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Profile and anaesthetic management following stabbed hearts: a one year retrospective review

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PROFILE AND ANAESTHETIC MANAGEMENT FOLLOWING STABBED HEARTS: A ONE YEAR RETROSPECTIVE REVIEW

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, in partial fulfilment of the requirements for the degree

of

Master of Medicine in branch of Anaesthesiology

Johannesburg, 2016

DECLARATION

I, Siju Joseph Abraham, declare that this research report is my own work. It is being submitted for the degree of Master of Medicine in the branch of Anaesthesiology in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

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ABSTRACT

Stabbed hearts are surgical emergencies that require a prompt and focused anaesthetic intervention. The aim of this study was to describe the profile and anaesthetic management of patients with stabbed hearts presenting to the Diepkloof Mortuary and Chris Hani Baragwanath Academic Hospital during a one year period.

A retrospective, contextual and descriptive design, with consecutive convenience sampling was used.

There were 44 patients with stabbed hearts; most were males (93%), between 20 and 29 years (53%), and stabbed in the right ventricle (63%); 48% survived to hospital admission. Of those 90% survived to receive surgical management in theatre. Seventy-four percent were intubated in theatre. Most patients were induced with etomidate (58%), suxamthonium (41%) or rocuronium (35%), and fentanyl (88%). Arterial lines (71%) and central venous catheters (76%) were frequently inserted. Fluid resuscitation with blood products or cell salvage (76%), colloids (70%) and crystalloids (70%) were used. Postoperatively, 89% of the patients were alive, 47% were still intubated and transferred to ICU.

Mainly young males were the victims of stabbed hearts. Almost half of the victims survived to hospital admission. Most patients were intubated in theatre following rapid or modified rapid sequence induction, had arterial lines and central venous catheters inserted, and received blood products. Eighty-nine percent of patients survived to theatre discharge.

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LIST OF ABBREVIATIONS

A-line:	Arterial line
CHBAH:	Chris Hani Baragwaneth Academic Hospital
CVP:	Central venous catheter
ECG:	Electrocardiogram
ICU:	Intensive care unit
MRSI:	Modified rapid sequence induction
RSI:	Rapid sequence induction

CHAPTER ONE
OVERVIEW OF THE STUDY

1.1 Introduction

In this chapter, an overview of the study was presented. This includes the introduction, background, problem statement, aim, objectives, research assumptions and definitions, demarcation of the study field, ethical considerations, research methodology, significance of the study, validity and reliability of the study, and the outline of the research report.

1.2 Background

In 1978 Dr. Wasily Sakalo arrived in Johannesburg to work at the then Baragwanath Hospital; the following is an extract taken from his article in the British Medical Journal in 1979 (1):

> *A seemingly lifeless body is literally thrown on to a stainless-steel trolley thinly covered by a rubber mattress and is wheeled past the casualty clerk, who doesn't even have time to extract the one-rand payment. I rush over and place my stethoscope on his chest and hear distant heart sounds. He is shocked and unconscious with laboured breathing. There is a laceration on the left of his chest. I plunge a needle into his pericardium and extract fresh blood. Stabbed heart! Without further ado I ask for gloves and scalpel, open his chest, and force his ribs apart. The heart is stabbed and blood squirts on to my clothes and shoes. I plunge my finger into the offending hole and race with the trolley and patient across an open corridor to the theatre that is always prepared for such emergencies.*
>
> *We stitched the hole and left the patient in the care of nurses. He was discharged 10 days later remarkably well. The time was now 11:30 and the night was young. In summer on a warm night anything can happen and the team on duty usually works all through the night. Already we had had four disembowelments and many beatings and stabbings, and this was the second stabbed heart. This was also my first day at work.*

Chris Hani Baragwanath Academic Hospital (CHBAH) is perceived to be one of the leading centres worldwide for the management of stabbed hearts due to the sheer number of patients admitted with this nature of injury (1-5). In the last three decades three studies were conducted at this hospital, and the incidence of stabbed heart wounds were:

- 1975 to 1980, 106 patients admitted to the intensive care unit (ICU) (2)
- 1988 to 1993, 310 patients were admitted (3)
- January 2002 to August 2004, 96 patients were admitted (5).

From 1985 to 2009 five South African studies, three from the Western Cape (6-8) and two from Kwazulu Natal (9, 10) were identified. The incidence of stabbed heart wounds varied from 17 to 65 per year.

The incidence of stabbed hearts in the developed countries varies from five patients in the ten year, 1988 to 1997 period in Sweden (11), to 19 autopsies that were performed in 1985 to 1986 in the Jefferson district Alabama (12).

In both developed and developing countries, only a small percentage of people who fall victim to stabbed heart wounds survive to receive hospital treatment (10, 12-14). Surgical management of varying stab wounds to the heart has been well documented. However, limited literature was identified describing the anaesthetic management these patients. This could be partly due to the limited number of such cases in developed countries, or to the difficulty in receiving hospital treatment in developing countries.

1.3 Problem statement

Internationally, the incidence of stabbed hearts varies, with a higher incidence in developing countries (2, 5, 6, 9-11, 15-19). The majority of the literature identified were case studies which detailed the surgical management of stabbed hearts (3, 5-7, 9-11, 15-31).

At CHBAH, three studies over the past three decades have shown a high incidence of stabbed hearts (2, 3, 5), with as many as 5 to 6 cases every month (4). However, the actual number of patients dying prior to receiving hospital treatment, those patients arriving alive at CHBAH following a stabbed heart, and how many survive to progress to surgical repair in theatre, has not been described.

Stabbed hearts are surgical emergencies that require a prompt and focused anaesthetic intervention. However, the patient profile and management from an anaesthetic perspective is not well described internationally, nationally and more specifically at CHBAH.

1.4 Aim

The aim of this study was to describe the profile and anaesthetic management of patients with stabbed hearts presenting to the Diepkloof Mortuary, emergency department and to operating theatres at CHBAH over a one year from 1 July 2012 to 30 June 2013. This study was done in two parts.

1.5 Objectives

The objectives of Part I were to describe the patients presenting to the mortuary with regard to:

- the number of patients with stabbed hearts
- the demographic details (age and gender)
- the sites of the entry wounds at the level of the skin
- the sites of myocardial injury.

The objectives of Part II were to describe the patients that present alive to the hospital with regard to:

- the number of patients with stabbed hearts
- the demographic details (age and gender)
- the sites of the entry wounds at the level of the skin
- the sites of myocardial injury
- the haemodynamic status on admission to the emergency department (pulse, heart rate and blood pressure)
- resuscitation in the emergency department
- preoperative complications
- the number of patients who died in the emergency department
- the time trajectory from the admission to the emergency department to the start of surgery
- site of intubation (pre-hospital, emergency department or theatre)
- intraoperative anaesthetic management
- intraoperative complications related to the stab wound
- the intraoperative complications related to the anaesthesia and surgery
- the patients' outcome at the end of surgery.

1.6 Research assumptions and definitions

The following definitions were used in this study.

Stabbed heart: a penetrating myocardial wound as a result of stabbing with a sharp object.

Database/record/sources: were used interchangeably in the study, and was based on what was found at each data collection site:

- Diepkloof Mortuary database was composed of physical records of post-mortem reports
- trauma database was an electronic database of all trauma patients that present to the emergency department at CHBAH
- anaesthetic database was the physical anaesthetic charts filed.

Postoperative patient outcome: refers to the status of the patient after surgical intervention in theatre (see Figure 1.1 below).

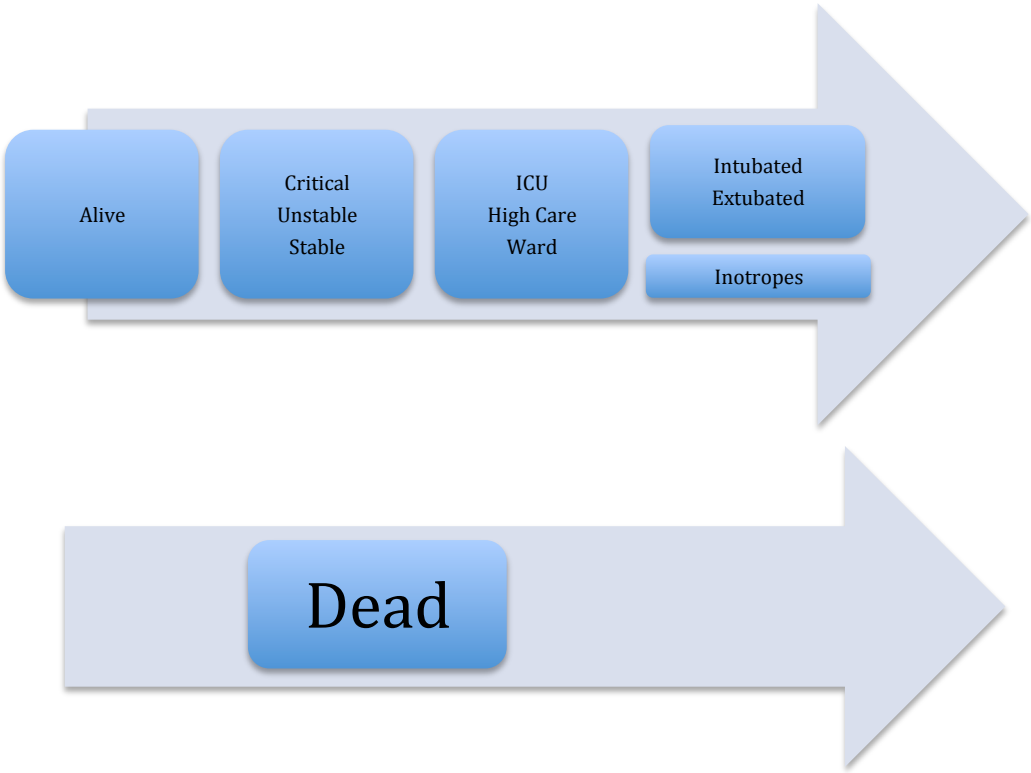

Figure 1.1 Postoperative patient outcome

1.7 Demarcation of study field

This study took place at Diepkloof Mortuary and CHBAH, Gauteng Province, South Africa.

Patients that died before receiving hospital treatment are taken to Diepkloof Mortuary. This is a state forensic pathology mortuary situated in Soweto, where on average 1700 autopsies are done per year.

Patients who survive to receive hospital treatment, are admitted to CHBAH which is a 2888 bed central hospital that serves the community of Soweto and is affiliated to the University of the Witwatersrand.

1.8 Ethical considerations

Approval to conduct this study was obtained from the relevant authorities (Appendix A). Anonymity and confidentiality of patients' records were ensured. This data will be securely stored for a six year period once the research has been completed.

This study was conducted in accordance of with the Declaration of Helsinki (32) and the South African Guidelines for Good Clinical Practice (33).

1.9 Research methodology

The study used a retrospective, contextual and descriptive design. Records of patients with stabbed hearts presenting to Diepkloof Mortuary and CHBAH formed the study population. Sample size was determined from available records of patients with of stabbed hearts presenting to Diepkloof Mortuary and CHBAH during the one year period from 1 July 2012 to 30 June 2013. Consecutive convenience sampling was used for this study and inclusion and exclusion criteria were defined.

After permission was obtained from relevant authorities, data was collected on site from the databases and entered directly onto a Microsoft® Office 365 Excel spreadsheet (Appendix B and C).

Data were analysed using Microsoft® Office 365 Excel. Descriptive statistics were used, frequencies and percentages were reported.

Measures were taken to ensure the validity and reliability of this study.

1.10 Significance of the study

Although stabbed hearts are surgical emergencies which require a prompt and focused anaesthetic intervention, no anaesthetic protocol or guidelines for the management of such cases are currently in place.

This study was the first to describe the comprehensive profile and anaesthetic management of patients with stabbed hearts, and as a result of CHBAH being perceived to be one of the leading centres worldwide for the management of stabbed hearts, it may contribute towards the development of an anaesthetic guideline in the management of such cases.

1.11 Outline of research report

This study consists of the following chapters.

Chapter One	Overview of the study
Chapter Two	Literature review
Chapter Three	Research methodology
Chapter Four	Results and discussion
Chapter Five	Summary, limitations, recommendations and conclusion.

1.12 Summary

In this chapter a brief overview of this study was given. In the following chapter the literature review is presented.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

Gaius Julius Caesar (July 100 BC – 15 March 44 BC) was a Roman general, statesman, consul and proclaimed “dictator perpetuity”, who was stabbed 23 times with around 60 men participating in his assassination (34, 35). According to Roman historian Gaius Suetonius Tranquillus, only one wound had been lethal, the wound to his heart (34).

Throughout history and mythology (as examples the staking of vampires through the heart, and cupid shooting people with an arrow though the heart), humanity has had to deal with penetrating wounds to the heart.

In this chapter the literature review was discussed. Topics covered include history, incidence, demographics, site of lesion, site of entry wound on skin, cardiac tamponade, associated injuries, resuscitation, and anaesthetic management.

2.2 History

The documented history of surgical repairs for penetrating wounds to the heart begins at the end of the 19th century. Accepted treatment methods, prior to this, were conservative (rest, external wound bandages and bloodletting). Axel Hermansen Cappelen attempted to perform the first suture to the human heart on 4 September 1895 (36).

Ludwig Rehn is regarded as the first person to successfully suture a stab to the right ventricle on 9 September 1896 (36, 37). On 8 April 1897 Antonio Parrozzani became the first to successfully suture a stab to the left ventricle (36).

Rehn’s patient, a 22 year old gardener (36, 37) who sustained a knife wound to his heart on 7 September 1896 was admitted to hospital in blood soaked clothing. “On examination he was found to be pale, with a barely palpable pulse and with skipped beats, he had labored breathing, but with clear heart sounds. However, he demonstrated with cardiac dullness shifted to the right on percussion, and a nonbleeding 1,5 cm wound in his fourth left intercostal space” (37).

After initial conservative management the patient the deteriorated (weak and irregular pulse, increased area of cardiac dullness, and severe tachypnoea) and a diagnosis of increasing haemothorax was made. They were unsure of the injured structure, “the heart or its the great vessels, an intercostal artery, or the internal mammary artery”. However, they suspected it was the heart since “the tract of the wound lay in the direction of the heart”. He decided to proceed with surgery to stop the bleeding (37).

A few hours postoperatively the patient’s respiratory rate was 28 breaths per min with a pulse of 112 to 132 beats/min and variable in strength. He developed an empyema by 19 September which was successfully drained. Rehn presented this case to the German Society of Surgery six months later by which time the patient had returned to good health (36).

There were 22 reported cases of stab wounds to the heart in the 19th century, of whom eight survived. The use of ether anaesthesia was reported in some cases, while other cases were performed without any anaesthesia (36).

2.3 Incidence

The incidence of stabbed hearts varies from developed to developing countries, with a higher incidence in the latter (2, 3, 5, 7, 9, 10, 15, 17). A postulated reason for this was the increase in gunshot wounds as opposed to stab wounds, in developed countries (12, 28).

International

In a retrospective study done in Los Angeles, California (29) between March 1972 and March 1978, 25 stabbed hearts were documented.

A review of cases at The Institute for Cardiovascular Disease in Belgrade, Serbia between 1982 and 2007 by Velinovic et al. (19) reported that 14 patients were admitted and treated surgically for penetrating cardiac wounds during the 25 year period; only 10 of these cases were due to stabbed hearts.

Between January 1983 to July 1985 Kulshrestha et al. (14) found 17 stabbed hearts during post-mortem examination at the All India Medical Institute of Medical Sciences in Delhi, India.

A review of a post-mortem examinations from Jefferson County, Alabama; Naughton et al. (12) found that there were 28 cases of stabbed hearts during 1985 and 1986.

Mohamed Thahar Maamouri Hospital in Tunisia admitted 17 cases of penetrating cardiac injuries from January 1994 to December 2010 cases (16). Sixteen of these were due to stabbed hearts.

A study in Gothenburg, Sweden (11) showed that during a 10 year period from January 1988 and December 1997, five patients were admitted to Sahlgrenska University Hospital in Gothenburg with stabbed hearts. All five patients presented with cardiac tamponade.

In a mortuary study in Bursa, Turkey, between 1997 and 2001, Fedakar et al. (38) found 77 stabbed hearts.

Two studies were identified from Turkey, Kamali et al. (39) between 1995 and 2009 who found 23 cases of penetrating cardiac injury and Ekim et al. (40) between May 1999 and January 2010 who found 16 cases of stabs to the chest, some of whom had sustained injury to the heart.

Between January 1998 and June 2006, 102 patients with penetrating cardiac injuries, with 83 patients being the victims of stab wounds to the heart, presented to one of either Dr. Joao Lucio Pereira Machado Emergency Hospital or August 28 County Emergency Hospital in Manus, Brazil (17).

Between January 2001 and June 2007 in Iran, Janati et al. (18) found 25 cases of stabbed hearts. All 25 patients were discovered to have cardiac tamponade.

South Africa

A study done in Cape Town during 1985 and 1986 consisting of both a post-mortem and Groote Schuur Hospital admissions study, showed that autopsies of 507 chest wounds indicated 240 cases of stabbed heart wounds. The study the 38 patient admissions for acute tamponade as a result of stab wounds, 34 of whom were a result of stabbed heart wounds, three were pulmonary artery bleeds while the other penetrated the pericardium, but not the myocardium. (8)

Two studies were identified from Tygerberg Hospital, Cape Town. Knott-Craig et al. (7) identified 129 patients admitted with stabbed hearts during a two year period between 1986 and 1988. Harris et al. (6) later did a study during a three year period from July 1994 to August 1997; 124 patients were admitted during this period with stab wounds to the chest, of which 110 were stabbed hearts (6)

Campbell et al. (10), in a review of 1198 cases of penetrating cardiac trauma between 1990 to 1992, at King Edward VIII Hospital in Durban, had 70 admissions to hospital for penetrating cardiac trauma, 35 of whom survived. Of the 70 patients, 66 had stabbed hearts. During the same three year time period, 1128 victims were taken directly to the mortuary with cardiac injury, in 631 of these cases stabbed hearts were discovered during post-mortem examination. They reported that 15 of the 35 non survivors had multiple chamber injuries, whereas all of the survivors had sustained just a single chamber injury.

A study done by Clarke et al. (9) in Pietermaritzburg, from July 2006 to July 2009 showed that the mortuary serving the Pietermaritzburg Metropolitan Complex performed 676 post-mortem examinations for penetrating cardiac injuries, of these 206 cases were stabbed hearts. During the same three year period, 108 patients with penetrating cardiac injuries taken to theatre in the Pietermaritzburg Metropolitan Complex (across the three hospitals), 102 were as a result of stab wounds, while 76 had stabbed heart wounds.

Chris Hani Baragwanath Academic Hospital

Three audits were identified over the past three decades, of stabbed hearts seen at CHBAH.

Joshi and Essop (2), reviewed the records of 114 patients with who were admitted to ICU post surgical repair of stabbed hearts between February 1975 and February 1980. Six patients were reported to have isolated pericardial injury and 108 had myocardial injury. The actual number of patients admitted to hospital with stabbed hearts during this period was not known.

From January 1988 to May 1993, at CHBAH, Velmahos et al. (3) reviewed the files of 373 patients admitted with penetrating cardiac injuries, of these 310 patients had stabbed hearts.

Degiannis et al. (5) did a retrospective review of 117 patients' files with a preoperative diagnosis of penetrating heart trauma that underwent surgery, at CHBAH, for the period between January 2002 and August 2004. They found 96 were patients transferred from trauma to theatre for surgical repair for stabbed hearts (5).

A comparison of average stabbed hearts as identified in the literature is presented in Table 2.1. An estimate of the average per year has been included.

Table 2.1 Incidence of stabbed hearts from previous studies

Study	Period	Total number of stabbed hearts	Average stabbed hearts per year
CHBAH			
Joshi and Essop (2)	1975-1980	108	22
Velmahos et al. (3)	1988-1993	310	57
Degiannis et al. (5)	2002-2004	96	36
South Africa			
Oakland and Vivian (Groote Schuur) (8)	1985-1896	34	17
Knott-Craig et al. (Tygerberg) (7)	1986-1988	129	65
Harris et al. (Tygerberg) (6)	1994-1997	110	37
Campbell et al. (King Edward) (10)	1990-1992	66	22
Clarke et al. (Pietermarizburg) (9)	2006-2009	76	25
International			
Mandal et al. (USA) (29)	1972-1978	25	4
Velinovic et al. (Serbia) (19)	1982-2007	10	0,4*
Rashid et al. (Sweden) (11)	1988-1997	5	0,5*
Rodrigues et al. (Brazil) (41)	1990-2003	43	3
Ezzine et al. (Tunisa) (16)	1994-2010	17	1
Kamali et al (Turkey) (39)	1995-2009	23	2
Costa et al. (Brazil) (17)	1998-2006	83	10
Ekim et al. (Turkey) (42)**	1999-2010	18	2
Janati et al. (Iran) (18)	2001-2007	25	4

* less than 1 case per year has been rounded off to the one decimal value

** Includes myocardial injury secondary to gunshot wounds

2.4 Demographics

The majority of patients presenting with stabbed were male. The lowest incidence (71%) was reported by Velinovic et al. (19) followed by Rashid et al. (11) and Ezzine et al. (16) who reported 82% and 89% respectively. All other studies (2, 5-7, 9, 10, 17, 18, 29, 41, 42) reported a male predominance of 90% or more , with Kamali et al. (39) reporting a 100%.

Stab hearts were identified mainly among younger patients with the majority between 24 and 36 year old (2, 5-7, 11, 16-19, 29, 39, 42). The youngest patient identified in the literature with a penetrating cardiac wound was a 3 year old in Brazil, however whether or not this was a stab was not reported (41). The oldest patient identified was a 77 year old in South Africa as reported by Campbell et al. (10), but again it was not reported whether or not this was stab.

2.5 Site of entry wound at the level of the skin

A stab wound to the precordium or the left anterior chest wall was usually the predominant surface entry wound in patients presenting with stabbed hearts (2, 3, 16, 17). Certain injuries, which may appear to be far away from the heart, can result in stabbed hearts, in particular to the base of the neck, the subclavian areas, the lateral chest or epigastrium and axilla (16).

2.6 Site of lesion

In the majority of the identified literature, the right ventricle was the predominant chamber damaged during a stabbing to the heart (2, 3, 6, 7, 9, 10, 16, 18, 19, 29, 41, 42). This is due to the normal anatomical position and orientation of the right ventricle within the thoracic cavity. It was interesting to note that in three studies (11, 17, 39) the left ventricle was injured more frequently. A summary of the distribution of site of lesion in presented in Table 2.2. Two studies were excluded from the summary (Degiannis et al. (5) and Oakland C. and Vivian J. (8)) as neither had clear indication of the site of lesion).

Table 2.2 Distribution of site of lesion

Site	Lesion				
	Right Ventricle	Left Ventricle	Right Atrium	Left Atrium	Multiple Sites
CHBAH					
Joshi and Essop (CHBAH) (2)	45	35	10	9	7
Valmahos et al. (CHBAH) (3)	179	138	58	8	0
South Africa					
Knott-Craig et al. (Tygerberg) (7)	71	32	24*		0
Harris et al. (Tygerberg) (6)	76	28	5	0	5
Campbell et al. (Durban) Mortuary (10)	498	440	223	135	0
Campbell et al. (Durban) Hospital (10)	37	20	8	28	0
Clarke et al. (Pietermaritburg) (9)	38	31	3	4	0
International					
Mandal et al. (Los Angeles) (29)	40	15	8	2	0
Velonovic et al.(Serbia) (19)	11	2	0	0	1
Rashid et al. (Sweden) (11)	2	3	0	0	0
Rodrigues et al. (Brazil) (43)	26	18	19	4	0
Ezzine et al. (Tunisia) (16)	14	2	0	0	0
Kamali et al. (Turkey) (39)	4	15	4	0	0
Costa et al. (Brazil) (17)	38	39	9	11	8
Ekim et al (Turkey) (40)**	11	6	4	1	2

* Both atria are combined

** Includes myocardial wounds secondary to gunshot wounds

2.7 Cardiac tamponade

Cardiac tamponade was a common finding when dealing with stabbed hearts (2, 5, 6, 8-11, 16, 18, 22, 29, 41). The highest incidence (78%) of cardiac tamponade was reported by Harris et al. (6) and the lowest (21%) by Ezzine et al. (16). A diagnosis of cardiac tamponade can sometimes be made difficult in the presence of intraabdominal haemorrhage caused either by a thoracoabdominal stab wound, or by concomitant thoracic and abdominal stabs (5).

Degiannis et al. (5) reported a 49% incidence of cardiac tamponade, however there was 92% of these patients survived. The authors then deducted that cardiac tamponade may be a positive survival factor as it protected patients from exsanguination.

2.8 Associated Injuries

Associated vascular and pulmonary injuries were common findings in patients with stabbed hearts (3, 5, 6, 10, 11, 17, 22, 43). However, non-cardiopulmonary injuries were also found (2, 7, 11, 12, 16-18, 43) including injuries to the oesophagus, diaphragm, liver, stomach and spleen.

Vascular damage to one of the major blood vessels following a stabbed heart was relatively common; laceration to the aorta (3, 5, 12, 17, 22, 43), pulmonary artery (3, 5, 6, 11, 12, 17, 22, 43), coronary arteries (10, 11, 43) and venae cavae (3, 5, 6, 12, 22, 43) have been documented in numerous studies.

Campbell et al. (10) reported in their review that injury to the left anterior descending artery (9%) was the most common vessel injury. Joshi and Essop (2) also reported that coronary injury was the most frequent intrapericardial vessel injuries (6%). However, they noted in their study that the most common vessel injury, was to the internal mammary artery (13%). In comparison Harris et al. (6) reported that injury to the main pulmonary artery (34%) was the most common major vessel to be injured in their study. Velmahos et al. (3) noted a relatively similar number of case of venae cave (1,6%) and pulmonary artery injury (1,3%) within the pericardium, followed by injury to the aorta (0,8%).

Haemothorax (11, 16, 18) and lung injury (12, 17, 18, 22) were the most common associated pulmonary injuries found in patients with stabbed hearts.

2.9 Resuscitation

The resuscitation of patients with stabbed hearts in emergency departments were varied and limited in the literature with the main focus on thoracotomies.
Patients admitted with stabbed hearts to the emergency departments in hospitals, were frequently resuscitated using the Advanced Trauma Life Support protocols (5, 22).

Part of the resuscitation strategy documented by Velmahos et al. (3) was the use of a digital examination once the suspicion of heart injury was made. Active infusion of fluids and blood was through central and peripheral lines. Oxygen was delivered via a face mask and pleural collections were drained.

Knott-Craig et al. (7) documented a more detailed resuscitation management strategy. Crystalloid infusion was initiated, during which central venous access (commonly via the subclavian vein) was obtained with a large gauge. Oxygenation was maintained based on patient status, either with the use of a facemask or after intubation. Intubated patients were then ventilated by hand. If deemed necessary, emergency pericardiocentesis or an emergency room thoracotomy was performed.

Clarke et al. (9) did not encourage emergency room thoracotomy due to environmental difficulties. It was still noted that a number of trauma centres perform emergency room thoracotomies (2, 3, 5, 7, 16, 22).

Asensio et al. (44) indicated for that patients presenting in cardiopulmonary arrest emergency room thoracotomy was “indicated for the management of penetrating cardiac injuries with immediate cardiorrhaphy along with aortic cross clamping and open cardiopulmonary massage”, with approximately a 10% success rate. In an earlier study Asensio et al. (22) reported a mortality rate of 84% in patients who had an emergency department thoracotomy.

All three studies done at CHBAH documented the use of emergency room thoracotomy (2, 3, 5); Joshi and Essop (2), in patients who developed preoperative cardiac arrest; Velmahos et al. (3), patients with no signs of life; however Degiannis et al. (5), did not perform emergency room thoracotomies on patients presenting in a lifeless condition if vital signs have been absent for longer than five minutes.

The mortality rate for patients who underwent emergency room thoracotomy was found to be high in multiple studies; Joshi and Essop (2) indicated 46%, Degiannis et al. (5) 57% (from stabbed hearts), Velmahos et al. 70% (3), Asensio et al. 84% (22) and Demetriades 91% (31).

2.10 Anaesthetic management

Only three articles were identified from literature in which the anaesthetic management of patients with stabbed hearts were included.

At The Institute for Cardiovascular Disease in Belgrade, Serbia (19), the management of all patients sustaining penetrating cardiac injuries included surgery. This was pre-empted with intubation and ventilation under general anaesthesia. Intraoperative monitoring included invasive blood pressure monitoring via an arterial line (A-line) and central venous catheter (CVP), as well as standard non-invasive electrocardiogram (ECG) and haemodynamic monitoring. Biochemistry was also monitored intraoperatively. Both crystalloid and colloid infusions were used.

Knott-Craig et al. (7) recorded that stable patients underwent rapid sequence induction with ketamine and succinylcholine because the patients' stomachs were full. However, some patients were intubated under local anaesthesia and were allowed to breathe spontaneously until the start of surgery.

In a single case report published in the Indian Journal of Anaesthesia. Panchamia et al. (45) described the management of a patient who was intraoperatively found to have a stab to the right ventricle. Preoperatively the patient was conscious and oriented. However, he was also reported to be pale with cold peripheries, he was tachycardic and hypotensive, and presented with decreased air entry in the left lower zone. Induction with ketamine and succinylcholine was followed by intubation, and intermittent positive pressure ventilation was initiated with 100% oxygen. Intraoperative monitoring was preformed using a pulse oximeter and ECG. However, no note was made regarding whether invasive blood pressure monitoring was used. Intraoperative inotropy with dopamine was used; while atracurium was used for the maintenance of muscle relaxation.

2.11 Complications

Perioperative complications that arise from a stab to the heart can be divided into three groups; those complications arising directly as a result of the stab wound, those that occur as a result of the surgery, and those that occur from the anaesthetic management.

Perioperative complications are summarised in Table 2.3.

2.13 Summary

An overview of the literature was provided in this chapter. The following chapter contains the methodology of the study.

Table 2.3 Perioperative complications

Stab wound	Preoperative	Intraoperative	Postoperative
Haemopericardium (18) Haemothorax (16, 18) Lung injury (17, 18) Supraventricular tachycardia (17) Conduction defects (2, 16) Intracardial lesions (7)	Pericardial effusion (17) Hypovolaemic shock (17) Cardiac arrest (2, 17) Respiratory failure (17)	Hypovolaemic shock (17) Cardiac arrest (7, 17) Respiratory shock (17) Patient awareness	Hypovolaemic shock (17) Cardiac arrest (2, 17) Respiratory failure (5, 17) Pleural effusion (18) Nosocomial pneumonia (2, 3, 5, 17) Empyema (17) Postoperative ventilation (2, 6) Re-exploration for bleeding (6) Hemiparesis or residual neurological deficit (2, 5, 6) Mitral valve stricture or regurgitation (5, 6) Valsalva fistula (6) Post intubation tracheal stricture (6) Wound sepsis (2, 3, 6, 7) Acute tubular necrosis (2) Residual haemothorax (3, 5) Septal defects (3) Cardiac failure (5) Apex thrombosis (5)

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

In this chapter the research methodology was discussed in detail. The problem statement, aim, and objectives have been repeated. Followed by ethical considerations, research methodology, and validity and reliability.

3.2 Problem statement

Internationally, the incidence of stabbed hearts varies, with a higher incidence in developing countries (2, 5, 6, 9-11, 15-19). The majority of the literature identified were case studies which detailed the surgical management of stabbed hearts (3, 5-7, 9-11, 15-31).

At CHBAH, three studies over the past three decades have shown a high incidence of stabbed hearts (2, 3, 5), with as many as 5 to 6 cases every month (4). However, the actual number of patients dying prior to receiving hospital treatment, those patients arriving alive at CHBAH following a stabbed heart, and how many survive to progress to surgical repair in theatre, has not been described.

Stabbed hearts are surgical emergencies that require a prompt and focused anaesthetic intervention. However, the patient profile and management from an anaesthetic perspective is not well described internationally, nationally and more specifically at CHBAH.

3.3 Aim

The aim of this study was to describe the profile and anaesthetic management of patients with stabbed hearts presenting to the Diepkloof Mortuary, emergency department and to operating theatres at CHBAH in the year from 1 July 2012 to 30 June 2013. This study was done in two parts.

3.4 Objectives

The objectives of Part I were to describe the patients presenting to the mortuary with regard to:

- the number of patients with stabbed hearts
- the demographic details (age and gender)
- the sites of the entry wounds at the level of the skin
- the sites of myocardial injury.

The objectives of Part II were to describe the patients that present alive to the hospital with regard to:

- the number of patients with stabbed hearts
- the demographic details (age and gender)
- the sites of the entry wounds at the level of the skin
- the sites of myocardial injury
- the haemodynamic status on admission to the emergency department (pulse, heart rate and blood pressure)
- resuscitation in the emergency department
- preoperative complications
- the number of patients who died in the emergency department
- the time trajectory from the admission to the emergency department to the start of surgery
- site of intubation (pre-hospital, emergency department or theatre)
- intraoperative anaesthetic management
- intraoperative complications related to the stab wound
- the intraoperative complications related to the anaesthesia and surgery
- the patients' outcome at the end of surgery.

3.5 Ethical considerations

Approval for this study was obtained from both the Human Research Ethics Committee (Medical) and from the Postgraduate Committee of the University of the Witwatersrand (Appendix A).

A letter of permission from the Manager of Diepkloof Mortuary was obtained in order to allow access to their patients' records (Appendix A). Since this was a retrospective study, which required access to patients' records, informed consent from the Medical Advisory Committee of CHBAH (Appendix A) was obtained in order to conduct research within the hospital and to utilise these records. Letters of permission were also obtained from the Heads of Department of Trauma Surgery and Anaesthesiology, the gatekeepers of the respective database (Appendix A).

To ensure patient anonymity, patient records were allocated a study number. Only the researcher had access to the patients' names and hospital number, which were kept in a separate file. This was also done to ensure anonymity of patient information. Only the researcher and supervisors had access to raw data that ensured confidentiality. The raw data will be securely stored for a six year period from completion of this study.

This study was conducted in accordance of with the 2013 Declaration of Helsinki (32) and the South African Guidelines for Good Clinical Practice (33).

3.6 Research methodology

3.6.1 Research design

The study used a retrospective, contextual and descriptive design.

Retrospective studies are usually cross-sectional in nature and set out to investigate an effect (phenomenon, problem, situation or issue) and proposed cause that has already occurred (46-48). This study was retrospective in nature as it involved analysis of recorded data from databases for patients who sustained stab wounds to the heart.

Contextual studies are used when the social and environmental setting influence the intervention and study outcome (48). This study was contextual in nature as it was conducted within a specific context, which was Diepkloof Mortuary and CHBAH.

Descriptive studies are used to explore and describe phenomena as they occur naturally. It may be used to identify problems, and to justify or determine what other professionals are doing in similar situations in current practice (46). This study was descriptive in nature since it aimed to gain more information about the patients presenting directly to Diepkloof Mortuary, and to those who survive to receive hospital treatment at CHBAH following stabbed hearts.

3.6.2 Study population

Records of patients with stabbed hearts that presented to Diepkloof Mortuary and CHBAH.

3.6.3 Study sample

Sample size

Sample size was determined from available records of patients that presented to Diepkloof Mortuary and CHBAH during the year from 1 July 2012 to 30 June 2013 with stabbed hearts.

Sampling method

Consecutive convenience sampling was used for this study. Consecutive sampling is "a version of convenience sampling where every available individual or event within an accessible population is chosen" (49). With convenience sampling, subjects are included due to their easy availability for utilization in the study because "they happen to be at the right place at the right time" (46-48). Consecutive sampling is the best choice of non-random sampling (49).

Inclusion and exclusion criteria

Inclusion criterion for this study were records of patients with myocardial wound from stabbed hearts.

The exclusion criterion for this study was illegible handwriting on records.

3.6.4 Data collection

In order to address the research objectives, quantitative research requires obtaining numerical data through consent from the setting where the study is to be conducted. The data collection is implemented though a variety of techniques, such as questionnaires, forms, and data collection sheets (48).

Patients who died either on scene or on route to hospital were taken directly to Diepkloof mortuary. Patients who were alive were admitted to the emergency department of CHBAH. The patients who survived were subsequently transferred to theatre for surgical intervention.

Data collection was therefore from three sources:

- mortuary database
- trauma surgery database
- anaesthetic database.

Microsoft® Office 365 Excel spreadsheet was utilised for the data capturing from each specific source (Appendix B and C). Data was collected on premises.

Data collections from hospitalised patients were collected from multiple sources. However, data missing from one source did not exclude the patient from the overall analysis, but merely from specific analysis.

Patients who had a died after admission to hospital and who subsequently had a post-mortem were excluded from the mortuary database, but were included in the trauma surgery database and the anaesthetic database (for those who died in theatre).

From the mortuary database the following information was sought:

- age
- sex
- site of skin lesion
- site of lesion in myocardium.

From the trauma surgery database the following information was sought:

- time of admission
- vital signs on admission
    - blood pressure
    - heart rate
    - saturation
- resuscitation preformed in emergency department
    - cardioversion
    - cardiac massage
    - emergency thoracotomy
    - pericardiocentesis
    - adrenaline use
- patients that died in emergency department.
- site of lesion in myocardium
- presence of cardiac tamponade
- associated cardiac injuries to the major vessels.

Anaesthetic charts for the patients appearing in the trauma surgery database was obtained. From the anaesthetic chart the following information was sought:

- time of arrival in theatre or surgery start time
- anaesthetic start time
- induction agent
- muscle relaxant
- intubation
- opioid
- inotrope
- volatile agent
- other drugs
- haemodynamic monitoring
    - A-line
    - CVP
- fluids
    - crystalloid
    - colloid
    - packed red cell concentrate
    - fresh frozen plasma
    - platelets
    - cell saved blood
- postoperative outcome
    - alive
    - dead
    - intubated
    - extubated
    - inotrope use on transfer postoperative
    - transfer to
        - ICU
        - high care
        - ward
- intraoperative complications.

Demographic data such as age and gender was obtained from any source where available.

3.6.5 Data analysis

Data capturing was preformed using a Microsoft® Office 365 Excel spreadsheet. This data was analysed using descriptive statistics. Categorical data was described using frequencies and percentages.

3.7 Validity and reliability

The accuracy and truthfulness of scientific research describes the validity of the study. The external validity of a study refers to the degree in which the results can be generalized beyond the sample used in the study (46, 48).

"Reliability is concerned with the consistency, stability and repeatability of the informants' accounts as well as the investigator's ability to collect and record information accurately" (46).

Validity and reliability of this study was ensured by:

- an appropriate study design being used
- the data collection sheet developed following a literature review
- recording data for a full year
- the researcher being the only data capturer therefore ensuring consistency of the data collection process
- including all the records of stabbed hearts during data collection period.

3.8 Summary

The methodology of the study was presented in this chapter. The following chapter contains the results and discussion of this study.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, the results of the study according to the objectives are presented followed by the discussion.

The objectives of Part I were to describe the patients presenting to the mortuary with regard to:

- the number of patients with stabbed hearts
- the demographic details (age and gender)
- the sites of the entry wounds at the level of the skin
- the sites of myocardial injury.

The objectives of Part II were to describe the patients that present alive to the hospital with regard to:

- the number of patients with stabbed hearts
- the demographic details (age and gender)
- the sites of the entry wounds at the level of the skin
- the sites of myocardial injury
- the haemodynamic status on admission to the emergency department (pulse, heart rate and blood pressure)
- resuscitation in the emergency department
- preoperative complications
- the number of patients who died in the emergency department
- the time trajectory from the admission to the emergency department to the start of surgery
- site of intubation (pre-hospital, emergency department or theatre)
- intraoperative anaesthetic management
- intraoperative complications related to the stab wound
- the intraoperative complications related to the anaesthesia and surgery
- the patients' outcome at the end of surgery.

4.2 Sample realisation

All available records were collected for patients with stabbed hearts presenting to Diepkloof Mortuary and CHBAH during the one year period from 1 July 2012 to 30 June 2013.

There were 44 patients included in the study. The mortuary group comprised 23 patients who died either on the scene or on route to hospital. The CHBAH group comprised 21 patients who survived to admission at CHBAH. There were no exclusions made.

4.3 Results

Some data were missing, either due to incomplete documentation or missing anaesthetic charts. The missing data were excluded from the specific analysis. Percentages are rounded off to the nearest whole number, and may therefore not add up to exactly 100%. Part I and the first 4 objectives of Part II have been reported together under Part I.

Part I

4.3.1 Objective: describe the number of patients with stabbed hearts

There were 44 patients who sustained a stab to the heart. There was an almost equal split between those who survived to arrive in hospital (n=21, 48%) and those who demised and were taken directly to the mortuary (n= 23, 52%). Figure 4.1 shows the pathway that patients followed in this study.

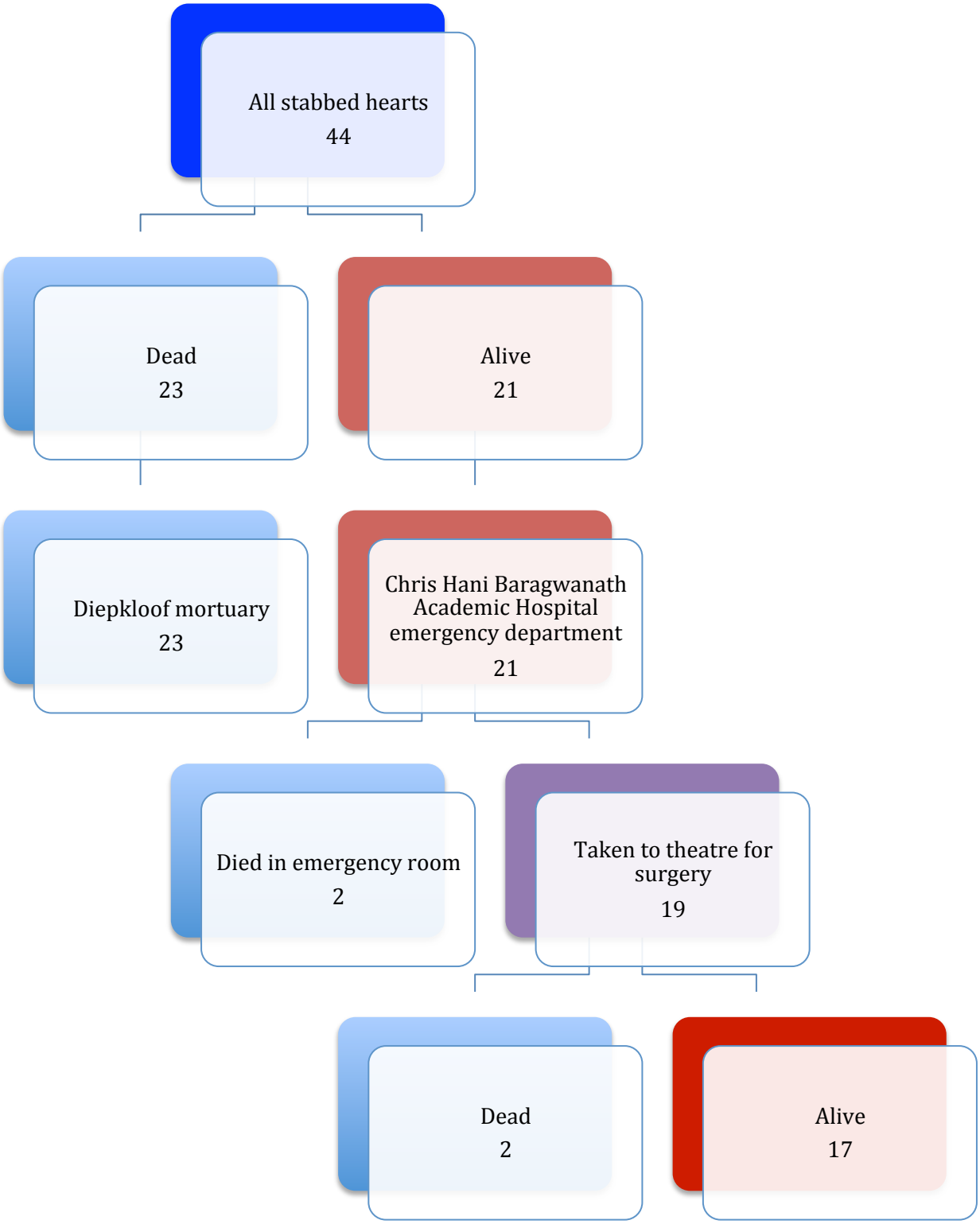

Figure 4.1 Pathway of study patients

4.3.2 Objective: describe the demographics details

Most of the patients were male (n=41, 93%), and were between the ages of 20 and 29 (n=23, 52%). The demographics of the patients included in the study are displayed in Table 4.1.

Table 4.1 Demographics

Demographics	**Total** (n = 44) n (%)	**Mortuary** (n = 23) n (%)	**CHBAH** (n = 21) n (%)
Gender			
Male	41 (93)	22 (50)	19 (43)
Female	3 (7)	1 (2)	2 (5)
Age Groups			
18 – 19	2 (5)	2 (9)	0 (0)
20 – 29	23 (52)	12 (52)	11 (52)
30 – 39	10 (23)	7 (30)	3 (14)
40 – 49	4 (9)	1 (4)	3 (14)
Unknown	5 (11)	1 (4)	4 (19)

4.3.3 Objective: describe the sites of the entry wounds at the level of the skin

Most of the deceased were stabbed in the left chest (n=17, 74%). The site of entry wound for the deceased is displayed in Table 4.2. There were no data available for the sites of the entry wounds among the patients who survived to hospital admission.

Table 4.2 Entry wound at the level of the skin for the mortuary patients

Site	**Number** (n = 23)	**Percentage**
Left Chest	17	74
Right Chest	2	9
Bilateral Chest	3	13
Sternal	1	4

4.3.4 Objective: describe the sites of myocardial injury

The right ventricle was the most frequently injured chamber (n=15, 65%) in the deceased; 10 (43%) right ventricle only plus 5 (22%) where both ventricles were penetrated. In those alive (n=13, 62%) the right ventricle was penetrated in the majority of patients. Overall the right ventricle was penetrated in 28 (64%) of patients. The combined sites of myocardial injuries for all patients is displayed in Table 4.3.

Table 4.3 Combined sites of myocardial injuries for all patients

Site	Total (n = 44) n (%)	Mortuary (n = 23) n (%)	CHBAH (n = 21) n (%)
Right ventricle only	23 (52)	10 (43)	13 (62)
Left ventricle only	10 (23)	6 (26)	4 (19)
Both ventricles	5 (11)	5 (22)	0 (0)
Right Atrium	5 (11)	1 (4)	4 (19)
Left Atrium	1 (2)	1 (4)	0 (0)

Two out of 4 (50%) patients with left ventricular injuries died before getting to theatre, both of these patients underwent emergency room thoracotomies. Figure 4.2 displays the breakdown of chambers injured for the patients admitted to CHBAH, those that went to theatre, and for those that were alive postoperatively.

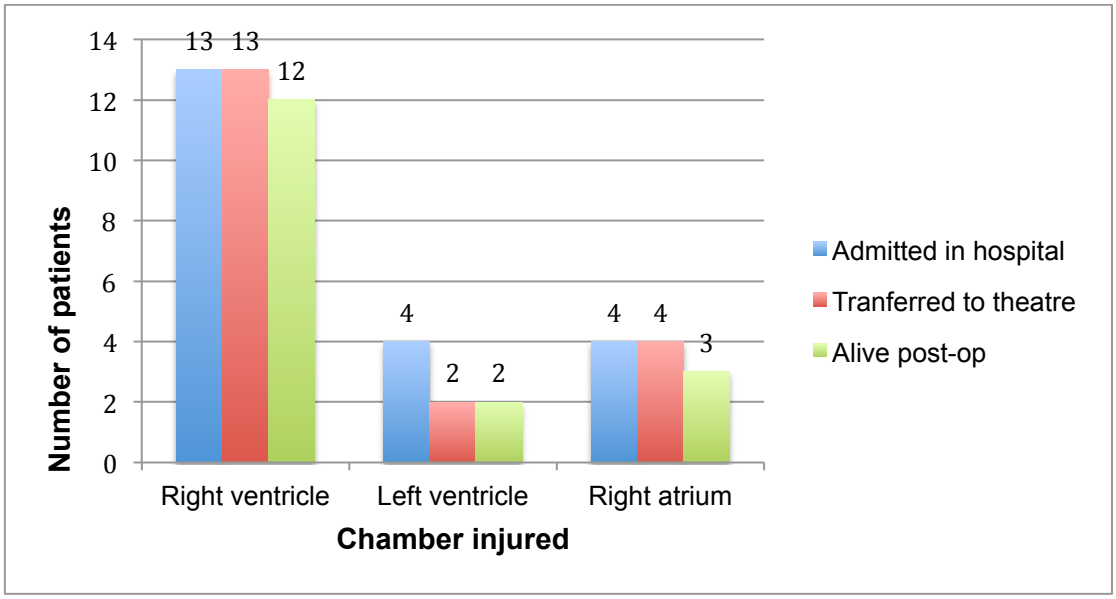

Figure 4.2 Chambers injured for patients admitted to CHBAH

All patients with multiple chamber and left atrial injuries died before arriving at hospital. Figure 4.3 displays the breakdown of chamber wounded for all those who demised; either before getting to hospital or in hospital; either in the emergency department or in theatre.

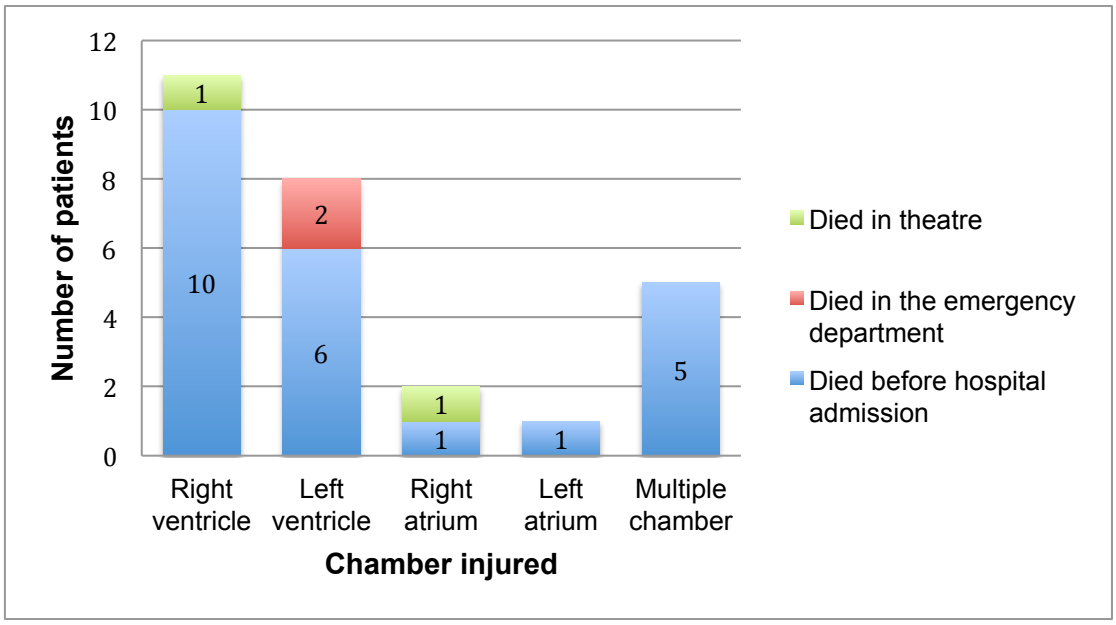

Figure 4.3 Chamber injured for patients who demised

Part II

4.3.5 Objective: describe the haemodynamic status on admission to the emergency department

No data were available with regards to the pulse, heart rate or blood pressure of the patients on admission to the emergency department.

4.3.6 Objective: describe the resuscitation in the emergency department

There were 2 (10%) patients who underwent emergency room thoracotomies. No other data were available for the resuscitation that occurred in the emergency department.

4.3.7 Objective: describe the preoperative complications

No data were available with regards to preoperative complications (eg. pericardial effusion, hypovolaemic shock, etc).

4.3.8 Objective: describe the number of patients who died in the emergency department

There were 2 (10%) patients who died in the emergency department. Both of these underwent emergency room thoracotomies.

4.3.9 Objective: describe the time trajectory from the admission to the emergency department to the start of surgery

This was not possible as the time of admission to the emergency department was not available.

4.3.10 Objective: describe the site of intubation (pre-hospital, emergency department or theatre)

There were no data available on whether the 2 patients who died in the emergency department had been intubated. Of the 19 patients, 14 (74%) were intubated in theatre, 2 (11%) in the emergency department, and 3 (16%) unknown. The site of intubation is displayed in Figure 4.4.

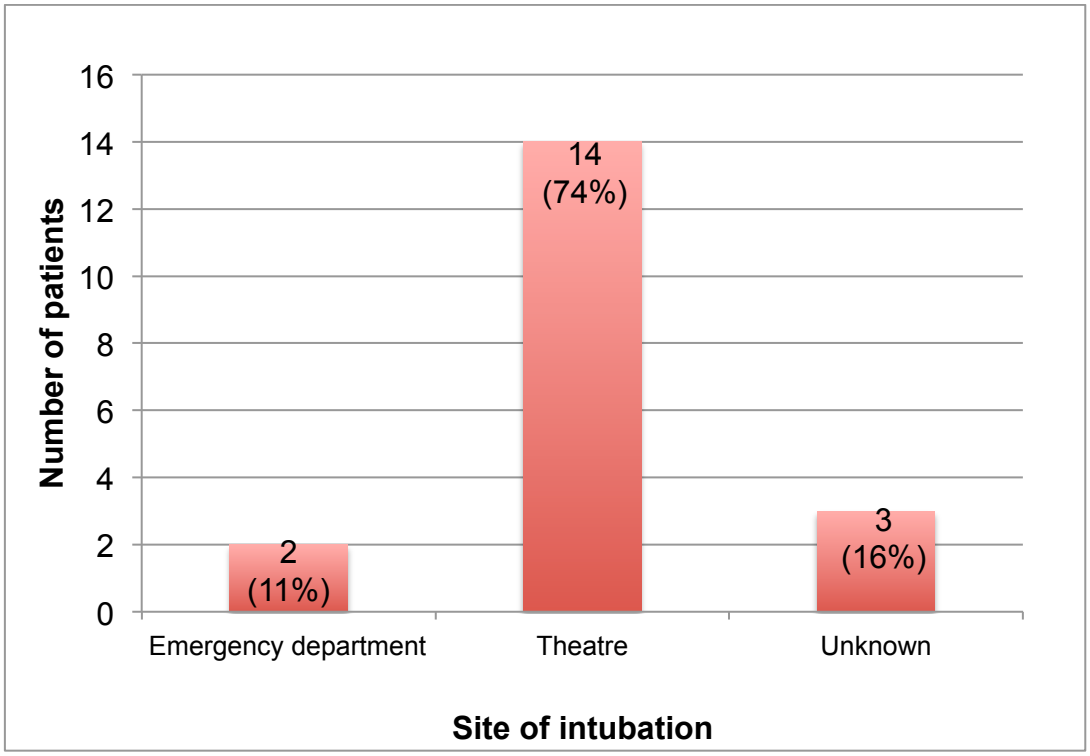

Figure 4.4 Site of intubation

4.3.11 Objective: describe the intraoperative anaesthetic management

Of the 21 patients who survived to hospital admission, 19 (90%) received surgical management in theatre. Of these 19, anaesthetic charts were available for only 17 (89%) patients. The intraoperative anaesthetic management with regards to the drugs, fluids, and invasive haemodynamic monitoring used was therefore available for 17 patients.

Drugs

Etomidate was the most common induction agent (n=10, 59%), while suxamethonium (n=7, 41%) was used more frequently than rocuronium (n=6, 35%) as a muscle relaxant. Fentanyl was the most commonly used opioid (n=15, 88%). Sevoflurane was the only documented volatile anaesthetic agent used (n=7, 41%). Adrenaline infusions (n=8, 47%) were required in just under half of the cases. The list of all drugs that were used is displayed in Table 4.4.

Table 4.4 Intraoperative drug use

Drugs n = 17	**Number**	**Percentage**
Induction agents		
Etomidate	10	59
Propofol	2	12
Ketamine	1	6
Muscle relaxants		
Suxamethonium	7	41
Rocuronium	6	35
Atracurium	1	6
Vecuronium	2	12
Opioid		
Fentanyl	15	88
Morphine	2	12
Volatile		
Sevoflurane	7	41
Inotropes infused		
Adrenaline	8	47
Other drugs		
Midazolam	3	18
Tranexamic acid	5	29
Hydrocortisone	3	18
Ketamine (non-induction)	2	12
Sodium bicarbonate	1	6
Magnesium sulphate	1	6
Calcium chloride	4	24
Insulin	1	6
Phenylephrine	2	12
Dexamethasone	2	12
Paracetamol (IV)	2	12

Fluids

Blood products or cell salvage (n=13, 76%) were most frequently used, while colloids (n=12, 71%) and crystalloids (n=12, 71%) were used in an equal number of cases.

Packed red cells (n=9, 53%) were used more than cell salvage (n=7, 41%). The colloid, Voluven® (n=12, 76%) was the most frequently used fluid, while Ringers lactate (n=11, 65%) was the most frequently used crystalloid. Intraoperative fluids used are displayed in Table 4.5.

Table 4.5 Intraoperative fluid use

Fluid n = 17	Number	Percentage
Blood Products		
Packed red cells	9	53
Fresh frozen plasma	6	35
Platelets	2	12
Cell salvage	7	41
Colloid		
Voluven®	13	76
Gelofusine	3	18
Crystalloid		
Ringers lactate	11	65
Balsol	2	12
Normal saline	2	12

Patients received blood products, colloids, and crystalloids in varying combinations. The majority of patients (n=9, 53%) received a combination of all three fluids, while no patients received a colloid alone. There were 2 (12%) patients who had no fluids documented. The combinations of fluids used are shown in Table 4.6.

Table 4.6 Combinations of fluids used

Fluid n = 17	Number	Percentage
Blood products only	1	6
Blood products + colloid	2	12
Blood products + crystalloid	1	6
Blood products + colloid + crystalloid	9	53
Colloid only	0	0
Colloid + crystalloid	1	6
Crystalloid only	1	6
Not documented	2	12

Invasive haemodynamic monitoring

A-lines (n=12, 71%) and CVPs (n=13, 76) were inserted in more than half the patients. Both A-line and CVPs were inserted in 11 (65%) patients. In 3 (18%) neither an A-line nor CVP were inserted. This is displayed in Table 4.7.

Table 4.7 Invasive haemodynamic monitoring

Invasive Monitor n = 17	Number	Percentage
A-line	12	71
CVP	13	76
Breakdown		
A-line + CVP	11	65
A-line only	1	6
CVP only	2	12
None	3	18

4.3.14 Objective: describe the intraoperative complications related to the stab wound

There were no intraoperative complications related to the stab wound, however there was only one complication as a result of the stab wound reported for the 21 patients that survived to hospital admission, this a cardiac tamponade in 1 (5%) patient. This patient underwent an emergency room thoracotomy and demised in the emergency department.

4.3.15 Objective: describe the intraoperative complications related to the anaesthesia and surgery

Cardiac arrest secondary to hypovolaemic shock (n=1, 5%) was the only documented intraoperative complication.

4.3.16 Objective: describe the patients' outcomes at the end of surgery

Of the 19 patients, 17 (89%) were still alive at the end of surgery, 9 (47%) were still intubated, and 9 (47%) were transferred to ICU. The postoperative patient outcomes are displayed in Table 4.8. There was an 89% postoperative survival rate for all patients who went to theatre. While the postoperative survival rate for all patients admitted to CHBAH was 81%.Two intubated patients were transferred to the ward for postoperative ventilation as no ICU beds were available.

Table 4.8 Postoperative patient outcomes

Postoperative patient outcome n = 19	Number	Percentage
Alive vs demised		
Alive	17*	89
Dead	2	11
Extubated vs intubated		
Extubated	3	16
Intubated	9	47
No data available	7	37
Postoperative inotropes		
Adrenaline	2	11
No inotropes	15	79
No data available	2	11
Postoperative ward		
ICU	9	47
High care	1	6
Ward	3	16
No data available	6	32

* The two patients with missing anaesthetic charts were not found in the mortuary data base and were therefore presumed to still be alive.

4.4 Discussion

From the literature identified, this is the first study to look at the holistic picture of stabbed hearts.

Almost half (48%) of the 44 patients with stabbed hearts survived to arrive in hospital. This was more than reported in previous studies; Campbell et al. (10) 6%, Kulshresthra et al. (14) 10%, Naughton et al. (12) 19%, and Honigham et al. (13) 30%

The 21 cases of stabbed hearts admitted to CHBAH during the one year study period was more than the international incidence of stabbed hearts which varies from 10 cases over a 25 year period (average of 0.4 per year) in Serbia as reported by Velinovic et al. (19), to 83 cases over an eight and half years (average of 10 per year) in Brazil as reported by Costa et al. (17)

The incidence of stabbed hearts is similar to some South African studies; Joshi and Essop (2) reported 108 cases during a 5 year period (average of 22 per year) in CHBAH, Oakland and Vivian (8) reported 34 case during a two year period (average 17 per year) in Groote Schuur Hospital, Campbell et al. (10) reported 66 cases during a three year period (average of 22 per year) in King Edward Hospital, and Clarke et al. (9) reported 76 cases during a three year period (25 cases per year) in hospitals in Pietermaritzburg. However, the following South African studies had a higher reported incidence; Velmahos et al. (3) 310 cases during a five year five month period (57 cases per year) in CHBAH, Degiannis et al. (5) 96 cases during a two year eight month period (36 cases per year) in CHBAH, and two studies from Tygerberg, Knott-Craig et al. (7) 129 cases during a two year period (average of 65 per year), and Harris et al. (6) 110 cases during a three year period (average of 37 per year). This decline in number from the last two CHBAH studies could be due to increased firearm related injuries.

There was a predominance (93%) of male patients with stabbed hearts in this study. This was also reported by Rodrigues et al. (41) 90%, Ekim et al. (42) 90%, Campbell et al. (10) 91%, Degiannis et al. (5) 93%, Knott-Craig et al. (7) 93%, Clarke et al. (9) 93%, Harris et al. (6) 95%, Costa et al. (17) 95%, Joshi and Essop (2) 97%, Janati et al. (18) 97%, and Kamali et al. (39) 100%.

The majority (75%) of patients in this study were young (between the ages of 20 and 39). This is in keeping with studies by Joshi and Essop (2), Degiannis et al. (5), Knott-Craig et al. (7), Harris et al. (6), Campbell et al. (10), Ezzine et al. (16), Velinovic et al. (19), Rashid et al. (11), Rodrigues et al.(41), Costa et al. (17), and Ekim et al. (42) who all reported mean ages between 24 and 36 years. However, unlike Rodrigues et al.(41) who reported in a 3 year old as the youngest patient and Campbell et al. (10) who reported a 77 year old as the oldest patient with a penetrating cardiac wounds (though it was not reported whether or not these was stabs). There were no extremes of age, with the youngest patient being 18 and the oldest 48 years in this study.

The fatal (the one resulting in myocardial penetration) chest entry wound tract had been identified during the post-mortem examination. However, no documentation of chest entry wound for the patients who survived to hospital admission was found. In this study most (74%) patients were stabbed in the left chest, which is in keeping with the identified literature as the predominant site of entry wound at the level of the skin (8, 31, 47, 49). All these entry wounds were in the chest (left, right, bilateral or sternal) in this study. This is in contrast to Costa et al. (17) and Velmahos et al. (3) who reported that injuries to base of the neck, subclavian areas or epigastrium and axilla were also found.

As detailed in the literature the right ventricle was the predominant chamber damaged during a stabbing to the heart (2, 3, 6, 7, 9, 10, 16, 18, 19, 29, 40, 43). This was found in both the mortuary and the hospital patients in this study.

In this study ventricular injuries (86%) were the predominant cardiac lesion which was also reported in numerous studies (2, 3, 6, 7, 9-11, 16-19, 29, 43). Right ventricular injuries accounting for 64% of ventricular injuries in this study which is also in keeping with many other studies (2, 3, 6, 7, 9, 10, 16, 18, 19, 29, 43). With regards to the atrial injuries, the right atrium (11%) was more frequently injured than the left atrium (2%) in this study which was also reported in numerous studies, when

atrial injuries were present (2, 3, 6, 10, 18, 29, 43). Multiple chamber injuries (11%) were found to be uncommon in this study as in other studies (2, 6, 17, 19, 40).

In this study none of the surviving patients sustained a left atrial injury, nor did they sustain multiple chamber injuries, which were both were found only in the mortuary group. There were no hospitalised patients with left atrial injuries reported in studies by Harris et al. (6) and Kamali et al. (39). While there were no atrial injuries in hospitalised patients as reported by Velinovic et al. (19), Ezzine et al. (16), and Rashid et al. (11). Campbell et al. (10) reported that all of the survivors had sustained a single chamber injury only. Left atrial or multiple chamber injuries could potentially indicate a poor prognostic finding.

In this study there was a higher percentage of left ventricular injuries in the mortuary group, 13 (57%) cases as compared to 3 (14%) of hospital admissions. Naughton et al. (12) reported that 35 post-mortems were performed on patients who sustained left ventricular injury, while in their study only five patients who sustained left ventricular injuries survived.

Four patients with left ventricular injury were hospitalised in this study. Two demised in the emergency department following emergency room thoracotomy, while two survived both the perioperative period in the emergency department and theatre. The postoperative survival rate for hospitalised patients with left ventricular injury was 50%.

There was an 89% postoperative survival rate for all patients who went to theatre. While the postoperative survival rate for all patients admitted to CHBAH was 81%.

Although emergency room thoracotomies are performed at a number of trauma centres, the mortality rate was found to be high in multiple studies; Joshi and Essop (2) indicated 46%, Degiannis et al. (5) 57%, Velmahos et al. (3) 70%, Asensio et al. (22) 84%, and Demetriades (31) 91%. Two patients (10%) out of all the hospital admissions in this study, required emergency room thoracotomies, both of whom demised in the emergency department. This 100% mortality rate post emergency department thoracotomy could be due to the grave condition of these two patients.

Asensio et al. (22) reported a 74% mortality rate for patients with penetrating cardiac injuries who arrived at hospital intubated, this along with the reported 82% of patients without a blood pressure and 88% without a pulse would indicate that pre-hospital intubation occurred when patients are severely haemodynamically unstable. Almost three quarters (74%) of patients in this study were intubated in theatre. This could imply that most of the hospitalised patients with stabbed hearts were relatively haemodynamically stable therefore surviving to hospital admission. Patients are transferred from the emergency department to theatre prior to intubation because they are either haemodynamically stable or are critically unstable and are therefore rushed to theatre. Unfortunately, the vital signs on admission were not available from the trauma database.

Patients from the emergency department are transferred to theatre in one of the following haemodynamic states:

- stable (or relatively stable); these patients would be transferred extubated and undergo rapid sequence induction (RSI) or modified rapid sequence induction (MRSI) in theatre
- unstable; these patients would be intubated in the emergency department before being transferred to theatre
- critically unstable; these patients would be rushed to theatre and undergo RSI or MRSI in theatre.

Since trauma patients are considered as full stomach, RSI or MRSI is required to secure the airway to prevent aspiration, which is in keeping with what was reported by Knott-Craig et al. (7) . Induction for stable (or relatively stable) patients would be with either propofol or etomidate, while extremely unstable patients would be with either etomidate, ketamine, or in some cases no induction agent depending on the status of the patient. Sometimes patients arrive in theatre perimortem and may not require an induction agent, opioids to blunt the intubation response or even a muscle relaxant in extreme cases.

The advantage of etomidate over propofol as an induction agent and fentanyl is that they are haemodynamically stable. Although there is a risk of corticosteroid synthesis suppression (in the adrenal cortex by inhibiting 11-β-hydroxylase) with etomidate administration, the benefit of haemodynamic stability on induction can outweigh this risk in the haemodynamically unstable patients. However, even in haemodynamically stable (or relatively stable) patients, the hypotension caused with the use of propofol

can be avoided with the use of cardiac stable drugs. This can explain the 59% use of etomidate as opposed to the 12% use of propofol in this study.

Besides the use of neuromuscular blocking agents for intubation, they are also required for the maintenance of muscle relaxation. Maintenance is required for both patients intubated in theatre and for those who arrive intubated. Intubation following RSI or MRSI can be done using suxamethonium or rocuronium respectively. This explains the use of suxamethonium (41%) and rocuronium (35%) in this study. Maintenance of muscle relaxation can be with rocuronium, vecuronium, cisatracurium, or atracurim depending on availability and anaesthetist preference (there was no documented cisatracurium use in this study).
Sevoflurane was the only documented volatile anaesthetic agent used, in 41% of cases. In other cases, the use of volatile anaesthetic agent was either not documented, or the patients where not haemodynamically stable and no volatile agent was used, or became unstable with the use of volatile agents. This is not an uncommon occurrence as even haemodynamically stable and relatively stable patients can often become unstable intraoperatively when volatile anaesthetic agents are used.

Fentanyl was the predominant 15 (88%) opioid used, provides good intraoperative analgesia. Fentanyl can also be used for induction for a cardiac anaesthetic, as it is cardiac stable (however it does not provide anaesthesia or amnesia). Morphine was used in 2 (12%) cases, both these patients were extubated postoperatively, indicating that these patients were probably haemodynamically stable. However, morphine can cause haemodynamic instability and is not routinely used for stabbed hearts, usually varying dosages of fentanyl are used.

When using a high dose opioid anaesthetic, without the use of any volatile anaesthetic agents, there is a higher risk of intraoperative patient awareness. Patients are sometimes given non-induction dosages of ketamine to provide a dissociative anaesthetic state or midazolam for retrograde amnesia.

Adrenaline infusions were documented in 8 (47%) cases. However, there were 2 (11%) patients who still required adrenaline infusions postoperatively indicating that most the patients were haemodynamically stable postoperatively with successful cardiorrhaphy and adequate intraoperative fluid resuscitation.

Glucocorticoids (dexamethasone, and hydrocortisone has some glucocorticoid effect) are important for the responsiveness of the cardiovascular system to catecholamines during a response to stress. This explains the 30% use of steroids (dexamethasone and hydrocortisone) in this study.

The limited use of phenylephrine 2 (12%) is not surprising as although it causes an increase in the blood pressure by vasoconstriction, this is not the primary cause of the hypotension in these patients with stabbed hearts, as the main problem in a decrease in cardiac output, mainly due to hypovolaemia from blood loss.

One of the major intraoperative management goals for stabbed hearts is the active resuscitation with fluids to combat the severe hypovolaemia. Early and adequate fluid resuscitation will result in reduced intraoperative inotropic requirements, provide relative haemodynamic stability for surgical repair, and decreased postoperative neurological fallout. An adequate mean arterial pressure is required by the surgeons once cardiorrhaphy has been completed in order see if there are any other injuries or further bleeding. Ideally the volume of blood lost, should be replaced in equal volume with either cell salvage or blood products. In this study 13 (76%) received blood products or cell salvage most likely due to replacement of high volumes of blood loss with blood. While both crystalloids (71%) and colloids (71%) were used in an equal amount of cases, which was most probably while waiting for blood products to arrive from blood bank.

A-lines and CVPs can be inserted for multiple reasons. A-lines for invasive blood pressure monitoring and for arterial blood gas sampling (monitoring for acid-base status, biochemical disturbances, haemoglobin). CVPs for lack of peripheral intravenous access, access for inotropic administration if required, and for haemodynamic monitoring.

Majority of patients had A-lines (71%) and CVPs (76%) inserted. While 11(65%) patients had both a CVP and an A-line inserted in theatre. Some patients may not have had A-lines inserted as they were either extremely stable, or because they arrived in theatre peripherally shutdown resulting in the inability to insert an A-line. While patients who did not have a CVP could have been either extremely stable, or because they had large bore peripheral access and it was deemed that rapid fluid transfusion was more efficient via these lines.

Although cardiac tamponade is a common finding with stabbed hearts, with the incidence varying between 21% as reported by Ezzine et al. (16) and 78% as reported by Harris et al. (6), there was only one (5%) documented among the hospitalised patients in this study. This patient demised in the emergency department following emergency room thoracotomy. Degiannis et al. (5) had a 49% incidence of cardiac tamponade of whom 96% survived. The authors then deducted that cardiac tamponade may be a positive survival factor as it protected patients from exsanguination.

Postoperatively, 17 (89%) patients were still alive. Of the two deaths in theatre, one case was documented as cardiac arrest secondary to hypovolaemic shock, while in the other case no documentation had been made. The two patients with missing anaesthetic charts were not found in the mortuary data base and were therefore presumed to be still alive.

There were 9 (47%) patients who were documented to have remained intubated postoperatively. Of the 3 (16%) postoperatively extubated patients, one patient remained in theatre for more than 12 hours after surgery as no ICU bed was available before being extubated and transferred to the ward.

Only 2 (11%) patients were still haemodynamically unstable and documented as still requiring adrenaline infusion postoperatively.

Almost half (47%) the patients were transferred to ICU postoperatively. No data (due to lack of documentation in two cases and two missing anaesthetic charts in the other two cases) were available as to where the patient was transferred postoperatively in those four cases.

In two cases of the three patients transferred to the ward postoperatively, the lack of an ICU bed was the only reason for ward transfer. Although both patients required ventilation in the ward.

The trauma database did not contain the time of admission to hospital, the haemodynamic status (pulse, heart rate or blood pressure), the management/resuscitation in the emergency department (the only exception being two documented emergency room thoracotomies), nor any preoperative complications.

Missing anaesthetic charts were identified as a potential limitation due to the retrospective nature of the study. Normal practice is for the anaesthetist to return the copy of the anaesthetic chart to the theatre recovery room after transferring a patient to ICU. One reason for an anaesthetic chart missing, would be if this procedure does not happen. This results in either the chart being left in the patient's hospital file, or being misplaced and lost in ICU. There were two missing anaesthetic charts, resulting in some loss of data. However, this was not a criterium for exclusion from the study, but merely exclusion from specific analysis.

4.5 Summary

The results and discussions were presented in this chapter. The following chapter contains a summary of this study, the limitations, the recommendations and a conclusion.

CHAPTER FIVE
STUDY SUMMARY, LIMITATIONS, RECOMMENDATIONS AND CONCLUSION

5.1 Introduction

In this chapter a summary of the study is presented followed by the limitations, recommendations, and a conclusion.

5.2 Summary of the study

5.2.1 Aim

The aim of this study was to describe the profile and anaesthetic management of patients with stabbed hearts presenting to the Diepkloof Mortuary, emergency department and operating theatres at CHBAH in the year from 1 July 2012 to 30 June 2013. This study was performed in two parts.

5.2.2 Objectives

The objectives of Part I were to describe the patients presenting to the mortuary with regard to:

- the number of patients with stabbed hearts
- the demographic details (age and gender)
- the sites of the entry wounds at the level of the skin
- the sites of myocardial injury.

The objectives of Part II were to describe the patients that present alive to the hospital with regard to:

- the number of patients with stabbed hearts
- the demographic details (age and gender)
- the and sites of the entry wounds at the level of the skin
- the and sites of myocardial injury
- the haemodynamic status on admission to the emergency department (pulse, heart rate and blood pressure)
- resuscitation in the emergency department
- preoperative complications
- the number of patients who died in the emergency department
- the time trajectory from the admission to the emergency department to the start of surgery
- site of intubation (pre-hospital, emergency department or theatre)
- intraoperative anaesthetic management
- intraoperative complications related to the stab wound
- the intraoperative complications related to the anaesthesia and surgery
- the patients' outcome at the end of surgery.

5.2.3 Summary of the methodology

The study used a retrospective, contextual and descriptive design.

All available records of 44 patients with stabbed hearts that presented to Diepkloof Mortuary and CHBAH during the year from 1 July 2012 to 30 June 2013 were included in this study.

Data collection was from three sources:

- mortuary database
- anaesthetic database
- trauma surgery database.

Data capturing was preformed using a Microsoft® Office 365 Excel spreadsheet. This data was analysed using descriptive statistics. Categorical data was described using frequencies and percentages.

5.2.4 Summary of main findings of the study

There were 44 patients who sustained a myocardial injury by means of a stab to the heart, there was an almost equal split between those who demised and were taken directly to the mortuary (n = 23, 52%) and those that survived to arrive in hospital (n = 21, 48%). Most of the patients were male (n=41, 93%), and were between the ages of 20 and 29 (n=23, 53%).

Most of the deceased were stabbed in the left chest (n=17, 74%). Overall, right ventricular injury (n=28, 63%) was the most common chamber injured. Multiple chamber injuries (n=5, 11%) were found only in the mortuary group, as was left atrial injury (n=1, 2%).

Most of the patients who survived to hospital admission (n=21) went on to receive surgical management in theatre (n=19, 90%). The 2 (10%) patients who underwent emergency room thoracotomies demised in the emergency department. Most of the patients (n=14, 74%) were intubated in theatre.

Etomidate was the most common induction agent (n=10, 58%), while there was marginally more suxamethonium (n=7, 41%) used than rocuronium (n=6, 35%), while

fentanyl the most used opioid (n=15, 88%). Sevoflurane was the only documented volatile anaesthetic agent used (n=7, 41%). Adrenaline infusions (n=8, 47%) were required in just under half of the cases.

Blood products or cell salvage (n=13, 76%) were most frequently used fluids. A-lines (n=12, 71%) and CVPs (n=13, 76%) were inserted in more than half of all cases. Of the 19 patients, 17 (89%) were still alive at the end of surgery, 9 (47%) were still intubated, and 9 (47%) were transferred to ICU.

5.3 Limitations of the study

The limitation of this study was that due to the retrospective nature of this study missing data could not be followed up.

5.4 Recommendations from the study

5.4.1 Recommendations for clinical practice

The following recommendations are suggested for clinical practice:

- steps must be taken to ensure better record keeping
- regular audits of records to ensure quality and completeness.

5.4.2 Recommendations for further research

The following recommendations are suggested for further research:

- a prospective study on the profile and anaesthetic management of patients with stabbed hearts presenting to CHBAH
- a national prospective study on the profile and anaesthetic management of patients with stabbed hearts
- a prospective study on the periopeative management of patients with stabbed hearts presenting to all hospitals in the University of Witwatersrand circuit (CHBAH, Charlotte Maxeke Johannesburg Academic Hospital, and Helen Joseph Hospital).

5.5 Conclusion

Had Gaius Julius Caesar been fortunate enough to be stabbed in Soweto between the 1st of July 2012 and the 30th of July 2013, he would have had almost a 48% chance of receiving hospital treatment (though with possibly multiple chamber injuries he may have been one of those who did not). Had he then gone on to theatre (without having an emergency room thoracotomy) he would have been intubated after receiving Etomidate (58%), Fentanyl (88%) and Suxamethonium (41%). He would have had an arterial line (71%) and a central venous catheter (76%) inserted. After which he would have been infused with Voluven (76%) and Ringers Lactate (65%) and transfused Packed Red Cells (53%).Postoperatively he would have remained intubated (47%), and subsequently transferred alive (89%) to ICU (47%).

Stabbed hearts are surgical emergencies that require a prompt and focused anaesthetic intervention. This study gives valuable insight into the profile and anaesthetic management of patients with stabbed hearts.

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APPENDIX A: Ethics approval

R14/49 Dr Siju Joseph Abraham

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M130702

NAME: (Principal Investigator)	Dr Siju Joseph Abraham
DEPARTMENT:	Anaesthesiology Charlotte Maxeke Johannesburg Hospital Diepkloof Mortuary Chris Hani Baragwanath Academic Hospital
PROJECT TITLE:	Profile and Anaesthetic Management Following Stabbed Hearts: A One-Year Retrospective Review
DATE CONSIDERED:	26/07/2013
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Juan Scribante
APPROVED BY:	Professor A Woodiwiss, Co-Chairperson, HREC (Medical)
DATE OF APPROVAL:	22/10/2014

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

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

Principal Investigator Signature _____ Date _____

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

APPENDIX A: Postgraduate Committee approval

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Vorna Valley
1686
South Africa

Dear Mr Abraham

Master of Medicine: Approval of Title

We have pleasure in advising that your proposal entitled *Profile and anaesthetic management following stabbed hearts: A one year retrospective review* has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

APPENDIX A: CHBAH Medical Advisory Committee

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

MEDICAL ADVISORY COMMITTEE
CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL

PERMISSION TO CONDUCT RESEARCH

Date: 09 June 2014

TITLE OF PROJECT: Profile and anaesthetic management following stabbed hearts: a one year retrospective review

UNIVERSITY: Witwatersrand

Principal Investigator: S J Abraham

Department: Anaesthesiology

Supervisor (If relevant): J Scribante

Permission Head Department (where research conducted): Yes.

Date of start of proposed study: June 2014
Date of completion of data collection: Dec 2015

he Medical Advisory Committee recommends that the said research be conducted at Chris Hani Baragwanath Hospital. The CEO /management of Chris Hani Baragwanath Hospital is accordingly informed and the study is subject to:-

- Permission having been granted by the Committee for Research on Human Subjects of the University of the Witwatersrand.
- the Hospital will not incur extra costs as a result of the research being conducted on its patients within the hospital
- the MAC will be informed of any serious adverse events as soon as they occur
- permission is granted for the duration of the Ethics Committee approval.

.....
Recommended
(On behalf of the MAC)
Date: 09 June 2014

.....
Approved/Not Approved
Hospital Management
Date: 09/06/14

APPENDIX A: Permission letter from Department of Trauma Surgery

Dr S J Abraham
Student number 0100038w
Department of Anaesthesiology
University of the Witwatersrand
10 July 2013

To Proffesor E Degiannis
Head of Department, Trauma Surgery
Chris Hani Baragwanath Academic Hospital

RE: Permission to conduct research for MMed at Chris Hani Baragwanath Academic Hospital
Title: Audit of stabbed hearts at Chris Hani Baragwanath Academic Hospital and Diepkloof Mortuary for the year from 1 July 2012 to 30 June 2013

I am a registrar in the Department of Anaesthesiology at the University of the Witwatersrand and request your permission to conduct my research for my MMed at Chris Hani Baragwanath Academic Hospital.

My research is a retrospective study on the stabbed hearts admitted at Chris Hani Baragwanath Academic Hospital and Diepkloof Mortuary during the year from 1 July 2012 to 30 June 2013. My data collection at CHBAH will requires access of patients' records from the Department of Trauma Surgery. No patients' name or hospital numbers will be used to ensure patient confidentiality.

Attached please find a copy of the authorization for research received from both the Wits Postgraduate Committee and the Human Research Ethics Committee.

Yours sincerely

Siju Joseph Abraham
084 547 0997
siju.82@gmail.com

Jennings
Dr MA Jennings
pp. Prof E Degiamis

APPENDIX A: Permission letter from Department of Anesthesia

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL
DIRECTORATE - ANAESTHESIA
Enquiries: Prof AC Lundgren
Tel. number: (011) 933-9334
Fax number: 086 553 2529
Email: chris.lundgren@wits.ac.za

9th July 2013

TO WHOM IT MAY CONCERN

RE: ACCESS TO ANAESTHETIC RECORDS.

This is to confirm that **Dr. S. J. Abraham** has been granted permission to access anaesthetic records for his study from Chris Hani Baragwanath Academic Hospital.

Kind regards.

PROF A.C. LUNDGREN
CHIEF SPECIALIST AND HEAD
DEPARTMENT OF ANAESTHESIA
CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL
AND
UNIVERSITY OF THE WITWATERSRAND

ACL/st

APPENDIX A: Permission letter from Diepkloof Mortuary

Dr SJ Abraham
Student number 0100038w
Department of Anaesthesiology
University of the Witwatersrand
10 July 2013

To Dr J B Mwesilwa
Gatekeeper of the database, Diepkloof Mortuary

RE: Permission to conduct research for MMed at Diepkloof Mortuary
Title: Audit of stabbed hearts at Chris Hani Baragwanath Academic Hospital and Diepkloof Mortuary for the year from 1 July 2012 to 30 June 2013

I am a registrar in the Department of Anaesthesiology at the University of the Witwatersrand and request your permission to conduct my research for my MMed at Chris Hani Baragwanath Academic Hospital.

My research is a retrospective study on the stabbed hearts admitted at Chris Hani Baragwanath Academic Hospital and Diepkloof Mortuary during the year from 1 July 2012 to 30 June 2013. My data collection at Diepkloof Mortuary will requires access of patients' records/death certificates. No patients' name or file/case number will be used to ensure patient confidentiality.

Attached please find a copy of the authorization for research received from both the Wits Postgraduate Committee and the Human Research Ethics Committee.

Yours sincerely

Siju Joseph Abraham
084 547 0997
siju.82@gmail.com

Dr J.B. Mwesilwa.

APPENDIX B: Mortuary data collection sheet

Study Number	Age	Gender	Site on skin	Site of Lesion					Associated Crdiac Injury					
				R V	L V	R A	L A	Intra-septal	Pulmonary Artery	Pulmonary Vein	Aorta	Vena Cava	Coronary Vessel	Tamponade

APPENDIX B: CHBAH data collection sheets

Study number	Age	Gender	Intubated		Resuscitation in trauma
			Arrived	Trauma	

Study number	Anaesthetic / sugery start time	Induction agent	Intubated		Opioid	Muscle Relaxant	Adrenaline Infusion	Volatile	Other drugs
			Arrived	Theatre					

Study Number	Haemodynamic Monitoring		Fluids						
	A-live	CVP	Colloid	Crystaloid	RCC	FFP	Platelets	Cryopercipitate	Cell Saved

Study number	Post-op								Intraoperative complications
	Extubated	Intubated	ICU	HC	Ward	Inotropes	Alive	Dead	

Study Number	Site of Lesion					Associated Cardiac injury					
	RV	LV	RA	LA	Intra-septal	Pulmonary Artery	Pulmonary Vein	Aorta	Vena Cava	Coronary	Tamponade