br>p = 0.603<br>Fisher's exact = 0.637 | $X^2$=0.6643, *df* = 2,<br>p = 0.717<br>Fisher's exact = 0.698 |

As in the previous analysis, the steps in synchronized cardioversion that were analyzed were:

- Checking the patient's pulse;
- Checking the rhythm display on the defibrillator / monitor;
- Pressing the synchronization button;
- Confirming the presence of markers on the R- wave; and
- Setting appropriate joule level.

#### 4.2.7.2 Influence of categorical variants on scene management

**Table 4.5** Use of pads vs paddles to deliver the shock

| Variant | Significance |
|---|---|
| Age | $X^2$= 2.1190, df = 3, p = 0.548<br>Fisher's exact = 0.629 |
| Years experience as medical flight crew | $X^2$ = 2.6848, df = 3, p = 0.443<br>Fisher's exact = 0.448 |
| Qualification | $X^2$ = 0.2909, df = 2, p = 0.708<br>Fisher's exact = 0.776 |
| Years experience in medical field | $X^2$ = 0.9576, df = 3, p = 0.812<br>Fisher's exact = 0.893 |
| Last ACLS course | $X^2$ = 0.1678, df = 2, p = 0.920<br>Fisher's exact = 1.000 |

**Table 4.6** Clearing the patient before delivering the shock

| Variant | Significance |
|---|---|
| Age | $X^2 = 5.7468$, df = 3, p = 0.125<br>Fisher's exact = 0.080 |
| Years experience as flight crew | $X^2 = 1,6913$, df = 3, p = 0.639<br>Fisher's exact = 0.758 |
| Qualification | $X^2 = 2.8521$, df = 2, p = 0.240<br>Fisher's exact = 0.237 |
| Years experience in medical field | $X^2 = 1.9474$, df = 3, p = 0.583<br>Fisher's exact = 0.731 |
| Last ACLS course | $X^2 = 1.1818$, df = 2, p = 0.554<br>Fisher's exact = 0.795 |

4.2.7.3 Influence of variants on time to first and second shock

**Table 4.7** Influence of variants on time to first and second shock

| | Time to first shock | | Time to second shock | |
|---|---|---|---|---|
| Age | $X^2$= 3.623, 3*df* | p = 0.3051 | $X^2$ = 2.866, 3*df* | p = 0.4129 |
| Qualification | $X^2$= 3.568, 2*df* | p = 0.1680 | $X^2$ = 5.430, 2*df* | p = 0.0662 |
| Years experience as medical flight crew | $X^2$= 2.249, 3*df* | p = 0.5224 | $X^2$= 3.288, 3*df* | p = 0.3493 |
| Years experience | $X^2$= 1.237, 3*df* | p = 0.7440 | $X^2$ = 2.987, 3*df* | p = 0.3936 |
| Last ACLS course | $X^2$ = 3.206, 2*df* | p = 0.2013 | $X^2$= 5.284, 2*df* | p = 0.0712 |

Kruskal-Wallis equality-of-populations rank test was used to analyze significance.

# CHAPTER 5: DISCUSSION OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

## 5.1 DISCUSSION OF RESULTS

### 5.1.1 Relationship between the treatment process and performance of synchronized cardioversion.

There was a significant relationship between the experimental sample group and the correct performance of some of the vital steps of synchronized cardioversion:

- checking the patient's pulse ($p<0.05$);
- activating the SYNC button ($p<0.05$); and
- selecting of the correct joules for the second shock ($p<0.05$).

Of the six steps in synchronized cardioversion that were analyzed, the treatment process had a significant influence on the correct performance of three. Refer to Table 4.1

One of the outcomes used to measure performance of synchronized cardioversion was to measure time to first successful shock. The time to first shock was quicker in the control sample group vs the experimental sample group and the time to second shock was similar for both groups. There was no relationship between the group who received the treatment process (experimental sample) and the time to first shock. This may be attributed to fact that twelve of the participants in the experimental group applied multifunction pads to shock in contrast to only one member of the control group. The remainder of the participants in the control group used paddles to deliver the shock.

5.1.2 Performance of the participants in the control group.

As discussed, the participants in the control group were not exposed to a simulation based exercise but rather the routine orientation / training offered by the specific air ambulance service.

The only area where there was noted better performance was the time to deliver first shock. Besides the fact that only one person in the control group used pads to deliver the shock, the quicker time to first shock may be due to fewer steps of the synchronized cardioversion performed correctly or if at all. Refer to Figure 5.1

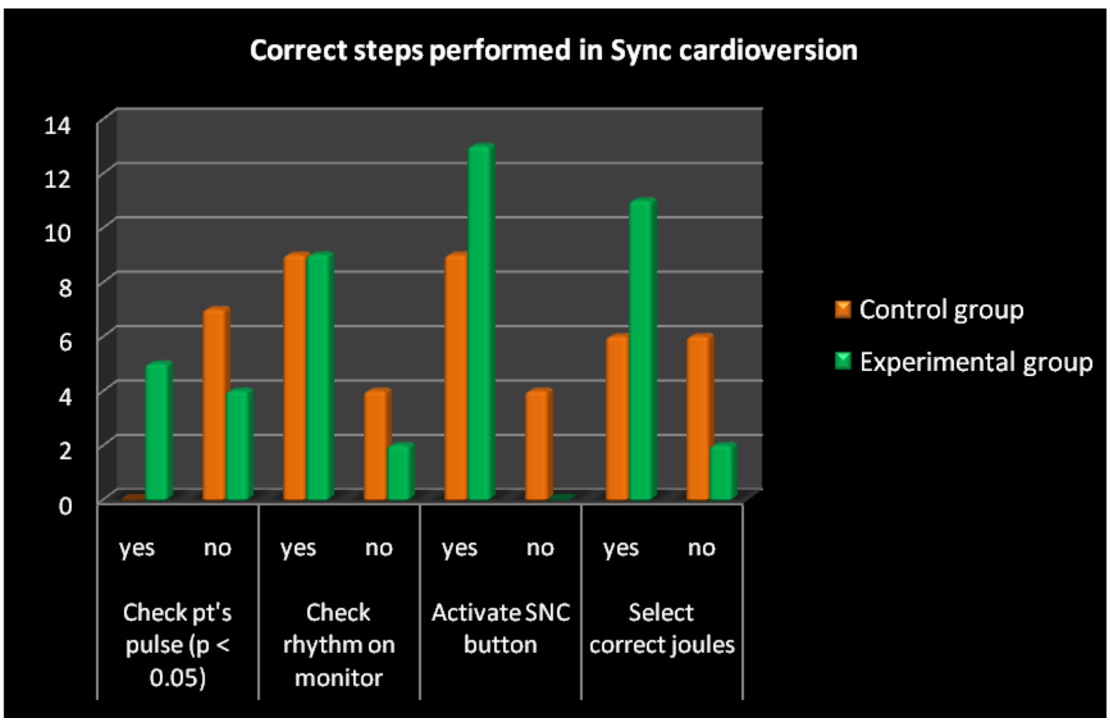


**Figure 5.1** Comparison between the control and experimental groups in respect of the correct performance of synchronized cardioversion (excluding scene management)

### 5.1.3 Relationship between the treatment process and scene management

When assessing the influence of the treatment process on the management of scene safety, the results were very significant:

- use of multifunctional pad vs paddles ($p < 0.0001$)
- clearing the patient before delivering the shock ($p < 0.05$)

Refer to section 4.2.5.1 and 4.2.5.2

### 5.1.4 Relationship between variants within the sample groups and the performance of synchronized cardioversion and scene management.

Most medical flight crew appeared to have less experience in aviation medicine than in practicing as a health care professional in the normal health care environment. Although, as individual practitioners, the participants may be considered experienced, when looking at the average of years experience across the various qualifications, 42% had less than two years experience as medical flight crew. Refer to Figure 4.3, Figure 4.4 and Figure 4.5

The results confirmed the author's contention that synchronized cardioversion is seldom performed within these individuals' normal working life and less frequently on air ambulance missions. Eighty-five percent of participants had never performed synchronized cardioversion on an air ambulance flight whereas 42% of participants had not performed this skill in their normal work environments within the last year. Refer to Figure 5.2

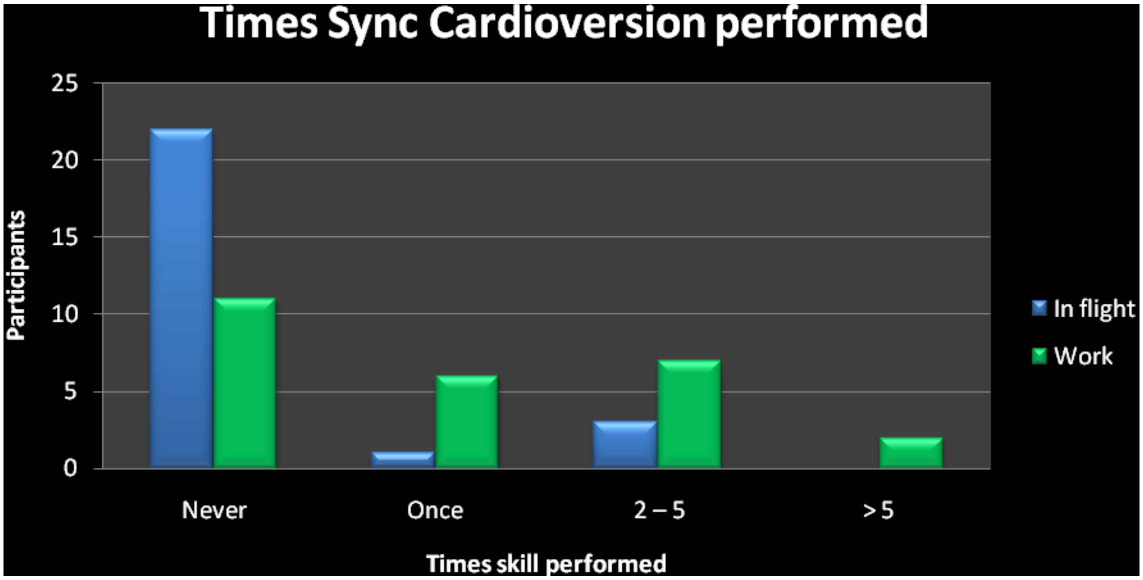


**Figure 5.2** Times that synchronized cardioversion has been performed by the participants in the various work environments

None of the measured variants had a significant influence on the performance of the steps of synchronized cardioversion, time to first and second shock and the management of scene safety. Refer to Table 4.5, Table 4.6, Table 4.7. and Table 4.8

## 5.2 DISCUSSION OF THE SIMULATION EXRECISE (TREATMENT PROCESS)

The simulation exercise in synchronized cardioversion that was presented to the participants in the experimental sample group contained the characteristics of simulation as defined by Gredler (1994), in Eaves et al., (2001):

### 5.2.1 Problem-based learning.

Problem-based learning is when students develop understanding through active participation (Perkins, 2007). The case of a patient in transit in an air ambulance that suddenly becomes unstable was presented and the participants were then requested to perform synchronized cardioversion.

Del Bueno (2005) said there is a crisis in critical thinking in nursing in that fewer nurses are able to transfer their extensive theoretical knowledge into the practical care of patient, i.e. they have poor clinical judgment. She stated that one of the best ways to reduce this problem was practice, i.e. presentation of problems where students have to apply, analyze and synthesize knowledge for specific practical patient situations.

By providing a simulated learning experience that imitated the working environment of aviation medicine, elements of the real world were integrated. There was value in this as seen by the performance of the experimental group - they were better in demonstrating the required procedural techniques, decision making and critical thinking skills pertaining to synchronized cardioversion. The new experiences of performing the skill in the aircraft fitted in with existing beliefs (consequent on their having done synchronized cardioversion in non-aviation environments). Once the new experiences were assimilated, the participants in the experimental group had a richer understanding of the concept.

The four stages of Tanner's Clinical Judgment Model (Tanner 2006, Lasater, 2007) were clearly visible in the process of the simulation exercise. The participant was presented with an unstable patient requiring synchronized cardioversion. This evidence was given in the form of vitals signs and general appearance of the patient (Noticing). The mannequin's condition correlated with this. Although participants had been instructed that synchronized cardioversion was required, they had to decide appropriate steps and safety considerations within the cabin of the aircraft and with the available equipment (Interpreting). The third stage of, responding, was then the actual demonstration of the skill of synchronized cardioversion. During the first three steps, the facilitator of the simulation provided continual feedback to aid clear understanding.

After the simulation exercise, there was a period of reflection (fourth stage), where participants discussed of the challenges of performing synchronized cardioversion in the confined space of the cabin of an air ambulance. These were challenges that they had never considered before. The cramped quarters and proximity to sensitive electrical equipment and safety concerns were discussed during these reflection periods. Various steps of synchronized cardioversion, like the importance of synchronizing the shock and the choice of correct joules, were also discussed. The participants were therefore able synthesize the knowledge gained from the actual experience. Medical flight crew were allowed to practise the skill of cardioversion multiple times until they felt efficient. Peer review was encouraged and continual feedback was given to medical crew (thinking-on-action).

When looking at the clinical judgment of the participants in the experimental group vs the control, as assessed in the post-test, the first three actions of thinking-in-action skills (notice, interpret and respond) were shown to be superior in the experimental group

(Refer to Section 4.2.4 and Section 4.2.5). This also implies that reflection after the first simulation exercise aided the change of understanding and improved clinical skill.

### 5.2.2 The subject matter, settings and issues.

Simulation offers the opportunity to present issues that are not usually textbook problems (Lasater, 2007). Although the steps of synchronized are very standardized according to best practice as defined by the American Heart Association (2005), the aeromedical environment in which this skill needs to be implemented is very unique with its own set of challenges that may influence implementation of this skill.

As seen in Figure 5.2, synchronized cardioversion is not a skill that is frequently performed and therefore not frequently practiced, and even less so in the aeromedical environment. This is why there is such value in simulation based learning, in that situations that are difficult to predict, and therefore which large numbers of learners (practitioners) rarely experience, can be created. (Decker, et al., 2008).

### 5.2.3 The participants perform functions associated with their specific roles and settings

As mentioned in the introduction, all medical flight crew on this specific air ambulance are required to be certified in ACLS, which includes being skilled in synchronized cardioversion.

The simulation took place in the cabin of one of the air ambulances, with all standard equipment available as used in the service. The only exception is that the aircraft was on the ground and noise interference was not simulated.

### 5.2.4 Outcomes of the simulation are the consequences of participants own actions

Participants needed to realise that the outcome of the simulation was not determined by chance or luck (Eaves, et al., 2001). The participants were expected to give priority to the safety of the patient and fellow medical crew. The mannequin had to be treated as if it was a real patient and any disregard shown to the mannequin was considered a negative outcome of the exercise.

One of the aims was that the participants realised that the patient's safety and well-being also dependent on their familiarity and experience with the instruments and equipment used in the aeromedical setting .

### 5.2.5 Reality of roles and functions and the associated responsibilities.

Decker, et al., (2008) described the value of a simulation learning experience, and this was achieved in this study, as the simulation exercise imitated the working environment where elements of the real world of aeromedicine were integrated and the participant was required to demonstrate synchronized cardioversion which included decision-making and critical thinking skills to achieve this specific goal (Decker, et al., 2008).

These standard precautions are that air medical personnel should follow the ACLS defibrillation standards for selection of energy levels and use self-adhesive monitor/defibrillation pads. The medical crew must also inform the pilot before defibrillation and stand clear of the patient and stretcher when discharging the current. (Holleran, 2003).

Using all the above mentioned as a guide, the author designed a simulation exercise that allowed for active involvement of the student (participant). The simulation had clearly defined expectations, used a performance checklist as a guideline and continual feedback on performance was provided. The intention was that with the integration of psychomotor skill training and problem-based learning that occurs in a simulation exercise, there would be improved performance of the skill of synchronized cardioversion.

## 5.3 LIMITATIONS OF THE STUDY

### 5.3.1 Design

Even though quasi-experimental designs are less reliable, it would however have been difficult to conduct true experimentation because there was no control over potential variants (Polit & Beck, 2008).

### 5.3.2 Small sample size

Although the sample size was representative, it would be beneficial to have a bigger number of participants, to reduce the chance of statistical errors of interpretation. Many of the cells in the statistical tests were small and there was only a df of 1.

### 5.3.3 Outcome of time to first shock

In retrospect, the objective of measuring time to first shock was not a reliable outcome. The use of paddles vs pads may have had a significant influence on this outcome, rather than the overall ability of the person performing the skill. In future studies, the author should measure the time to use paddles vs time to use pads or only give the participants the option to use pads.

### 5.3.4 Cost

This was not a limitation for this research as all assistance and equipment, in the form of research assistants, mannequins, simulation area and monitor were provided for free. However, cost is always something that needs to be calculated when planning simulation-based learning. Editing, printing and additional expenses were not sponsored.

### 5.3.5 Time restraints

The simulation was extremely labour intensive and considering the author and assistants all have full-time jobs, each participant was given limited time to practice the skill during the simulation exercise as this would influence total time. This was also one of the reasons a pre-test was not done on the base line skill of all participants. Similarly, all participants had to offer up personal time to participate in the research. This may have been a contributing reason for no response from certain Medical Flight Crew to participate.

### 5.3.6 Identification of variants

A weakness of quasi-experimental studies is the possible influence of rival hypotheses to the experimental manipulation (Polit & Beck, 2008). The author attempted to identify possible variants that may have influence the outcome of the treatment process but none were found to have a significant influence. These were also defined prior the post-test and there could have been a consideration in allowing participants to identify variants as there is always the possibility of unidentified variants.

### 5.3.8 Performance anxiety

From subjective assessment by the author of participants prior the post –test, there appeared to be an element of performance anxiety. Many participants verbalised (even though there was voluntary participation) that they equated the exercise with an examination. This is termed reactivity and is a shortcoming of direct observation (Polit, et al., 2008).

## 5.4 RECOMMENDATIONS

The fourth step of Tanner's Clinical Judgment Model, reflection, should be formally assessed in future studies. Participants should give feedback, in the form of a tick sheet or simple questionnaire as to what were the main learning points of the simulation exercise. This will help identify participant (Medical Flight Crew) needs and also guide future planning for simulation exercises.

During feedback sessions after the simulation exercise (treatment process) there was very positive feedback from the participants regarding the value of such an exercise. Because preparation and coordination of personnel (and participants) is complex but essential to a successful simulation exercise (Eaves, et al., 2001), the author recommends that there be a dedicated simulation unit coordinated by the appropriately qualified person(s). Attending simulation exercises should also be part of the intended participants' orientation and training schedules.

There may be value in adding pre-recorded noise interference to simulation exercises in the air medical environment.

Some of the participants had just returned from air ambulance missions. There may be value in assessing the effects of fatigue on the performance of skills (general and life-saving) within in the air medical environment.

As there will be extensive cost in setting up a simulation unit, the researcher recommends that there be a cost analysis done as there may be a reduction in cost by sharing of resources with an accredited training academy that has the appropriate mannequins.

As anticipated, the results of this study revealed that there is value in providing simulation-based learning opportunities within the aeromedical environment. The results of this study may become the basis for further research into simulation-based learning.

### 5.5 CONCLUSION

Of the eight steps of synchronized cardioversion analyzed, there was a significant relationship between the experimental sample group and the correct performance of five these steps (including scene management). There appears to be sufficient evidence to consider the value of simulation-based learning in promoting safe practice, in contrast to the standard orientation / training offered to medical flight crew.

Because synchronized cardioversion it is a life-saving skill, the final results of the performance of the group as a whole will be reported to the medical director of the concerned air ambulance service. It will also be pointed out that the variant of being current in ACLS did not have a significant influence on the performance of synchronized cardioversion in the aeromedical environment. One therefore cannot assume because medical flight crew are certified to perform certain skills, they will be able to perform these safety and effectively in the aeromedical environment. The researcher recommends re-orientation / training in the form of simulation based learning, of existing Medical Flight Crew  regarding the skill of synchronized cardioversion in the air medical environment.

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