ESTIMATING THE COST OF ROAD TRAFFIC INJURIES IN A TERTIARY HOSPITAL IN GAUTENG PROVINCE IN 2009

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A research report submitted to the Faculty of Health Sciences,

University of the Witwatersrand, in partial fulfillment of the requirements for the degree of Master of Medicine in the branch of Community Health

May 2012

DECLARATION

I, Nonkululeko Mthembu, declare that this research report is my own work. It is being submitted for the degree of Master of Medicine in the branch of Community Health, in the University of Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other university.

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Nonkululeko Mthembu

On this 15th day of May 2012

DEDICATION

This work is dedicated to my husband Itumeleng Boikhutso.

To our beautiful daughters Omolemo and Boitumelo Boikhutso, I love you girls.

To my mother who was always there to help me and pray for me.

Most importantly to my Lord and Saviour Jesus Christ for always being my Light and Hope.

EXECUTIVE SUMMARY

Introduction: South Africa has seen a 23% rise in the annual numbers of fatalities due to road traffic accidents between 2001 and 2008. Road traffic injuries (RTIs) are estimated to cost 1.5% of the Gross National Product (GNP) in middle-income countries like South Africa. In South Africa, 60% of all acute injuries are treated in a hospital, 75% of those in public facilities placing a significant burden on public hospitals. Generally there are no cost data available from the public hospital information systems as it not routinely collected, yet cost information is necessary for the purpose of accurate reimbursement from entities such as the Road Accident Fund (RAF) which provides medical insurance for all road users in South Africa.

Aim: The aim of this study is to estimate the cost burden of road traffic injuries at Charlotte Maxeke Johannesburg Academic Hospital in Gauteng Province for the year 2009 by estimating admission costs and factors associated with these costs. The study also compared cost derived from a mixed-costing approach to the charges used in the billing system at the hospital.

Methodology: The study was a facility-based cost estimation of patient care following a road traffic injury using cost accounting methods. A retrospective review of medical records of patients admitted following a road traffic accident was done. Systematic sampling was used to select the files. Univariate and multivariate regression models were fitted to determine which factors were associated with cost and length of stay, the two outcome variables selected for the analysis. Log transformation of the cost data was done prior to doing the regression analysis because the cost data were not normally distributed. Assumptions for linear regression were assessed to ensure the validity of the model.

Results: A total of 259 files were included in the sample. The study showed that the majority of admissions were young males aged between 26-35 years and pedestrian vehicle accidents were the most common (54%) type of accident. Admission peaked over the weekend and peaked on a Saturday. The cost analysis showed that overhead costs make up the bulk of the total costs. These costs were significantly correlated with length of stay. The analysis of factors associated with costs revealed that the injury severity score, intensive care unit (ICU) admission, having surgery and having a disability were significantly associated with log of admission costs in the multivariate model after adjusting for other variables.

Factors significantly associated with length of stay were having a disability, the number of injury sites and having an underlying medical condition. The analysis of the costs using the current hospital billing method and the mixed costing approach used in the study showed a significant difference between the two methods. The geometric mean (±SD) for the current billing method was R9.046 ± 0.920 and R9.102 ±1.24 for the mixed costing approach (p-value = 0.000).

Conclusion: The cost analysis showed that having surgery, being admitted to ICU and having a disability were significantly associated with higher hospitalization costs, supporting the need for prevention strategies that not only reduce the number of road traffic injuries but also the degree of severity of injuries and associated disability. Road traffic injury prevention using primary, secondary and tertiary methods is necessary to curb this burden.

Finally, there needs to be more accurate costing of hospital services in view of the expected health funding reform under the National Health Insurance. Accurate costing methods would

allow more accurate revenue generation from funds such as the RAF and other private medical insurers.

Key words: Road traffic injuries, hospitalization, cost analysis, predictors of cost, predictors of length of stay.

ACKNOWLEDGEMENTS

First and foremost I would like to acknowledge my supervisors Drs Ruxana Jina and Julia Moorman for their guidance, patience and advice during the entire process. This research would not have been possible without their support. I am eternally grateful for the role they have played in my learning and encouraging me to excel in my work.

I am grateful to Dr Barney Selebano (CEO – Charlotte Maxeke Johannesburg |Academic Hospital) and Dr Mmamorena Mofokeng (Clinical Superintendent – Charlotte Maxeke Johannesburg Academic Hospital) for allowing me to conduct the research at the hospital.

I would also like to acknowledge Ms. Witness Mance and the entire medico-legal team for their assistance in retrieving the medical records from the hospital which can be a difficult task at times.

I would like to acknowledge a research grant I received to conduct this study from the Faculty of Health Sciences, University of Witwatersrand.

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GLOSSARY

AVERAGE LENGTH OF STAY

Average length of stay is computed by dividing the number of days stayed in the hospital by the number of discharges (including deaths) during the year (1).

CASELOAD

The number of cases handled in a given period at a hospital (2) .

CHARGE

The amount expressed in monetary terms, that providers ask for products sold or services provided, and these charges may or may not reflect actual resource consumption or costs (3).

COST

The cost of a medical procedure is the total sum of all resources needed to carry it out (3).

- **Unit cost** - costs are usually measured in total and/or per unit. Unit cost is the cost of one unit of service, while the full cost or total cost is the sum of all costs associated with a particular cost object (3).
- **Direct cost** - direct costs can be directly linked to a particular service (3).
- **Indirect cost** - indirect costs have no direct relationship to the cost object; they cannot be traced to the cost object "easily" or in an economically feasible way (3).

DISABILITY

Is having permanent loss of function of one or more parts of the body, including quadriplegia, paraplegia, blindness and limb amputation

MORBIDITY

Morbidity describes a diseases state. It is an illness or an abnormal condition or quality (2).

OUTCOME OF INJURY

In this study, the outcomes of road traffic injury were classified as discharged, death or transferred out.

PATIENT DAY EQUIVALENT

The patient day equivalent is a measure used to calculate average costs for inpatient stays using an average cost for all patients regardless of the nature of disease and the complexity of treatment required. The PDE is a daily rate of the total hospital expenditure for one financial year (4).

THEATRE TIME

The number of minutes a case is in the operating theatre, from the time that anaesthetic administration starts to the end of the procedure.

ABBREVIATIONS AND ACRONYMS

ABC	Activity-Based Costing
CMJAH	Charlotte Maxeke Johannesburg Academic Hospital
DRGs	Diagnostic Related Group
FBC	Full blood count
GNP	Gross National Product
ISS	Injury Severity Score
LOS	Length of stay
MBA	Motorbike Accident
MVA	Motor Vehicle Accident
NANFISS	National Non-fatal Injury Surveillance System
NGO	Non-government Organization
NHI	National Health Insurance
NHLS	National Health Laboratory Services
NHRPL	National Health Reference Price List
NIS	Number of Injuries
NTSG	National Tertiary Services Grant
PDE	Patient-Day-Equivalent
PVA	Pedestrian Vehicle Accident
RAF	Road Accident Fund
RTIs	Road Traffic Injuries
U&E	Urea and Electrolytes
UPFS	Uniform Patient Fee Schedule
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

This chapter presents a background to road traffic injuries in South Africa in terms of prevalence, mortality, morbidity and the economic burden. The nature of the problem is illustrated, a justification for the study provided and the aims and objectives of the study outlined. Relevant literature pertaining to the costs of road traffic injuries is described.

1.1 Background

Motorization has enhanced the lives of many individuals and societies. However, the benefits have come with a price. According to a 2004 joint report by the World Health Organization (WHO) and the World Bank on injury prevention, there has been a significant rise in the numbers of road traffic injuries (RTIs) globally (5). Worldwide, an estimated 1.2 million people are killed and almost 50 million are injured each year in road traffic accidents. Road traffic injuries are currently the ninth leading cause of death worldwide and it is projected that, by 2030, if significant interventions are not implemented, road traffic injuries will be the fifth leading cause of death globally resulting in an estimated 2.4 million fatalities per year (5;6).

The number of lives lost in road traffic accidents in high-income countries indicates a downward trend in recent decades. However, for most of the world's population, the burden of road-traffic injuries in terms of societal and economic costs is rising and disproportionately affecting sub-Saharan Africa (6;7). South Africa has seen a 23% rise in the annual numbers of fatalities due to road traffic accidents between 2001 and 2008 (8). According to the Lancet series on South Africa published in 2010, the mortality rate following road traffic injuries in 2008 was 39.7 per 100 000 population (9). Data on the number of road traffic injuries is scant. However, an estimate by the Road Accident Fund[1] shows that in 2002, an average of 167 people were injured daily on South African roads (10). The South African burden of disease study for 2000 showed that RTIs accounted for 1,157 disability adjusted life years (DALYs) lost per 100,000 population making injuries the second leading cause of DALYs lost after HIV/AIDS and 11.2% of the total DALYs in South Africa (5;11).

A road traffic accident results from a combination of factors related to the condition of roads, the environment, vehicles and road users, and the way they interact as modelled by the Haddon Matrix (Table 1) (5).

Table 1: Haddon matrix(5)

	FACTORS		
PHASE	**Human**	**Vehicles and equipment**	**Environment**
Pre-crash	Information Attitude Impairment Police enforcement	Roadworthiness Lighting Braking Handling Speed Management	Road design and layout Speed limits Pedestrian facilities
Crash	Use of restraints Impairment	Occupant restraints Other safety devices Crash protective design	Crash protective road side objects
Post-Crash	First Aid skills Access to medical professionals	Ease of access to crash site Fire risk of the vehicle	Rescue facility availability Congestion

Human factors such as excessive alcohol consumption, being young and male, driver fatigue and speeding are associated with road traffic injuries (12). The high burden of traffic injury

[1] The RAF is a public entity which has been set up to pay compensation to people injured in road accidents or the dependants of people killed in road accidents arising from the negligent driving of a motor vehicle in South Africa. The Fund gets its money from a fuel levy included in the price of petrol and diesel which is paid by drivers of motor vehicles.

mortality in South Africa has been attributed mainly to unsafe road environments, poor enforcement of existing traffic laws, road rage and aggressive driving, as well as alcohol misuse (13-15)

1.1.1 Economic consequences of RTIs

The death and residual disability of a breadwinner as a result of a RTI has a considerable impact on households and country economies especially in low-to-middle income countries (5;10;16). According to the WHO report, RTIs are estimated to account for 1.5% of the Gross National Product (GNP) in a country like South Africa (5).

The Road Accident Fund estimated the total cost of RTIs to be R42.3 billion in South Africa in 2002 alone. This is the most comprehensive and most recent estimate of total costs in South Africa (17;18). Total direct costs included costs of hospital and medical care, funeral costs, vehicle and property damage costs, legal aid and policing costs. Hospital costs account for approximately 50% of total direct costs of RTIs (19).

The high cost of RTIs places a significant demand on the health care system which already has to contend with the increasing pool of individuals seeking care for diseases such as HIV/AIDS, TB and non-communicable diseases (11;20). Sixty percent of all acute injuries in the country are treated in a hospital, and 75% of those people who require admission are admitted to a public facility (16).

1.1.2 Estimating costs in public hospitals in South Africa

In middle-income countries hospitals consume 60% of the total health facility budget (21). Tertiary hospitals in South Africa accounted for 32% of total health care expenditure on hospitals in 2007 (22). Yet costing of hospital services has not always been a priority in the public health sector although fiscal constraints have led to an increasing interest in cost evaluation (22-24). Contrary to the private sector, where costing is a day-to-day practice, the public sector does not depend on revenue generation for service provision and sustainability (25). Budgets in hospitals therefore are drawn-up using historical budgeting and are not based on actual outputs and projected needs (26;27).

Although the public sector does not depend on revenue generation for service provision, services provided at hospital level are not free for all users (28). There is a system in place for billing patients based on their level of income using the Uniform Patient Fee Schedule (UPFS). The UPFS is a charging mechanism for hospitals developed specifically for the public sector and is simpler to implement than the itemized billing approach (29).

The UPFS is based on health service activities and is linked to the National Health Reference Price List (NHRPL) that serves as a guide for itemized billing in the private health sector in South Africa. The NHRPL was developed by the Director General of the Department of Health through a consultative process with various stakeholders in the health care system such as services providers, health care funders and health professional bodies (29;30). The NHRPL was used as the reference for the Uniform Patient Fee Schedule and the billing rules of the NHRPL are inferred where the UPFS does not make a rule explicitly (29).

The tariffs in the UPFS are applicable to all full paying and subsidized patients in the public health sector. This includes patients covered by insurance such as the RAF. The tariffs under the UPFS differ according to the level of the hospital. The UPFS provides recommended tariffs for overhead costs classified as facility fees, for inpatients, intensive care unit (ICU) and high care admissions. The UPFS also provides tariffs for theatre procedures, anaesthesia, dialysis, radiology services, pharmaceutical products and emergency medical services.

1.2 Problem Statement

At public hospitals in South Africa, there are no cost data available from the hospital information system as hospital services are not routinely allocated (31). Data on what the patient is charged for a hospital admission, according to the UPFS, is available on the hospital information system. However it is not known to what degree this charge reflects the actual cost of treatment. Cost information for the management of RTIs would be useful for understanding resource utilization in the hospital (32).

The public hospital system in South Africa in general has been under mounting pressure with increasing deficits year-on-year and overspending (22). This has been in part due to rising medical sector costs for medicines, equipment and personnel but also due to inefficiencies in the system which exacerbate the financial challenges in the public sector (22;33). Hospital managers are now under pressure to properly implement their revenue collection mechanisms and recover costs of treatment from entities such as the RAF and other private medical insurance companies (34).

1.3 Justification

This study will provide information that can be used to advocate to policy makers to prioritize investments in road traffic injury prevention by the Department of Health. The health sector has been slow in engaging in road traffic injury prevention as it was seen to be out of the scope of health departments. The role of the health sector as recommended by the WHO in injury prevention includes advocacy (5). Costing methodologies have the potential to be strategically employed to leverage a greater emphasis on primary prevention (35;36). Finally this study will also add to the body of knowledge that exists on costing road traffic injuries in South Africa.

1.4 Literature Review

1.4.1 Hospital admissions

Road traffic injuries are one of the leading causes of death in South Africa according to the burden of disease study for 2000. However, for every death that occurs as a result of a RTI, there are several non-fatal injuries, that can lead to lifetime disability, that have to managed by the health care system (13;16;37). Non-fatal injuries are more difficult to measure as this data is not routinely collected. (16). The burden of road traffic injuries on society and the hospital care system is therefore likely to be greater than we know.

Studies have estimated that traffic-related injuries account for between 18 and 60% of all trauma admissions in low-to-middle income countries. (38-41). In a study based in three regional hospitals in Mexico that described the epidemiology of RTIs in an urban setting, 54% of injury admissions were due to RTIs (39). RTIs were responsible for 18% of trauma patients presenting to the casualty unit of a primary level hospital in Bangladesh and 40% of those required hospitalization (40). In Kenya, 45-60% of all admissions to surgical wards in 310 hospitals reviewed in the study were due to RTIs (41). In the capital city of Uganda, 35% of trauma patients presenting to a teaching hospital had injuries sustained in road traffic accidents and 50% of these patients required hospitalization (38).

1.4.2 Cost of road traffic injuries

The literature review showed the extreme variation in reported costs and this highlights the need for more standardized costing methods that have the same outcome measures in order to enhance cost comparisons. Nonetheless, the cost of hospitalization due to RTIs has been shown in a few studies to constitute a significant portion of the direct cost related to RTIs (42-44). Trauma care in a hospital is often expensive, in part due to the complexity of injuries that patients sustain (40;43;45).

The total cost of injuries in 2002 in South Africa amounted to nearly R 42 billion (46). This cost was a composite of the cost of loss of output, qualitative costs and direct costs which included hospital, medical and funeral costs, vehicle damage costs, damage to goods carried, damage to fixed property, legal costs, insurance administrative costs, towing costs, policing and promotion costs (47). The direct medical costs were 54% of total costs (R 23 billion) and they ranged from R9, 797 per patient on average for minor injuries to R13 835 for fatal injuries (48).

In a costing study in Vietnam, health care costs were shown to constitute 44% of total direct costs related to road traffic injuries (49). A study in Barcelona which measured all costs of road traffic injuries in a metropolitan city estimated the total direct costs of road traffic injuries to be 89.8% of all costs, and the direct costs were mostly related to hospital care (42). Finally, a study conducted in Norway estimated costs from hospital accounts and insurance outlays and found that medical care costs of RTIs accounted for 36% of total direct costs (43).

In South Africa there are a few hospital-based studies that have attempted to estimate the direct cost of treating road traffic injuries. These studies use a variety of methods to estimate cost of care, most of them are outdated and several have very small samples (50-52). The most recent study was done at Charlotte Maxeke Johannesburg Academic Hospital in 2004, and estimated the cost of RTIs to be R3, 885 per patient on average. This study however was done on a very small sample of 48 general trauma patients and only 14 of these patients had sustained injuries in road traffic accidents (53). The study only looked at the costs of ICU and of treatment in the casualty unit.

1.4.3 Factors associated with hospitalization costs

There are several patient and admission characteristics that have been shown to be associated with high hospital costs. These include certain demographic characteristics, the length of stay, having a surgical procedure, ICU admission, and use of diagnostic services such as laboratory and radiology, and rehabilitation services (54-58).

Demographic characteristics

In a study of inpatient costs across ten European countries, peaks in costs per capita were observed among children 0–4 years old and among 15- to 24-year-old males. Costs per capita increased exponentially in older age groups (age >65 years) and in older females in particular (59). In a study of the costs of paediatric head injury patients, children who were in their preteen years had significantly higher costs as compared to younger children (60). Finally, a study based in the USA showed that age was independently associated with hospitalization costs (61).

Reported past medical history

Co-morbidities, particularly when determined from the medical record, are important determinants of patient costs (62). Various co-morbidity scales have been used to show that co-morbid illness, as measured by the scales, are associated with increases in cost (63;64).

Mechanism of injury

Injuries that occurred as a result of road traffic accidents were shown to be significantly associated with higher admission costs compared to injuries due to non-traffic related causes (65-67). Traffic injuries were responsible for 12% of hospital costs in Europe. The mean hospital cost per admitted patient for traffic injuries was R17,575[1], slightly higher than the costs for non-traffic injuries at R16,142, which included home and leisure, sport, and occupational accidents (68).

In a study in Mexico, pedestrians involved in a road traffic accident (RTA) had higher health care costs when compared to other road users such as drivers and passengers ($P < 0.05$) (39).

[1] Figure converted to South African Rands based on the Rands/Euro exchange rate for the year the study was conducted which was 2004 and the rate was 7.54 to 1.

A similar finding was shown by a study in New Zealand where pedestrians were on average, twice as costly to treat as motor vehicle occupants (65). An Australian study also showed that the road user group was a significant predictor of hospital costs and again, in this study, pedestrians were more expensive to treat than other categories of road users (69).

Nature of injuries

The area or region of the body that is injured also impacts on the cost of admission (70;71). Hip fractures were shown in one study to have significantly higher hospital costs compared to other injuries (72). Apart from hip fracture, spinal cord injury, lower extremity injuries (fractures and complex soft-tissue injuries), and burns also showed high costs per admitted patient. Another study showed that the diagnosis or type of injury was independently associated with admission costs (73).

In an Australian study, the body region of injury and injury severity level were associated with higher hospital costs on multivariate regression modeling (69). Hospital costs per casualty ranged from an average of R4,927.40[1] for those sustaining minor (Abbreviated Injury Scale severity score of 1 or 2) spinal injuries to R58,889 and R118,655, respectively, for those sustaining severe (Abbreviated Injury Scale severity score of 4 or 5) head and spinal injuries (69).

Admission characteristics

ICU admission and having surgery have been associated with higher hospital costs (55;65;74-76). ICU admissions have higher costs due to the nature of the treatment required by patients admitted in ICU (65;77). Similarly, a surgical procedure requires the use of more resources

[1] Figures converted to South African Rands based on the rand/dollar exchange rate for that year which was 3.55 South Africa rands to one Australian dollar.

compared to non-surgical interventions and therefore patients who have a surgical procedure have been shown to be more costly compared to those who did not have surgical procedures after adjusting for confounders (78).

1.4.4 Cost accounting methods

Unit costs can be estimated using several methods depending on the type of service, the reason for costing and the financial feasibility of doing the cost calculation exercise (79). Cost accounting methods are used to determine cost of providing a hospital service and includes direct and indirect costs of providing a particular service (79-81).

Any costing exercise however must follow some basic principles regardless of the type of costing method being use. These are as follows (80):

- The formation of a well-defined decision problem, including the objectives of costing, the perspective of costing, and the time horizon.
- The description of a particular service (cost object).
- The identification of resources used to deliver the service.
- The measurement of resource utilization in natural units.
- Attaching monetary value to resource use.
- Sensitivity analysis

a. Definition of decision problem

The objectives of the costing need to be clearly defined and the cost object identified so that the appropriate costing methodology can be selected (82). A cost object is the service for which the cost must be estimated (82;83). When conducting a study the perspective from which the costing will be done also needs to be clear at the onset, as this will affect the cost information required (83;84).

b. Service description

The service for which costs need to be estimated has to be clearly defined in detail. Service description in health care can be challenging, as there are various ways in which health services can be defined however there a number of options that can be used. These include comparing costs of particular services such as surgery or outpatient visits, comparing costs of a single treatment episode and comparing annual total costs of a service (79;85-87).

c. Resources used to deliver service

Once the service for costing has been described, relevant costs for the delivery of the service have to be identified (79;85). The delivery of a service that is facility-based broadly requires human resources, equipment, pharmaceutical products, infrastructure and administration (82;88). The development of a clinical care pathway or flowchart assists in identifying the items that will be used to deliver a particular service (80). The identification of resources that are not directly related to patient care can be challenging, however a hospital expenditure report can provide guidance on these resources (89). Studies have shown that these costs can make up 55% of total costs, and therefore it is important that they are identified (80;90).

d. Measurement of resource use

Measurement of resource use can vary widely and the methods used depend on the aim of the cost analysis. Measurement of resource use can employ a top-down, bottom-up or a mixed-costing approach. The bottom-up approach includes activity-based costing, or mixed costing approach (91-94). The activity-based costing (ABC) method has gained a lot of ground in hospital costing over the past 10 years because it is better able to allocate overhead costs and employs micro-costing techniques, which measure patient-specific resource utilization (82;83;95). Although it can provide more detailed cost structures and accurate cost estimates, the implementation of the system has been found to be resource intensive, time consuming and difficult (82).

An alternative approach is the estimation of resource utilisation and costs by assigning an average figure for health services provided on non-patient specific basis. This is called the top-down approach (80;91). Top down costing can be simple and transparent, and results may be externally valid. In addition, top down costing is usually faster and cheaper than micro-costing, but may be less accurate, because relatively large resource units are measured (for instance one hospital episode, or one day in intensive care unit is the unit of measurement rather than a single procedure or activity performed during the hospital stay) (80;91).

A mixed costing approach has been used to deal with missing data that can often be a problem with hospital based studies which rely on retrieving data from patient records or hospital information systems (83;94;96). This costing approach uses elements of both bottom-up and top-down approaches (80). The advantage of this approach is that it is cheaper than bottom-up approaches which are very detailed and time consuming, whilst providing better accuracy of resource consumption that is lacking in top-down approaches (80;91;94). The one limitation however of mixed costing approaches is that they suffer from low external validity (94).

The mixed costing model allows analysts to tailor the cost measurement towards the study objectives and decide where they will rely on direct cost measurement and where they will use macro-costing (82;87;97). The level to which either the bottom-up or the top-down approaches are used in the mixed approach depends on the level of data available on resources used. For resources that can be easily traced to individual patients such as laboratory investigations, theatre time, radiology services and medication administered, the bottom-up approach can be used. Overhead and capital costs for example are more difficult to allocate directly to individual patients, and the top-down approach can used (82;87).

Costs that need to be measured have to be defined and classified according to traceability to the defined cost object (97-101). The total cost of a service comprises of direct and indirect costs. Sometimes these terms are used interchangeably with the terms fixed and variable costs, with fixed cost describing indirect costs and variable costs, direct costs (97). In reality however, fixed cost can be direct or indirect; similarly variable cost can be direct or indirect (97;100). Overhead costs in a hospital environment such as cleaning, catering and electricity are considered to be indirect costs, as they cannot be traced to a specific patient and the cost of drugs, pathology services and radiology are direct costs, which are traceable to a particular patient (97;101).

e. Attaching monetary value to hospital services

Costing studies of hospital services use various methods when attaching monetary values to hospital resources that are used. These include traditional charges, Diagnostic Related Group (DRG)-based costs, ABC, pseudo-billing and average cost (21;82;97;101). The most commonly used method in studies that adopt a provider perspective is by using charges, fees and official tariffs such as the NHRPL and the UPFS that are used in South Africa. However, charges or fees could be the result of political bargaining or cross-subsidization and they do not necessarily reflect resource consumption (21;29;30;97).

f. Sensitivity analysis

Sensitivity analysis can be defined as a systematic assessment of how changes in selected resource use, input price or assumption affects the unit price estimates. Ideally, all relevant health care costs should be included in the costing exercise however this is not always possible. In certain instances, accurate measurement of unit prices is not feasible. A costing exercise may therefore apply several assumptions and a sensitivity analysis should be performed to check the robustness of the results

In summary the trade-off between information accuracy and the cost of retrieving the information is important to consider when deciding on a costing approach. Hospital costs can be determined by following the above mentioned principles. Since hospital services are one of the main cost drivers in the health care system, accurate costing of these services is essential (21). Expensive medical interventions such as surgery and overhead costs account for over 40% of hospital costs (21;97). A costing exercise in a hospital should attempt to focus on these. In the case of RTIs, a focus on surgical costs is important, as admitted patients often require surgery (102).

1.5 Aim and Objectives

1.5.1 Aim

The aim of this study is to estimate the admission costs for road traffic injuries in a tertiary level academic hospital in Gauteng Province for the year 2009 in order to compare these to the charges the hospital uses for road traffic injuries.

1.5.2 Objectives

I. To estimate the direct and indirect costs of a first time admission to a tertiary hospital with road traffic injuries in 2009 using a mixed-costing approach.

II. To determine which factors are associated with a higher admission cost for patients admitted to a tertiary hospital for road traffic injuries in 2009.

III. To compare costs allocated to patients admitted with road traffic injuries in a tertiary hospital in 2009 using their current billing system to those using the mixed costing approach.

CHAPTER TWO

METHODOLOGY

This section describes the methodology of the project and outlines the design, scope, study setting, study period and population. The data management, which includes collection, cleaning and analysis, is also described.

2.1 Study Design

The study was a facility-based cost analysis of patient care following road traffic injuries using cost accounting methods as described in the literature review.

2.2 Scope

A retrospective review of medical records of patients admitted to Charlotte Maxeke Johannesburg Academic Hospital following a road traffic accident between January and December 2009 was conducted. The study excluded any out-patient or follow-up treatment records and repeat admissions as these patients do not get admitted through the trauma unit when they are readmitted and records are difficult to trace. The study was done from a provider perspective using a mixed costing approach, following the principles described in the literature review.

2.3 Setting

The study was conducted at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH), which is one of two tertiary academic hospitals in Johannesburg. The hospital is attached to the University of the Witwatersrand Medical School and is used for training undergraduate and postgraduate health sciences students.

The 1088 bed hospital serves as a referral center for surrounding primary health care centers and regional hospitals across the province. The entire professional and support staff of the hospital exceeds 4000. As a teaching hospital it has a full staff complement that consists of specialists, registrars, medical officers, community service doctors and newly qualified medical interns.

Patients with a RTI are admitted via a 24-hour trauma casualty at the hospital as referrals from surrounding clinics or directly from accident scenes. They are channeled to one of the surgical units depending on the type and severity of injuries sustained. These are general trauma, orthopaedic, neurosurgical, paediatric and plastics units. There are three specialized intensive care units for trauma, neurosurgical and paediatric patients.

The hospital has some essential services that operate 24 hours a day such as theatre, laboratory and radiology services. The radiology department in the hospital has CT scans, X-ray and ultrasound facilities required for emergencies. Furthermore, there are rehabilitation services offered by the physiotherapy, occupational health, and speech and hearing departments which are offered during working hours from Monday to Friday, 8am to 4pm. The hospital also provides outpatient follow-up services for RTI patients.

The trauma casualty manages an average of 180 patients a day and in 2009, 1240 patients were admitted following a road traffic injury. The trauma unit at the hospital uses a standardized data collection tool called the trauma bank data sheet for collecting data on all patients presenting to the trauma casualty unit. This tool captures information on all of the resources used in the treatment of the patient. This tool was developed by the trauma unit for its own research purposes.

Charlotte Maxeke Johannesburg Academic Hospital was chosen to conduct this study because of the quality and availability of data that is collected using the trauma bank data sheet. Data collection would have been more labour intensive in another hospital where this system of data collection does not exist. Conducting the study in a tertiary hospital also provided the opportunity to estimate the costs of a wide range of injuries including very severe injuries that would normally be referred to a tertiary hospital.

2.4 Study Period

The study period was from the 1st of January to the 31st of December 2009. A one-year period is used in most costing studies in the literature to ensure that seasonal variation does not introduce bias into the study (82).

2.5 Study Population

Patients who were admitted to Charlotte Maxeke Johannesburg Academic Hospital with a road traffic injury during the study period were included in the study. The records of these patients are kept separately in the medico-legal department[1] at the hospital.

Medical records for a patient had to be available for review for inclusion into the study. There were four patients who had missing records in the sample. Available information on these patients was collected and compared with the patients whose records were found to determine whether there was a significant difference in terms of the demographic and injury profiles. The available information included age, sex, and injury sustained (Table 2).

Table 2: Analysis of available variables from missing patient records[2]

Variable	Missing records	Study population	p-value
Age (mean, SD)*	29 years ±4.57 years	31 years ±14.68 years	0.3974
	N (%)	**N (%)**	
Sex#			
Male	3 (75)	189 (73)	0.195
Female	1 (25)	70 (27)	
Primary injury site#			
Head and neck	1 (25)	64 (24)	0.093
Extremity	2 (50)	164 (63)	
Abdomen and pelvis	0 (0)	26 (10)	
Chest	1 (25)	5 (2)	

* T-test
# Fisher Exact test

[1] Medico-legal department keeps all patient records that may be required by the legal system for insurance claims or criminal cases

[2] This table shows that there is no significant difference between the missing records and the files that were available in terms of the variables of interest. The results of the study therefore would not have been significantly different had the missing files been included. Data availability bias would not be a factor in the study.

2.6 Sampling

2.6.1 Sample Size

Calculating sample size using the variance between actual costs and amount billed was not feasible as the variance of the cost could only be calculated once the costs had been estimated. Four health economists were consulted regarding calculating sample sizes in cost analysis. They explained that this was not common practice and the calculation was very complicated and not required for estimating cost. In light of this, due to resource constraints 20% of the records were selected across the entire study period to include in the study.

2.6.2 Sampling method

Systematic sampling was used to select the records of patients admitted with RTIs from all registers of 2009 from the Medico-legal Department and Records Department. The sample size comprised of approximately 20% of files selected for inclusion into the study and thus a sampling interval of five was used. A random number between one and five was selected to start and thereafter every fifth record was selected.

Only records covering initial admissions were reviewed. The inclusion criteria were: admission to hospital for one day or more, records had to have the age, sex, date of admission and discharge, diagnosis, doctors' notes, prescription chart, anaesthetic record, investigations ordered and a trauma bank data sheet. When data was missing, the next file was selected for review.

2.7 Data Management

2.7.1 Data Collection

The selected patient files were retrieved from the Medico-legal department filing room. The patient data were collected from each patient file using a data collection tool (Annexure 1). The researcher collected data from the patient files and the hospital information system. Information on the demographics of the patient, accident details, and services provided during admission and outcomes of injuries were extracted from patient records (Table 3).

Table 3: Data on patient baseline and clinical characteristics

DATA SOURCE	DATA EXTRACTED
2009 patient records	• Age • Sex • Accident details • Date of admission • Date of discharge • ICU admission • Types of injuries including primary injury based on discharge summary • Interventions that include the following: surgery or non-surgical treatment such as neurological observation, application of plaster of Paris, insertion of intercostal drain • Theatre time from anaesthetic notes in the patient’s record • Radiological investigations done • Rehabilitation services provided: physiotherapy, occupational therapy, speech and hearing therapy, dietician • Social worker consultations • Pharmaceutical products provided • Outcome of treatment • Disability

2.7.2 Data Entry and Cleaning

Data from the data collection tool were entered into a Microsoft Excel 2010 spreadsheet by a single person responsible for capturing data at the end of each day of data collection. This spreadsheet was imported into STATA 10 statistical software, after which data cleaning was done to identify incorrect entries and missing variables. The completed data collection tools were used to counter check errors identified that occurred during the data entry process.

Injury severity score allocation

An injury severity score was allocated to each patient during the data entry process based on the number and severity of injuries.

The Injury Severity Score (ISS) is an established medical score used in trauma care to assess trauma severity. The score uses an anatomical scoring system to provide an overall score for patients with multiple injuries. It correlates with mortality, morbidity and hospitalization time after trauma (103;104). A major trauma (or polytrauma) is defined as the Injury Severity Score being greater than 15.

The ISS is based upon the Abbreviated Injury Scale (AIS). Each injury is assigned an AIS score and is allocated to one of six body regions (head, face, chest, abdomen, and extremities (including the pelvis). The AIS is thus an anatomical scoring system and ranges from 1 to 6, with 1 being minor, 5 severe and 6 a fatal injury. This represents the 'threat to life' associated with an injury and is not meant to represent a comprehensive measure of severity. The AIS is not an injury scale, in that the difference between AIS1 and AIS2 is not the same as that between AIS4 and AIS5 (62).

When calculating the ISS, only the highest AIS score in each body region is used. The three most severely injured body regions then have their scores squared and added together to produce the ISS score. An example of the ISS calculation is shown below (Table 4):

Table 4: Calculation of Injury Severity Score(103;104)

Region	Injury description	AIS	Square top three
Head and Neck	Cerebral contusion	3	9
Face	No injury	0	
Chest	Flail chest	4	16
Abdomen	Minor contusion of liver Complex rupture of spleen	2 5	 25
Extremity	Fractured femur	3	
External	No injury	0	
		Injury Severity Score	**50**

The ISS score includes values from 0 to 75 with a higher score implying more extensive injuries. If an injury is assigned an AIS of 6 (fatal injury), the ISS score is automatically assigned to 75. The ISS score is virtually the only anatomical scoring system in use. Its weaknesses are that any error in AIS scoring increases the ISS error.

Also of note is that many different injury patterns can yield the same ISS score, and injuries to different body regions are not weighted. In this study, an ISS score was assigned for each patient using a guide to determine which score to assign an injury (Annexure 2) (103;104). After assigning injury severity scores for each patient, these scores were categorized in the analysis. Categories for the ISS were created using the following guide in Table 5:

Table 5: Categories of the injury severity score

LEVEL OF SEVERITY	ISS Score
Minor	1-12
Moderate	12-27
Serious	27-48
Severe	48-74
Fatal	75

2.7.3 Costing method

A. Identification of cost object

Inpatient treatment was identified as the cost object. Clinical care pathways in trauma were used to identify the services provided at the hospital for road traffic injury patient and trauma patients in general (Figure 1).

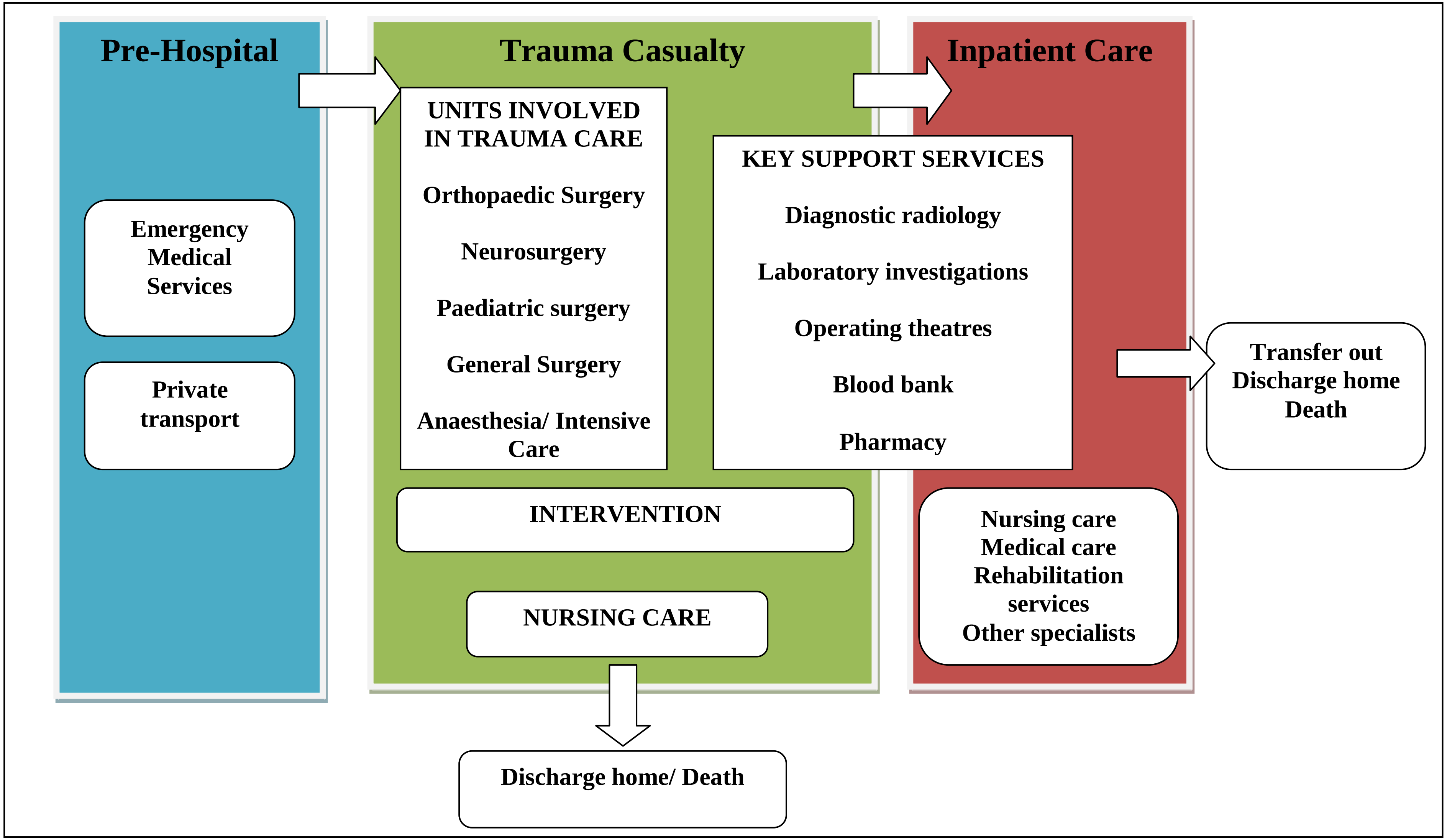

Figure 1: Model of clinical care pathway in trauma patient

B. Attaching monetary value to hospital services

A monetary value in South African Rands was attached to the services identified. The total cost per patient was the combined cost of all variable costs and a portion of fixed cost. Overhead costs were classified as fixed costs and were allocated using the top down approach. Costs of laboratory investigations, radiology, medication, and blood products were considered to be variable costs and a bottom-up approach was employed.

Fixed costs

Overhead cost and salaries were classified as fixed costs. Overhead costs include medical equipment, medical consumables from dry stock[1], municipal services, cleaning, laundry, security and catering. Salaries could not be calculated per patient as the hospital expenditure report does not separate medical, allied and support staff salaries and they were therefore classified as a fixed cost.

A modified patient day equivalent (PDE) was used to allocate fixed costs. The PDE is an estimate of the total daily cost to the hospital, which includes direct costs like human resource costs and indirect costs (4;26). A PDE traditionally combines outpatient visits with inpatient days by assuming that the cost of one outpatient visit equals a third of the cost of an inpatient day (4;26). The formula used to estimate PDE is shown in Figure 2 (26;105). The PDE at the hospital for 2009 was estimated to be R2,300 by the finance department (89;90).

Figure 2: Patient Day Equivalent calculation

$$\text{PDE} = \frac{\text{Total Hospital Expenditure}}{\text{(Inpatient Days + [0.5 X Day Patients] + [Casualty and Outpatient Head Count X 0.33])}}$$

[1] Dry stock includes drip sets, bandages, plasters, intercostal drain sets, alcohol swabs, syringes and needles.

To calculate the average monthly cost per patient day equivalent (PDE), data on inpatient days, day patients, casualty head count and outpatient days for 2009 were retrieved from the hospital information system. The figures for the components of the PDE calculation are shown in Table 6. The hospital expenditure was retrieved from the expenditure report for 2009 (Annexure 3). The modified PDE excluded the costs of laboratory services, radiology, blood products, medication, fluids and surgical consumables used in theatre from the total hospital expenditure as these were classified as variable costs.

Table 6: Components for calculation of modified PDE in 2009

	VALUE
Average number of Inpatient days/month	51338
Average number of Day patients/month	2053
Average Total outpatient & Casualty headcount/month	97321
Average Total expenditure/month*	R118,997,000.00
Average PDE cost/month	R1,391

**Excludes the variable costs that were calculated for each patient*

According to the hospital expenditure report of 2009, salaries accounted for 85% of all costs. It was assumed then that 85% of the PDE was costs of salaries and this meant that PDE cost due to salaries was R1, 182.35 and overhead costs were R208.65. Based on the figure above, the overhead and salary costs per patient were calculated using the formula in Table 7. In this formula the overhead cost allocation was based on the length of stay.

Table 7: Formula for overhead cost per patient

COST COMPONENT	**FORMULA**
Salary cost	R1, 182.35 × length of stay (A)
Overhead cost	R 208.65 × length of stay (B)
Total Fixed Costs	A + B

Calculating the overhead costs for ICU posed a particular challenge. The modified PDE would not have been appropriate to use because ICU costs are expected to be higher than in a general ward because of the lower nurse to patient ratios in ICU and the use of mechanical ventilation (90). The recommended fee from the UPFS was used instead. ICU overhead costs and general ward costs are presented separately. The recommended overhead cost for ICU in UPFS was R5586 per day.

Variable costs

The variable costs were identified and determined for every patient in the sample population. Costs of laboratory and radiological investigations, pharmaceutical products including blood products and theatre time were classified as variable costs. Variable cost information was obtained from the National Health Laboratory Services pricelist (Annexure 4), and state pharmacy prices (Annexure 5), South African National Blood Services, NHRPL (Annexure 6) and the Hospital Information System (Table 8). Data sources were drawn from differing years because of the availability of the sources.

Table 8: Data sources for cost information

DATA SOURCES	DATA EXTRACTED
2009 National Health Laboratory Services pricelist	Cost of laboratory investigations
2009 Government pharmacy prices	Costs of medicines and intravenous fluids
2009 South African National Blood Services	Costs of blood products[1]
2009 National Health Reference Price List 2006 National Health Reference Price List	Radiology costs Theatre time cost per minute

[1] Blood products included packed red cells and the cost of preparing the units of blood

The 2006 costs of theatre time were converted to a 2009 value based on the average inflation rates for the years 2007, 2008 and 2009. The formula below was used (Table 9).

Table 9: Conversion of 2006 prices to 2009 rates using inflation (106;107)

Year	Formula	Inflation rates
2007	[2006 price × (1+inflation rate for 2007)] (A)	4.8%
2008	[A × (1+ inflation rate for 2008)] (B)	5%
2009	[B× (1+ inflation rate for 2009)]	9%

The unit cost for each item was extracted from the relevant data source. The formulae used to calculate the variable costs are outlined in Table 10 below.

Table 10: Variable cost calculation per patient

COST	FORMULA
Theatre time[1]	Cost per minute × total theatre time in minutes
Pharmaceutical products	Number of doses × unit costs then sum of all unit costs
Blood products	Unit cost × number of units of blood product then sum of all unit costs
Radiological investigation	Unit cost per investigation then sum of all unit costs
Laboratory investigation	Unit cost per investigation then sum of all unit costs

Calculation of total cost per patient

The cost per patient was a composite of all fixed and variable costs. The cost per patient per day was calculated using the formula in Table 8. To calculate the costs related to road traffic injuries in the hospital, the average length of stay (ALOS) was calculated (Table 11).

[1] Theatre time was the total number of minutes spent under anaesthesia in theatre during the admission period and costs excluded human resource costs

Table 11: Calculation of ALOS and cost per patient per day

	FORMULA
Costs per patient per day	$\frac{\text{Total cost of admission}}{\text{Total inpatient days}}$
Average Length of Stay (ALOS)	$\frac{\text{Inpatient days}}{\text{Number of discharges}}$

Charges using hospital billing system

The hospital information system provides the daily rate charged for all patients in the hospital who are classified as private patients. Private patients are those who have medical insurance to cover the hospital bill. Patients admitted with a RTI are classified as private patients because the RAF is responsible for the hospital bill. The daily rate charged for a patient in a general ward is R998 and for a patient admitted in ICU it is R5, 046 per day. This is the recommended overhead fee from the UPFS. There was no evidence of other charges for theatre, pharmaceutical products or radiology service found from the hospital information system.

2.8 Data Analysis

The spreadsheets were imported into STATA 10 and analyzed using descriptive and analytic statistics.

2.8.1 Descriptive analysis

Means and standard deviations for normally distributed data, or medians and interquartile ranges for skewed data were used to summarize continuous data which included age, length of stay, theatre time, and number of injury sites. Proportions and frequencies were calculated for categorical variables such as sex, accident details, and admission day of the week, surgery, injury site, and injury severity score, transportation by emergency transport, rehabilitation services received, presence of disability and outcome defined as death, discharge and transfer to another facility. Medians and interquartile ranges were reported for all fixed and variable costs for the entire sample.

2.8.2 Tests of association

The non-parametric Wilcoxon Rank Sum and the Kruskall-Wallace test were used to compare medians of skewed cost data (Table 12). The non-parametric Spearman's rank correlation was used to determine the correlation between total costs and length of stay. Associations were considered to be significant if the p-value was <0.05.

Two univariate and multivariate models were fitted to determine whether there were associations between total cost and length of stay with the independent variables age, sex, and number of injuries, co-morbidities, type of accident, use of emergency medical services, surgical procedures, and ICU admission (Table 12). Continuous variables were categorized before they were fitted in the model; these include: the injury severity score. Linear regression was done after the cost data and length of stay were transformed into a logarithmic scale, as they were not normally distributed.

Table 12: Outcome and exposure variables

OUTCOME VARIABLES (Continuous)	EXPOSURE VARIABLES	
	CONTINUOUS	CATEGORICAL
• Total cost of treatment per patient • Length of stay	• Age	• Sex • Co-morbidities • Type of accident • Use of emergency medical services • Primary injury site • Number of injuries • Injury severity • ICU admission • Surgical procedure • Disability • Outcome of admission

Multivariate models were built using backward selection of non-significant variables based on the p-values. The process started with a model that included all possible predictor variables that were found to be significant on the univariate regression with a p-value of ≤0.1. Variables with the highest p values were then excluded one-by-one to obtain the final model. The association was considered statistically significant if the p-value was <0.05 in the multivariate model.

Retransformation of the coefficient was done after the regression analysis of the factors that were associated with cost was completed. This was conducted by calculating the exponent of the coefficient. The log coefficients and the retransformed coefficients are presented in the results section.

2.8.3 Testing for assumptions of linear regression

The assumptions for a linear regression model for factors associated with the log of the cost and the log of length of stay were tested with model diagnostics. Additionally the data was checked for outliers and observations that could influence the data before the assumptions were tested. The following steps were undertaken:

a. Cost model

I. Scatter plots were plotted to determine whether indeed there were outliers in the data. The studentized residuals were examined as a means of identifying the outliers that were found in the scatter plots. Observations that were found to be outliers in the data included observations with id number 28, 45 and 53 the residuals for observation 45 and 53 exceeded +2 or -2.

II. Cook's distance was used to examine which observations have significant influence on the data. The lowest value that Cook's distance can assume is zero, and the higher the Cook's D, the more influential the observation. The conventional cut off is 4/n with "n" being the number of observations in the sample. In this study the cut off was 4/259, which was 0.015. The observation that was found to have a Cook's D >0.015 was observation id number 250.

Observations that were found to be significant outliers and have influence on the data were removed from the data set after which the regression analysis was done. These findings are presented in the results section of the report.

The assumptions of linear regression were checked in the following steps:

I. Normality was checked using k-density graphs after the residuals were predicted. The graphs showed that the residuals were normally distributed (Figure 3).

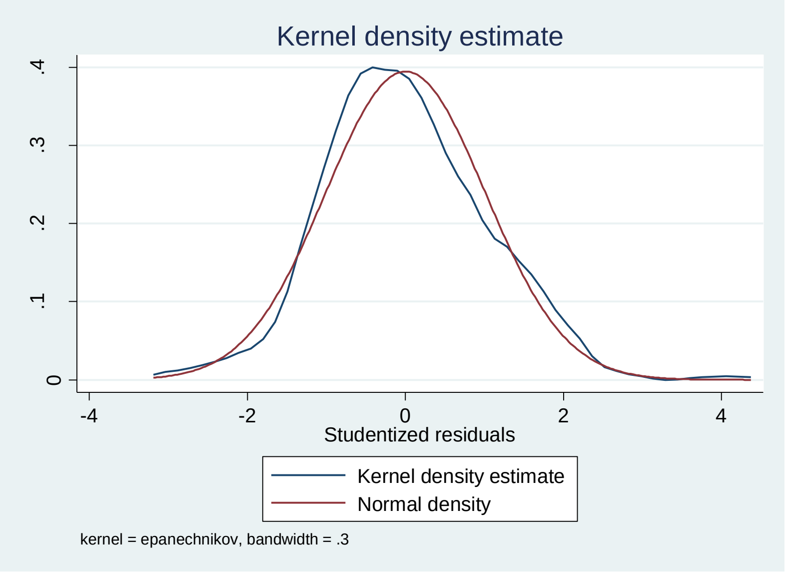

Figure 3: K-density graph of studentized residuals

II. Heteroscedasticity of the variance of the residuals was checked using the Breusch-Pagan test. The p-value was 0.054 which was of borderline statistical significance. The residuals were then plotted against the fitted (predicted) residuals to look for evidence of heteroscadascity (Figure 4). This graph showed how the data points did not have any specific pattern and the variance were considered to be homogenous. There was no strong evidence of heteroscedasticity in the model and therefore there was no need for correction.

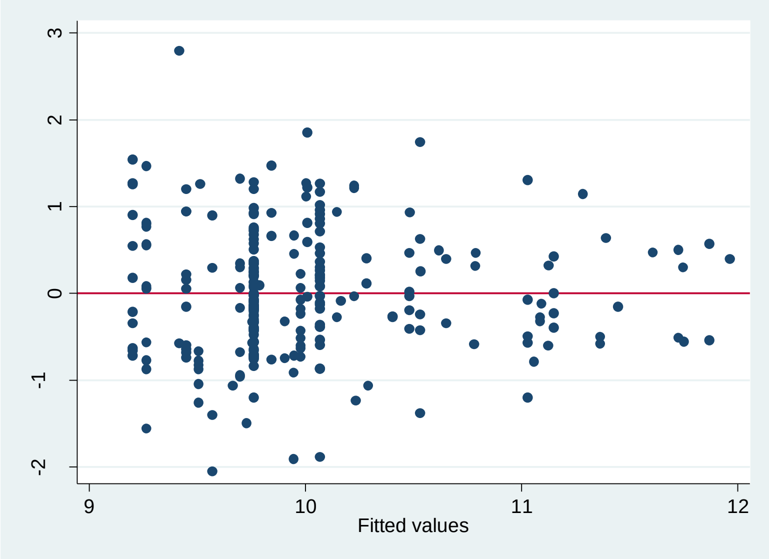

Figure 4: Plot of residuals against fitted residuals

III. Multicollearity was tested by computing the variance inflation factor (VIF). The rule of thumb is that a VIF greater than 10 warrants further investigation. The VIF values of the independent variables in the model of cost were all less than 10; this means that multicollinearity was not a problem in the model and the independent variables were not correlated. The mean VIF was 1.28.

The model that was built for the log of the cost did not violate the assumptions of linear regression and could therefore be considered to be valid. This model did not include length of stay; a separate model was built for length of stay.

b. Length of stay model

The same tests were then conducted for the model on length of stay.

I. Observation that were found to be outliers in the data included observations with id number 45 and 53 however the residuals did not exceed +2 or -2.

II. In this study the cut off was 4/259, which was 0.015. None of the observations had a Cook's distance of >0.015.

No observations were found to be significant outliers or had influence on the data. There was no need to remove any observation from the dataset for this model.

The assumptions of linear regression were checked in the following steps:

I. Normality was checked using k-density graphs after the residuals were predicted. The graphs showed that the residuals were normally distributed (Figure 5).

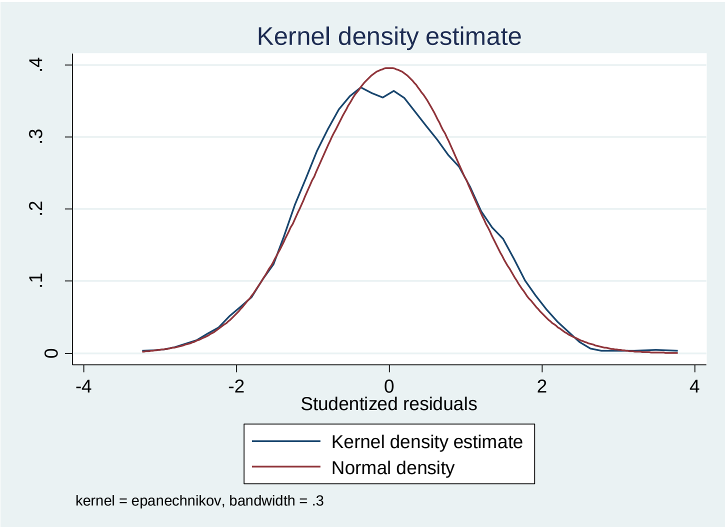

Figure 5: K-density graph of studentized residuals of log of length of stay

II. Heteroscedasticity of the variance of the residuals was checked using the Breusch-Pagan test. The p-value was 0.0839 which was not statistically significant. The residuals were plotted against the fitted (predicted) residuals (Figure 6). There was no strong evidence of heteroscedasticity in the model and therefore there was no need for correction.

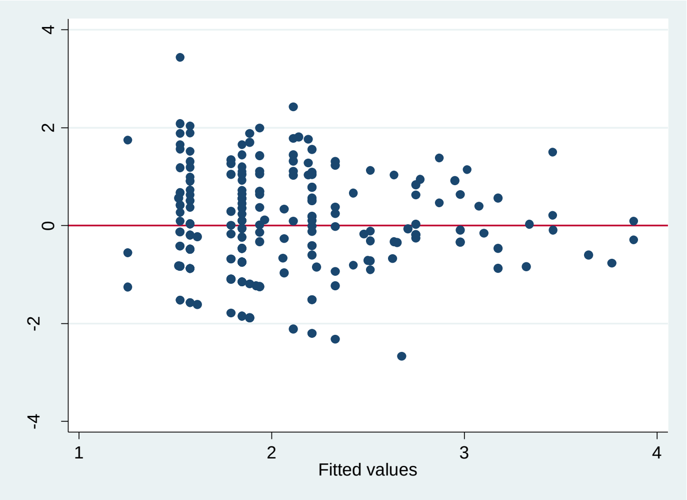

Figure 6: Plot of residuals against fitted residuals

III. Multicollearity was tested by computing the variance inflation factor (VIF). The mean VIF was 1.23.

The model that was built for the log of the length of stay did not violate the assumptions of linear regression and could therefore be considered to be valid.

2.9 Sensitivity Analysis

A sensitivity analysis was done to determine which parameters are the key drivers of a model's results. A one-way sensitivity analysis was done to check whether change in the total admission costs would affect the final cost model. The total admission costs using the current hospital charges were used in the sensitivity analysis. The results are presented in the next chapter.

2.10 Pilot study

A pilot study was done using ten patient files from patients admitted in 2008. The pilot study identified areas in the data collection tool that needed clarification and the proposed adjustments to the tool were made accordingly. The pilot study also assessed completeness of the data.

2.11 Ethical Considerations

The research protocol was submitted to the Committee for Research on Human Subjects (Medical) of the University of the Witwatersrand (Ethics Committee) for approval before commencement of the study, approval number M10352 (Annexure 7). The study also received approval from the Postgraduate Committee at the University of the Witwatersrand before commencement of the study (Annexure 8). Permission was granted by management at Charlotte Maxeke Johannesburg Academic Hospital to conduct this research using patient records for a retrospective review (Annexure 9).

Patient confidentiality was maintained by allocating codes to the patient records. No names, surnames, identity numbers or any other potential identifiers were captured from the records. Only the investigator and the person responsible for data capturing had access to the records. Codes were captured and stored on an Excel spreadsheet in two secure areas, a CD-ROM and dedicated memory stick and the spreadsheets were password protected. The research protocol was submitted to the Postgraduate Committee for approval prior to the study.

CHAPTER THREE

RESULTS

This chapter presents the findings of the study. Baseline characteristics, accident and admission details, and clinical characteristics are described. The cost analysis, and factors associated with cost and length of stay are also presented.

3.1 Baseline characteristics

3.1.1 Demographic

There were 189 (73%) males and 70 (27%) females in total. The mean age of patients admitted was 31 years ±14.68 years. Thirty three percent of admitted patients fell into the 26-35 year age group and 17% in the 36-45 year age group illustrated in Figure 7. There was a dip in the number of admissions in the 56-65 years age group

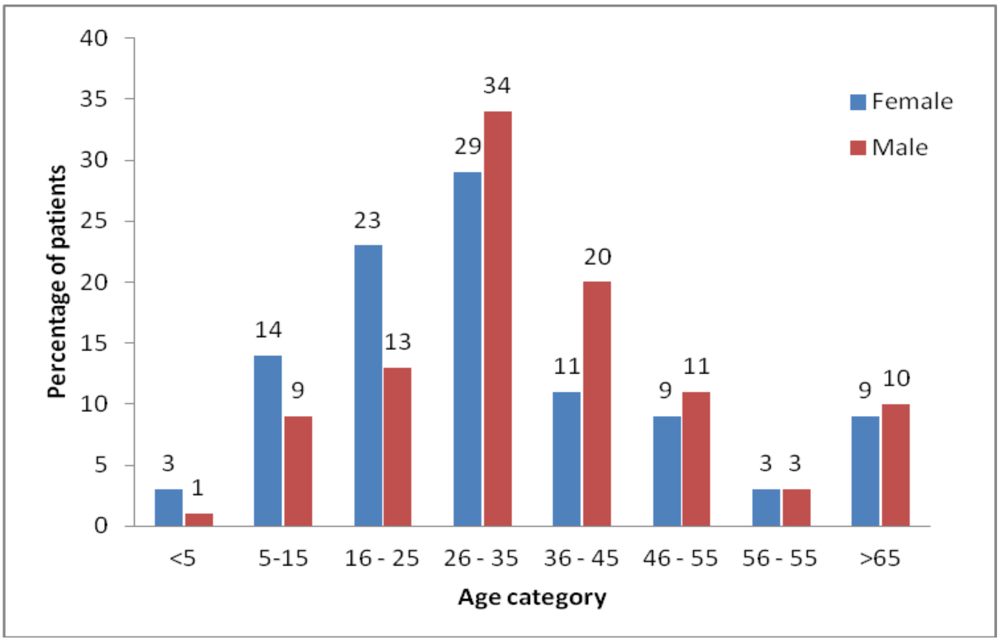

Figure 7: Age and sex distribution of patients with road traffic injuries

There were more males than females admitted across all age categories except in the <5 years category (Figure 7). However the sex differences in the age categories were not statistically significant (p-value = 0.183).

3.1.2 Medical conditions

The majority of patients who were admitted did not report having any underlying medical conditions. Only 9% of the patients were reported to have underlying conditions and these included hypertension (4%), asthma (3%), HIV (2%), diabetes (2%), epilepsy (1%), and tuberculosis (0.4%). According to patient records none of the patients were diagnosed with underlying medical conditions during admission apart from one patient who was diagnosed with tuberculosis.

3.1.3 Accident details

Pedestrian vehicle accidents (PVAs) were the most common mechanisms of injury reported (54%) followed by motor vehicle accidents (40%) and then motorbike accidents (6%) (Table13). Most patients were brought to the hospital from the accident scene by emergency medical services (76%).

Table 13: Accident details and emergency services

Variable	Number of patients (N)	%
Type of accident		
MBA	13	5.02
MVA	106	40.93
PVA	140	54.05
EMS		
No	63	24.42
Yes	195	75.58

There was a steady increase in the number of admissions from Wednesday with a peak on Saturdays. Almost 20% of patients were admitted with on Saturdays (Figure 8). The numbers show a decline on Sundays with approximately 11% of admissions occurring on a Sunday.

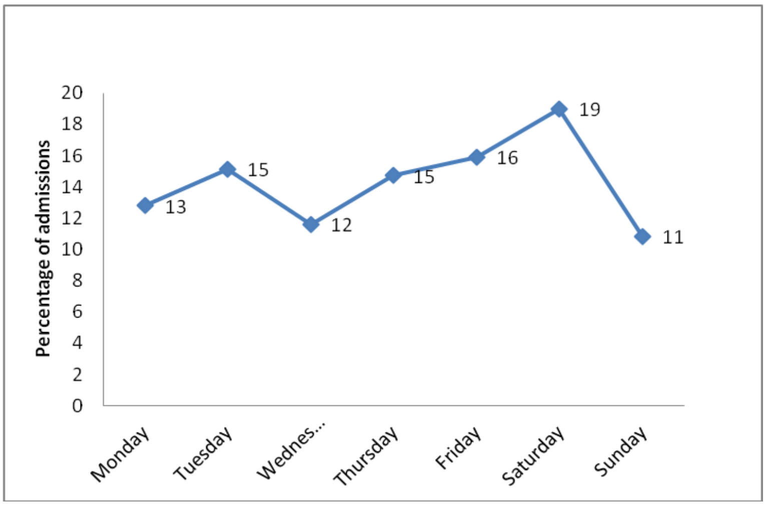

Figure 8: Percentage of accidents by day of the week

3.2 Clinical characteristics

The majority of patients sustained injuries to their extremities (63%), some sustained head and neck injuries, injuries to the chest and back, and abdomen (Table 14). Fifty-one percent of patient had single injuries, the rest had two or more injuries. Patients were admitted into the orthopaedics (60.6%), neurosurgical (20.5%), paediatric surgery (10.8%), general surgery (6.95%), and plastic surgery departments (1.1.6%). Thirteen percent of patients were admitted to ICU.

An ISS was allocated to each patient using AIS, which is described in the methodology section in chapter two of this thesis. The mean ISS score was 25 (SD = 19.93). Twelve percent of patients had an ISS of 75; these were patients who died as a result of their injuries. The majority of patients had a score of between 12 and 27 (55%).

Table 14: Clinical characteristics

Variable	Number of patients (N)	%
Primary injury site		
Head and neck	64	24.71
Extremity	164	63.32
Chest and back	26	10.04
Abdomen	5	1.93
Number of injuries		
1	134	51.74
2	107	41.31
3	8	3.09
4	7	2.70
5	1	0.39
6	2	0.77
Injury Severity Score		
1-12	44	16.99
12-27	142	54.83
27-48	40	14.44
48-74	2	0.77
75	31	11.97
ICU admission		
No	225	86.79
Yes	34	13.01

3.3 Length of stay

Total patient admissions in the general ward accounted for 3553 inpatient days and 361 ICU days. The total inpatient days accounted for 7.3% of the total inpatient days in the hospital in 2009. The average length of stay was 14 days for the general ward and 10.6 days for ICU admissions (Table 15).

Table 15: Length of stay at the hospital

VARIABLE	Patients (N)/%	Number of patient days	ALOS
General ward admission	256	3553	14
ICU admission*	34	361	10.6

**Three patients died in ICU , p = 0.196*

3.4 Services provided at the hospital

All patients received some form of treatment during their hospital stay. Services provided include surgical and non-surgical interventions such as neurological observations and rehabilitation therapy. Table 16 shows the type of treatment patients received.

3.4.1 Surgical intervention

Seventy-one percent of the patients admitted had some form of surgery, including orthopaedic procedures (75%), neurosurgery (2%), abdominal surgery (5%) and other general surgery procedures (18%). A full list of the procedures is included in Annexure 10.

3.4.2 Non-surgical treatment

Table 16 shows the treatment the patients received during admission. Twenty-nine percent of patients did not require a surgical intervention and were treated conservatively. Some patients who received surgery also received other non-surgical treatments. The treatment they received included neurological observations, bed rest, insertion of intercostal drain, skeletal traction, application of cervical collars, application of Plaster of Paris (POP) and slabs for fractures and rehabilitation services[1].

Physiotherapy was the most commonly used rehabilitation service with an average of one visit per patient (mean=1.1, SD±3.136). Occupational therapy (OT) and speeach and hearing therapy were less frequently prescribed for admitted patients. Dieticians were consulted in 2.7% of cases. Social workers were required in 11 cases (4.7%).

[1] Most of the equipment for conservative treatment comes from the dry stock mentioned in Chapter 2

Table 16: Services provided at the hospital following a road traffic injury

Variable	Number of patients (N)	%
Surgery		
No	76	29.34
Yes	183	70.66
Conservative Treatment		
Bed rest	9	6.92
Cervical collar	12	9.23
Collar and cuff	9	6.92
Intercostal drain insertion	12	9.23
Neurological observation	28	21.54
POP	18	13.85
Reduction	4	3.08
Suturing	20	15.38
Traction	18	13.85
Physiotherapy		
No	174	67.18
Yes	85	32.82
Occupational therapy		
No	242	93.44
Yes	17	6.66
Speech and hearing therapy		
No	255	98.46
Yes	4	1.54
Dietician consultation		
No	252	97.29
Yes	7	2.71
Social worker consultation		
No	248	95.75
Yes	11	4.25

3.4.3 Medication

Analgesics were ordered for all patients whilst admitted and were also prescribed on discharge. Antibiotics were prescribed in 80% of cases, and of these 86% were administered prior to surgery as prophylaxis. The antiepileptic Epanutin was prescribed for all of the patients suffering from a head injury. Other types of medication prescribed included those required for the treatment of reported underlying medical conditions such as antihypertensive medication, insulin for diabetics, TB chemotherapy and steroids for asthma. Anticoagulants were prescribed in 7% of patients.

3.4.4 Fluids and blood products

Most patients (87%) had intravenous lines inserted to administer fluids, medication and/or blood products. Resuscitation fluids were used on the 87% of patients on admission and the units were replaced over the duration of admission as required. Blood products were used in 20 patients (8%) with an average of three units per patient.

3.4.5 Radiological investigation

In terms of baseline investigations, all patients had baseline radiological investigations done on admission. The most commonly ordered investigations included chest x-rays (84%), cervical spine x-rays (79%) and a special ultrasound used to make a first assessment of fluid in the abdomen (75%). Radiological investigations excluded X-ray guidance required during orthopaedic procedures but included all repeat investigations during the admission. The type of investigation ordered depended on the site of injury and level of injury severity. There were a total 922 radiological investigations done with an average of 3 investigations per patient.

3.4.6 Laboratory investigations

Baseline blood analysis which included a full blood count (FBC) and urea and electrolytes (U &E) were ordered in 83% of admissions. These tests were ordered on the day of admission.

Liver function tests, C-reactive protein and blood clotting profile were ordered in 2%, 9% and 5% of admissions respectively. Approximately 60% of patients had some of the laboratory investigations repeated during the admission period according to the medical records. The most commonly repeated test was the full blood count following surgery for fracture repairs.

3.5 Outcome of injuries

3.5.1 Death

Thirty-one patients in the study died as a result of their injuries (Table 17). Head injuries were the cause of death in 46% of patients who died and septicaemia led to the death of four patients (1.5%). Thirteen percent of the patients who died had cervical spine injuries that had led to quadriplegia. Sixty-eight percent of patients who died sustained at least 2 injuries in the accident. There was a significant difference in the average number of injuries between patients who died (mean= 2, SD±1.38) and those who survived (mean = 1, SD±0.67) (p = 0.000). Most of the patients who died had not reported any underlying medical condition.

Table 17: Treatment outcomes

Variable	Number of patients (N)	%
Outcome		
Discharged	224	86.49
Died	31	11.97
Transfer to rehabilitation facility	4	1.54

3.5.2 Transfer out

A small proportion (<2%) of patients were transferred out to rehabilitation facilities, chronic care facilities and to hospitals closer to a patients home. Patients who were transferred out had sustained at least two injuries (75%).

3.6 Disability

Ninety-four percent (209) of patients were discharged with no permanent disability. Injuries in 16 (6.18%) patients resulted in a disability. Nine of the patients had limb amputations, three were left paraplegic and two were quadriplegics. Another two patients sustained severe brain injuries which left them with significant brain damage. Most of the patients with disabilities had sustained 2 or more injuries (62.5%) compared to patients who did not have a disability most of whom had sustained only one injury (p=0.003).

3.7 Cost Analysis

3.7.1 Breakdown of fixed and variable costs

A mixed-costing approach was used to estimate the costs related to the treatment of RTIs. Table 18 shows the breakdown of fixed and variable costs. Fixed costs accounted for 70% of all costs in the patients under study. This was expected as fixed costs were apportioned based on the length of stay. Spearman correlation revealed that the total cost had a significant correlation with fixed costs (rho = 0.9439, p = 0.000) and length of stay (rho = 0.9439, p = 0.000).

Theatre costs were the most expensive of the variable costs accounting for 16% of all costs and 58% of variable costs. Theatre time cost a little over 1 million Rands for the 183 patients who required surgical treatment. The next most expensive service was the cost of blood products with a median cost of R4, 261.92. The median total cost was found to be R21, 167.16 with an interquartile range from R11, 459 to R40, 042.8. The average cost per patient for variable costs was R10, 001. The cost per patient per day was calculated to be R 2, 655.80 for the 259 patients.

Table 18: Breakdown of fixed and variable costs

Cost component	N	Total cost (Rands)	% of subtotal	Median cost (Rands) (IQR)
TOTAL COST	**259**	**9,570,590.11**	**-**	**21,167.16 (11,459 - 40,042.8)**
Subtotal fixed		**6,965,724.00**	**-**	
ICU	34	2,016,546.00	29	27,930 (16,758 – 61,446)
General ward overhead	256	742,376.70	11	1,877.85 (625.95 - 4,381.65
General ward salaries	256	4,206,801.3	60	10,641.15 (3,547.05 - 24829.35)
Subtotal variable		**2,604,866.11**	**-**	**6,696.11 (4,040.02 – 10,818.84)**
Theatre time	185	1,516,596.90	58	7,665 (5,621 – 9.198)
Laboratory tests	218	59,727.63	2	254.26 (254.26 - 254.26)
Medication	259	249,737.53	10	183.14 (129.02 – 280.32)
Blood products	20	134,250.48	5	4,261.92 (4,261.92 – 6,392.88)
Fluids	226	77,669.57	3	163.88 (163.88 – 327.76)
Radiology	254	566,884.00	22	1,468.5 (436 – 3, 678)

3.8 Factors associated with admission cost

Factors that could be associated with higher admission costs were evaluated. Table 19 presents results of the tests of association comparing total admission costs by demographics, clinical and treatment characteristics. Sex, age, having an underlying medical condition, the mechanism of injury, injury outcome and ISS were all not significantly associated with cost.

3.8.1 Clinical characteristics

There was a significant difference in the cost in patients with different primary injury sites (p = 0.003). Abdominal and pelvic injuries were more expensive to treat; the median cost was R76, 085 compared to other types of injuries (p<0.001). Patients, who ended up with a disability cost the hospital more than twice the amount of patients who did not end up with a permanent disability (p<0.001).

3.8.2 Treatment characteristics

People who were brought into the hospital by emergency medical services had a significantly higher median costs compared to those who had not been brought in by the EMS, with the median cost of R 21,092 in the group that was transported by EMS with a p-value of (0.004).

Patients who were admitted to ICU had higher costs compared to patients who were not admitted, with the difference in the two groups being significantly different. The median cost for patients who were admitted to ICU was R33, 622 compared to R 17,671 for patient who had not been admitted to ICU (p-value of <0.001).

Similarly patients who had surgery had significantly higher cost compared to patients who only received non-surgical treatment (p-value <0.001).

Table 19: Factors associated with total admission costs

Variable	Median cost (Rands)	IQR (Rands)	p-value
Sex			
Female	20,548	11, 182 – 35,121	0.527
Male	21,320	11,737 – 40,183	
Age			
<5	13,779	2,806 – 14,534	0.432
5-15	21,092	3,874 – 62,628	
16-25	19,195	1,901 – 224,972	
26-35	21,774	2,284 – 209,665	
36-45	19,237	5,713 – 92,218	
46-55	18,440	3,640 – 85,891	
56-65	17,457	10,069 – 145,866	
>65	15295	4,910 – 108,089	
Reported medical condition			
No	21,167	11,435 – 37,141	0.329
Yes	21,427	12,286 – 73,573	
Mechanism of injury			
MBA	34,355	20,701 - 47,822	0.222
MVA	21,233	10,186 – 46,911	
PVA	19, 598	11,695 – 35,104	
Primary injury site			
Head and neck	15,654	2,806 – 36,383	0.003
Extremity	19,839	11,669 – 30,108	
Abdomen and pelvis	76,085	10,559 – 89,859	
Chest	40,825	23,920 – 65,549	
ICU admission			
No	17,671	10,013 – 30,111	<0.001
Yes	33,622	23,211 – 73,219	
Use of Emergency Medical			
Services	13,920	8,895 – 23,621	0.004
No	21,092	11,609 – 37,987	
Yes			
Number of injuries			
1	14,365	9,763.27 – 23,330	<0.001
2	24,092	10,910.66 – 42,741	
3	77,461	34,422.51 – 92,379	
4	73,219	37,987.88 – 85,147	
5	33,677	33,677 – 33,677	
6	70,603	67,607 – 7 73,599	
Injury Severity Score			
1-12	21,212	14,185 – 37,391	0.1868
12-27	18,412	11, 317 – 35,088	
27-48	26,093	10,112 – 47 ,689	
48-74	17,908	10, 856 – 24, 959	
75	29,132	15,745 – 57,386	

Variable	Median cost (Rands)	IQR (Rands)	p-value
Surgery			
No	13,318	6,672.29 – 33,734	<0.001
Yes	20,965	12, 487.56 – 13, 6845	
Disability			
No	18,440	10,013 – 32,410	<0.001
Yes	51,589	31,908 – 73,371	
Outcome			
Died	25405	2284 – 108089	0.209
Discharged	18814	3273 – 145866	
Transfer out	23883	8190 – 57747	

3.8.3 Ten patients with the highest admission cost

Table 20 shows the baseline, clinical and cost information of patients with the highest total admission cost. The total cost for these patients was R 2,436,275.44. The cost of these top ten admissions accounted for 26% of total costs. The total inpatient days in these patients made up 18% of the total, despite the patients accounted for only 4% of the total sample.

The table further illustrates that having surgery, ICU admission and having multiple injury sites were associated with high admission costs. Seven out of the ten patients had had surgery. Eight out of the ten patients had sustained multiple injuries most commonly head injuries (50%). All of these patients had been admitted to ICU during hospitalization. Three patients of the six who survived had a permanently disability as a result of their injuries.

Six of the ten patients were male. The mean age was 35years ±18 years. All patients been transported by emergency medical services which confirms the finding that EMS transportation was associated with high admission costs. Most patients did not have underlying medical conditions.

The most expensive patient treated was a 54 year old male patient with underlying diabetes and hypertension. He had been in a motor vehicle accident and had sustained an injury to his abdomen. He did not require surgery but was admitted to ICU. He was admitted for a total of 48 days. The patient was discharged without permanent disability.

In comparison to the most expensive patient, the cheapest person in the sample cost R1, 837.92 and was admitted for a single day. The person did not require a surgical intervention and only had one diagnostic investigation done.

Table 20: Ten patients with the highest admission costs

Sex	Age	TA	EMS	Reported medical condition	LOS	ICU	Primary injury site	NIS	Surgery	Outcome	Disability	Total Cost
Male	54	MVA	Yes	Diabetes and hypertension	48	Yes	Abdomen	1	No	Discharged	No	R 306,259.00
Male	19	PVA	Yes	None	53	Yes	Extremity	4	Yes	Discharged	Yes	R 302,246.37
Female	27	MVA	Yes	None	35	Yes	Head and Neck	2	Yes	Died	No	R 275,987.27
Female	15	PVA	Yes	None	38	Yes	Head and Neck	2	No	Died	No	R 264,875.54
Male	34	PVA	Yes	None	42	Yes	Chest	2	Yes	Died	No	R 247,909.58
Female	25	MVA	Yes	Asthma	142	Yes	Head and Neck	2	Yes	Discharged	Yes	R 236,242.70
Male	37	PVA	Yes	None	39	Yes	Head and Neck	4	Yes	Discharged	Yes	R 202,441.96
Female	26	MVA	Yes	Asthma	142	No	Head and Neck	1	No	Discharged	No	R 200,577.61
Male	41	MVA	Yes	HIV	28	Yes	Chest	2	Yes	Discharged	No	R 200,443.83
Male	75	MVA	Yes	Diabetes and hypertension	70	Yes	Chest	2	Yes	Died	No	R 199,291.58

**NIS = number of injury sites*

3.9 Univariate and multivariate regression of factors associated with cost

Univariate and multivariate regression was performed to determine which factors were associated with admission cost. Table 21 shows the results of the univariate analysis of factors associated with the log of the costs. The re-transformed coefficients of the parameter estimates are also presented. Length of stay was intentionally excluded from the cost model and a separate model was created for length of stay as length of stay showed a significant correlation with total cost when Spearman correlation was performed.

Patients who were brought in by EMS were more likely to have a higher admission cost compared to patients who were not transported by the EMS ($p = 0.009$). The number of injury sites, the primary injury site and the injury severity score were significantly associated with log of admission costs. The re-transformed coefficient shows that patients with two or more injuries were more likely to have increased admission cost.

ICU admission was significantly associated with the log of admission costs ($p = 0.000$), as was having a surgical intervention ($p = 0.000$). Patients who developed disabilities as result of their injuries were also more likely to have increased admission costs compared to those who did not have disabilities ($p = 0.000$).

There was an inverse relationship between the log admission costs and outcome of treatment ($p=-0.003$) meaning that people who died were less expensive.

Table 21: Univariate analysis of factors associated with log of admission costs

Independent Variable	Parameter estimate	95% CI	p-value	Re-transformed coefficient*
Age	0.002	-0.005 - 0.010	0.521	1.002
Sex				
Female	1	1	-	1
Male	0.100	-0.132 - 0.332	0.395	1.105
Mechanism of injury				
MBA	1	1	-	1
MVA	-0.254	-0.787 – 0.278	0.347	0.771
PVA	-0.339	-0.865 – 0.186	0.205	0.712
Emergency medical services				
No	1	1	-	1
Yes	0.314	0.078 - 0.549	0.009	1.368
Number of injury sites				
1	1	1	-	1
2	0.311	0.113 – 0.510	0.002	1.365
3	1.239	0.68 – 1.793	0.000	3.452
4	1.325	0.73 – 1.915	0.000	3.762
5	0.78	-0.747 – 2.306	0.315	2.181
6	1.519	0.435 – 2.603	0.006	4.568
Primary injury site				
Head and neck	1	1	-	1
Extremity	0.212	-0.023 – 0.447	0.077	1.236
Abdomen and pelvis	0.974	0.333 – 1.608	0.003	2.648
Chest	0.881	0.379 – 1.383	0.001	2.414
Injury severity score				
1-12	1	1	-	1
12-27	-0.082	-0.394 – 0.229	0.602	0.921
27-48	0.009	-0.385 – 0.405	0.960	1.009
48-74	-0.292	-1.600 – 1.015	0.660	0.746
≥75	0.327	-0.009 – 0.752	0.129	1.386
ICU admission				
No	1	1	-	1
Yes	1.275	0.979 – 1.570	0.000	3.579
Surgery				
No	1	1	-	1
Yes	0.422	0.203 0.642	0.000	1.526
Disability				
No	1	1	-	1
Yes	0.957	0.536 – 1.378	0.000	2.604
Outcome of treatment				
Discharged+	1	1	-	1
Died	-0.321	-0.639 - (- 0.003)	-0.003	0.726

**The exponent of the parameter estimate*
+Discharged patients included those who were transferred out

In the univariate model age, sex, mechanism of injury, having a co-morbid condition and ISS were not significantly associated with log of the admission costs. The variables therefore tested in the multivariate model included use of emergency medical services, number of injury sites, and admission to ICU, having had surgery, primary injury site, the outcome of admission and the presence of permanent disability at discharge.

In the multivariate model (Table 22) primary injury site, ICU admission, having surgery and having a disability remained significantly associated with log of admission costs. The associations of log admission costs with use of EMS, outcome of treatment, the number of injury sites and the primary injury sites became insignificant in the multivariate analysis.

Table 22: Multivariate analysis of factors associated with the log of admission costs

Independent Variable	Adjusted Coefficient	95% CI	p-value	Re-transformed adjusted coefficient*
Emergency medical services				
No	1	1	-	1
Yes	0.165	-0.529 – 0.383	0.137	1.179
Primary injury site				
Head and neck	1	1	-	1
Extremity	0.037	-0.218 – 0.292	0.776	1.038
Abdomen and pelvis	0.852	0.260 – 1.443	0.005	2.343
Chest	0.547	0.074 – 1.020	0.024	1.728
Number of injury sites	1	1	-	1
1	-1.246	-2.459 – 0.433	0.169	0.287
2	-0.440	-1.940 – 1.123	0.600	0.644
3	-0.465	-2.137 – 1.007	0.480	0.628
4	0.323	-1.599 – 1.934	0.852	1.381
6				
ICU admission				
No	1	1	-	1
Yes	0.461	0.159 0.763	0.003	1.586
Surgery				
No	1	1	-	1
Yes	0.484	0.276 0.692	0.000	1.622
Outcome of treatment				
Discharged+	1	1	-	1
Died	-0.081	-0.412 – 0.249	0.628	0.922
Disability				
No	1	1	-	1
Yes	0.808	0.409 1.207	0.000	2.243

**The exponent of the parameter estimate*

3.10 Factors associated with length of stay

Length of stay was found to have a strong correlation to admission costs in the analysis in using Spearman correlation (Table 23). A model was therefore built to examine factors that were associated with length of stay as this would indirectly affect admission costs.

Table 23: Spearman correlation of total cost with length of stay

Variable	Spearman's rho for correlation with total costs	p-value
Length of stay	**0.9439**	0.000

In Table 24 below, the results of the univariate analysis are shown. Sex, age, mechanism of injury, having an underlying medical condition and injury severity score were not significantly associated with length of stay. Factors that were also found to be significantly associated with length of stay included the use of EMS (p = 0.010), ICU admission (p = 0.000), and having a disability (p = 0.000).

Having multiple injury sites was also significantly associated with length of stay. Patients who had more than one injury site were more likely to stay longer in the hospital. Patients who had chest injuries stayed in hospital for shorter periods of time compared to those with head and neck injuries. However having an injury to the extremity and to the abdomen was not significantly associated with length of stay.

Table 24: Univariate analysis of factors associated with the log length of stay

Independent Variable	Parameter estimate	95% CI	p-value
Age	-0.002	-0.012 – 0.007	0.712
Sex			
Female	1	1	-
Male	-0.032	-0.341 – 0.275	0.833
Co-morbid medical conditions			
No	1	1	-
Yes	0.309	-0.161 – 0.275	0.197
Mechanism of injury			
MBA	1	1	-
MVA	-0.031	-0.679 – 0.616	0.923
PVA	-0.128	-0.767 – 0.510	0.693
Emergency medical services			
No	1	1	-
Yes	0.416	0.101 – 0.732	0.010
Number of injury sites			
1	1	1	-
2	0.354	0.083 0.626	0.011
3	1.347	0.585 2.109	0.001
4	1.476	0.664 2.288	0.000
5	1.056	-1.046 3.158	0.323
6	1.833	0.341 3.324	0.016
Primary injury site			
Head and neck	1	1	-
Extremity	0.082	-0.234 – 0.398	0.610
Abdomen and pelvis	0.776	-0.086 – 1.638	0.078
Chest	1.021	0.340 – 1.702	0.003
Injury severity score			
1-12	1	1	-
12-27	-0.159	-0.539 – 0.219	0.407
27-48	-0.095	-0.576 – 0.384	0.694
48-74	-0.190	-1.779 – 1.398	0.814
≥75	0.276	-0.239 – 0.791	0.292
ICU admission			
No	1	1	-
Yes	0.728	0.333 1.123	0.000
Disability			
No	1	1	-
Yes	1.371	0.829 – 1.914	0.000

Independent variables that were tested in the multivariate model included: co-morbid medical conditions, emergency medical services, number of injury sites, primary injury site, ICU admission and disability (Table 25). Factors that remained significant in the multivariate model included the primary injury site, ICU admission and having a disability.

Table 25: Multivariate analysis of factors associated with the log of length of stay

Independent Variable	Adjusted Coefficient	95% CI	p-value
Primary injury site			
Head and neck	1	1	-
Extremity	0.323	-0.008 – 0.654	0.056
Abdomen and pelvis	0.885	0.069 – 1.704	0.032
Chest	0.445	-0.240 – 1.130	0.202
ICU admission			
No	1	1	-
Yes	0.540	0.124 – 0.956	0.011
Disability			
No	1	1	-
Yes	1.130	0.597 – 1.663	0.000

As disability, ICU admission and primary injury site were found to be associated with both LOS and cost, a confounding relationship was tested for. This was shown as the coefficients for disability, ICU admission and primary injury site changed by >10% when LOS was included into the final cost model. These results confirm that there were confounding relationships.

3.11 Comparison of current hospital billing methods and NHRPL costs

A comparison was done of total costs using the mixed-costing approach that was used in this study and costs using the billing system in use at the hospital. With the current billing system, the daily charge for RTIs admissions in the general ward was R998 and for ICU it was R5, 046. This daily charge is a composite of all costs related to the treatment. This figure is the same for all patients regardless of the nature of the treatment required. There was no evidence of further charges for treatment received.

The results show that there was a significant difference in geometric means of the total costs between the mixed costing approach and the billing system (p-value<0.000) however the billing system at the hospital does not show a charge for variable costs and therefore the total costs are comprised of the fixed costs only (Table 26). The difference in fixed costs was also statistically significantly different (p = 0.000). The difference in the fixed costs was largely as a result of the difference in the fixed costs estimated for a general ward. There was no difference between the ICU costs as the hospital rate for ICU was used.

Table 26: Comparison of costs using the mixed costing method and the current hospital billing method after log transformation of fixed and variable costs

Cost component	CALCULATION USING MIXED COSTING METHOD		CURRENT HOSPITAL BILLING USING UPFS		
	Total cost (Rands)	Geometric mean (±SD)	Total cost (Rands)	Geometric mean (±SD)	p-value
Total fixed costs	6,965,724.00	9.994± 0.920	5,007,222.00	9.072± 1.243	0.000
General ward fixed costs	4,949,178.00	9.165± 1.118	3,190,606.00	8.833±1.118	0.000
Total of variable costs	2,604,866.11	8.836±0.924	0.00	0.00	-
TOTAL COST	**9,570,590.11**	**9.994±0.920**	**5,007,222.00**	**9.102± 1.24**	**0.000**

3.12 Sensitivity analysis

The total admission costs using the hospital charges were used in the sensitivity analysis. The multivariate model using the hospital charges as the dependent variable showed that primary injury site, ICU admission and disability were significantly associated with admission cost (Table 27). Admission costs using hospital charges only took overhead costs into account and not the variable costs. Therefore these admission costs were dependent on the length of stay. This multivariate model was expected to have the same independent variables as the model for length of stay which it did.

Table 27: Multivariate analysis of factors associated with the log of hospital costs using hospital charges

Independent Variable	Adjusted Coefficient	95% CI	p-value	Re-transformed coefficient
Primary injury site				
Head and neck	1	1	-	1
Extremity	0.358	0.032 – 0.684	0.032	1.430
Abdomen and pelvis	1.039	0.239 – 1.839	0.011	2.826
Chest	0.598	-0.075 – 1.271	0.081	1.818
ICU admission				
No	1	1	-	1
Yes	1.646	1.239 – 2.054	0.000	5.186
Disability				
No	1	1	1	1
Yes	1.042	0.506 – 1.578	0.000	2.835

The sensitivity analysis further examined whether factors associated with total costs would change if the total cost was 20% higher and 20% lower than the costs calculated using the mixed costing approach. The results of the multivariate analyses are shown in table 28 and 29. In both the models primary injury site, ICU admission, having surgery and having a disability were significantly associated with the log of the total costs. The sensitivity analysis showed that factors associated with total costs were the same even when the costs are 20% higher or lower than estimated.

Table 28: Multivariate analysis of factors associated with the log of total hospital costs at a 20% higher price

Independent Variable	Adjusted Coefficient	95% CI	p-value	Re-transformed adjusted coefficient*
Primary injury site				
Head and neck	1	1	-	1
Extremity	0.037	-0.218 – 0.292	0.776	1.038
Abdomen and pelvis	0.852	0.260 – 1.443	0.005	2.343
Chest	0.547	0.074 – 1.020	0.024	1.728
ICU admission				
No	1	1	-	1
Yes	1.187	0.896 – 1.478	0.000	3.278
Surgery				
No	1	1	-	1
Yes	0.453	0.217 0.688	0.000	1.573
Disability				
No	1	1	-	1
Yes	0.761	0.369 1.155	0.000	2.141

Table 29: Multivariate analysis of factors associated with the log of total hospital costs at a 20% lower price

Independent Variable	Adjusted Coefficient	95% CI	p-value	Re-transformed adjusted coefficient*
Primary injury site				
Head and neck	1	1	-	1
Extremity	0.037	-0.218 – 0.292	0.776	1.038
Abdomen and pelvis	0.852	0.260 – 1.443	0.005	2.343
Chest	0.547	0.074 – 1.020	0.024	1.728
ICU admission				
No	1	1	-	1
Yes	1.187	0.896 – 1.478	0.000	3.278
Surgery				
No	1	1	-	1
Yes	0.453	0.217 0.688	0.000	1.573
Disability				
No	1	1	-	1
Yes	0.761	0.369 1.155	0.000	2.141

3.13 Summary of the results

3.13.1 Baseline characteristics

The results from the study show that there were more males who were admitted compared to females across all age groups except for the <5 years. Pedestrian vehicle accidents were the most common mechanisms of injury. The majority of the patients were brought to the casualty unit by emergency medical services. Most of the patients had sustained injuries to a single site, the majority of which were injuries to the extremities. Of the 259 patients, 30 died and the rest were discharged and only four were transferred to rehabilitation facilities. Patients required a range of services during the admission. Diagnostic radiology services were used for all the patients on admission. Most of the patients had surgery and received other non-surgical interventions. Most of the patients were treated in a general ward and did not require intensive care.

3.13.2 Cost analysis

The cost analysis shows that overhead (fixed) costs make up the bulk of the total costs. Total costs were significantly correlated with length of stay. The analysis of factors associated with costs revealed that the injury severity score, ICU admission, having surgery and having a disability were significantly associated with log of admission costs in the multivariate model after adjusting for other variables. Factors significantly associated with length of stay were having a disability, the number of injury sites and having an underlying medical condition. The analysis of the costs using the current hospital billing method and the mixed costing approach used in the study showed a significant difference in the amount billed and the actual cost.

CHAPTER FOUR

DISCUSSION AND LIMITATIONS

This chapter will discuss the findings of this study in light of the relevant literature on costing of road traffic injuries and factors associated with admission costs and length of stay. The budgetary implications of road traffic injuries will be discussed, as well as the use alternative methods for estimating unit costs.

4.1 Discussion

4.1.1 Background characteristics

The study findings were consistent with international literature and South African data from National Injury Mortality Surveillance System (NIMSS) and the Burden of Disease study (5;12;36;38;39;108-113). It was therefore not surprising that the demographic profile of patients admitted showed higher rates of admissions amongst males (73%) and younger age groups (5;113).

The young people killed or injured in road crashes have been shown to be predominantly pedestrians, cyclists, motorcyclists or users of public transport in a few studies and in the WHO injury prevention report (5;114;115). Pedestrian vehicle accidents, which included cyclists, were the most common type of mechanism of injury seen in this study. It was not possible to establish, however, the number of patients injured in motor vehicle accidents who were passengers or users of public transport as this information was often missing in the medical records.

The most common types of injuries sustained were long bone fractures of the extremities (63%) followed by head and neck injuries (24%). Similar findings were shown in a study conducted in India where patients admitted had a high frequency of long bone fractures sustained from road traffic accidents (109). When a pedestrian is struck by a moving vehicle there is often an acceleration injury in addition to the direct trauma at the sites of impact. In an adult, injury is commonly due to bumper impact to the limbs leading to fractures of the extremity as seen in some studies (109;116;117).

The pattern of injury seen in the study is expected in RTIs. This study also showed high rates of head injuries although many patients had multiple injuries. This is a similar finding to that of an American study of teenagers which showed a high frequency of intracranial injuries (117). Victims of motor vehicle accidents (MVAs) may be injured either by rapid deceleration or by deformation with intrusion of vehicle components into the interior of the vehicle (109;117;118). Ejection of an occupant may occur and is associated with increased likelihood of serious injury such as a head injury and death (109;117).

Although the majority of patients did not have life threatening injuries, most had injury severity scores higher than 15 which is an indication of moderate to severe injury (104). The extent of the injury depends on the body region involved, degree of restraint and severity of the impact (117;119). Fatal injuries made up 12% of injuries in this study; most of the patients were discharged without permanent disabilities. This may in part be due to the fact that there is an emergency medical service attached to the hospital and the presence of an operational pre-hospital care system has been shown to improve injury outcomes (120).

4.1.2 Costs of treating RTIs

The total cost per patient per day was estimated to be R 2, 655.80. This was higher than the PDE at the hospital for 2009 which was R2, 300 (89). This higher cost per patient per day for road traffic injuries could be due to the type of treatment that these patients often require. Most of the study patients required a surgical intervention as most had long bone fractures. As in other studies, theatre time was shown to be a significant contributor to variables costs and therefore total costs accounting for 16% of total cost and second only to overhead and salary costs. While some procedures are less expensive than others, none are inexpensive (121).

The nature of injuries sustained in road traffic accidents also necessitates the use of various diagnostic, emergency and rehabilitation services (39;65;122;123). All patients in the study required diagnostics radiology services on admission and a few had repeat investigations done during their hospital stay. This is not uncommon and standard practice in an emergency room during resuscitation as imaging in used to exclude cervical vertebrae fractures which can be life-threatening (124). The increased workload in radiology departments and increased demand for physiotherapy and rehabilitation services were largely attributed to road traffic injuries in a study of developing countries (125). The use of these services increased the costs of treatment.

However variable costs accounted for only 30% of total costs. This is likely to be due to the high cost of human resources which accounted for 85% of fixed costs. Compensation of employees was the largest component of expenditure and accounted for 53% of the total expenditure of the Gauteng Department of Health for the 2007/08 financial year. In the same year, salaries made up 52% of the over expenditure (5;113;126). Human resources are generally the most expensive input in the health care system and this is not unique to South Africa (127). They usually account for between 60-85% of the total expenditure on health (21;97).

There is an extreme variation in reported costs of RTIs in the literature making comparison with other studies difficult, this is in part due to that fact that there are no standard methods of estimating costs even in the same settings (89;128;129). A study conducted at Charlotte Maxeke Johannesburg Academic Hospital 5 years prior to this study, in order to come up with cost per patient of RTIs, total ICU and trauma costs were divided by the number of patients studied. The figure estimated was R3, 398 per patient. A comparison cannot be made with the cost per patient stay that was calculated.

In 2004, the National Department of Transport published The Estimation of Unit Costs of Road Traffic Accidents in South Africa, using data from the Road Accident Fund to describe the cost of road traffic injuries by age, injury severity, and type of crash (130). This study calculated an average cost per injury to be R183, 463 from a public health perspective. Another study using South African national data on a sample of 511,600 crashes showed that medical cost per injured person was R94,600 (131;132). Both studies were not explicit on how the costs were derived except to mention that data from the RAF was used. The variability of the cost estimates emphasizes the need for standard data collection tools, cost data sources and cost allocation methods.

The total cost of admission was R9, 570,590.11. Although this accounted for only 1% of the total hospital expenditure in 2009, this cost only included a sample of 259 patients and it did not include costs of repeat admissions and follow-up. The true costs are most likely to be much higher than estimated in the study.

The aim of the study was to determine the cost of road traffic accidents on a tertiary hospital. Due to resource limitations the cost of all participants admitted following an RTI could not be calculated. The calculations from the study provided estimates of average length of stay (14 days) and the cost per day per patient (2, 655.80). The total number of participants admitted in 2009 according to the hospital information system was 1240. The estimate of the total cost of all RTI participants was estimated to be R46, 439,318.80. This is the estimated cost for initial admissions only and excludes costs of subsequent admissions and outpatient visits.

Based on the results in table 20, for 259 patients an extra R4.5 million could have been charged if variable costs were taken into account in the calculation of treatment costs. This translates to potentially an extra R22, 5 million in total that the hospital could have charged for the patients treated at the hospital following a road traffic injury in 2009.

4.1.3 Factors associated with high admission costs

This study did not show a significant association of costs with underlying medical condition or age as reported in some studies (133-135). Patients who reported having a medical condition did not have significantly higher costs in the study when compared to those who did not have a reported medical condition as found in some studies. In this study however people with reported medical conditions were a very small group and there may have been a different result if all patients had been investigated for an underlying medical condition especially HIV which patients might not readily disclose.

The results show that there are other factors that have a significant association with cost. These include having being brought to the hospital by EMS, the number of injuries sustained, the injury severity score, ICU admission, having surgery and having a disability were all independently associated with increased admission costs. On multivariate analysis after adjusting for confounding ICU admission, surgery and having a disability remained significantly associated with hospitalization cost.

Surgery

Having a surgical procedure was significantly associated with cost on the multivariate analysis, the reasons as explained before are that surgery is an expensive intervention regardless of the type of surgery required (136). In this study most of the patients had injuries that required an orthopaedic intervention which often take a long time to complete (137;138). Tests that may be required prior to surgery include x rays, computed tomography scans (CT scans), magnetic resonance imaging (MRI), myelograms, diagnostic arthroplasty, and blood tests which further increase costs related to surgery (137).

ICU admission

ICU admission is associated with severe injuries that require frequent monitoring by nursing and medical staff and mechanical ventilation (139;140). A hospital-based study in the USA showed that mechanical ventilation is associated with significantly higher daily costs for patients receiving treatment in the intensive care unit throughout their entire intensive care unit stay (139). Another study that assessed factors associated with the variation in ICU costs found that patients who required postoperative care in ICU had higher ICU costs and those who required mechanical ventilation also had higher costs (140). In this study amongst the ten most expensive admissions, seven had had surgery and required ICU admission.

Disability

In this study having a disability was significantly associated with cost because of the significant association having a disability has with length of stay. The study showed a confounding relationship between cost, length of stay and disability. The association of disability and length of stay has been illustrated in the literature (55;141;142). People who have a disability as result of their injury have severe injuries that require inpatient rehabilitation and prolonged care which escalates costs of treatment (142).

Primary injury site

The association between cost, length of stay and the primary injury site was also shown in other studies (143-145). Injuries to the abdomen, pelvis and extremities were significantly associated with length of stay compared to head and neck injuries and therefore led to higher admission costs. A similar finding was shown in a study of sports-related injuries where the length of stay was highest amongst patients who had sustained fractures to the extremities (145).

4.1.4 Factors associated with length of stay

This study found that the same factors that were associated with admission discussed above were also associated with length of stay. These included the primary injury site, ICU admission and having a disability. All factors were found to have a confounding relationship with cost and length of stay.

In this study, the ALOS was estimated to be at around 14 days which is dissimilar to published studies, which showed a mean length of hospital stay for inpatients with road traffic injuries to be approximately 20 days in low-and middle income countries (LMICs) (146). However low-and middle income countries are not a homogenous group and the ALOS could be different for a variety of reasons such as waiting times for surgery or treatment in a hospital setting which might vary depending on availability of resources.

4.1.5 Comparison of the current billing method and the mixed-costing approach

The costs of healthcare are escalating in South Africa in part as a result of an increased disease burden placing an increased demand on health services, the high costs of technology and new drugs that are required for emerging diseases (11;22). The public health sector is responsible for providing services to approximately 80% of the South African population as private insurance is unaffordable to most (22). It would be prudent therefore for public facilities, especially hospitals, which are expensive to run, to have methods in place that can allocate costs accurately to ensure that revenue generation is optimized and areas of fruitless expenditure are identified.

The Gauteng Department of Health faces financial crises with year-on year deficits. There are many reasons that have been put forward for the deficits some of which include the misalignment between the budget requests of the GDOH based on past (and future expected) activity and the top-down amount allocated from the Provincial Treasury (147). The budgeting process itself though has some flaws and is also a contributor to the current funding challenges in the health department. Currently, the budgeting process is a top down process which is an implicit process of resource allocation (22;89;148). In general, hospitals and provincial directorates receive their annual budgets which merely include an incremental increase from the previous years budget, and to a large extent not aligned with operational plans (149). Budget allocations do not adequately address the requests put forward at the budget committee meetings.

In light of the current financial crisis, optimization of revenue generation mechanisms in the public health system is essential. Patients at the hospital are billed based on a means test, however there are no ways of ensuring that they pay. As a result, hospitals are owed a significant amount in patient fees. There are very limited sources of revenue generation available to public sector hospitals at the moment and the RAF is one of the main sources of revenue. The use of cost accounting methods therefore would allow for more accurate claims from both medical insurance companies and the RAF (10;18). Patients with RTIs accounted for 62% of patients classified as private patients at the hospital according to the hospital information system meaning that these patients are a major source of revenue for the hospital and it would therefore be worthwhile to estimate costs of injuries (150).

The billing system at the hospital is not based on cost accounting methods but uses a charge recommended by the UPFS and this is outdated (29). The charge from the billing system was expected to be significantly different from the costs using the mixed costing and this was shown by this study. The comparison however could only be made to the fixed costs as there was no evidence of a method used to determine variable costs at the hospital. The fixed costs were statistically significant despite the use of a modified PDE in the mixed-costing approach which is an average figure and not a reflection of individual resource consumption. The hospital has the potential to claim more money than what they are currently, looking at fixed costs alone.

The need for accurate costing is not only essential for claiming from the RAF but with new health reform that is expected under the National Health Insurance (NHI), accurate methods of costing will be necessary. The NHI is health financing mechanisms that will be introduced in South Africa with the aim of ensuring that all South Africans have access to appropriate, efficient and quality health services (151). Introduction of the NHI will entail major changes in the service delivery structures, administrative and management systems including financial management systems. The NHI is expected to have reimbursement systems for inpatient services based on disease related groups (151). There will be a shift from the current UPFS tariffs. The NHI is expected to be implemented over a 14-year period providing ample time for hospitals to start shifting towards and implementing better cost accounting methods for private patients.

4.2 Limitations

- The study had a few methodological limitations. Firstly all records for 2009 could not be reviewed due to resource limitations and a sample had to be drawn. The actual cost of all RTIs as a proportion of the expenses at the hospital for 2009 could therefore only be estimated and not accurately calculated.

- Secondly the study relied heavily on patient records most of which were complete due to the recording system in the trauma unit at the hospital, however relying on secondary information means that whatever information the clinician did not collect or record in the notes whether intentionally or not, is unknown and could therefore not be included in the data collection.

- Salaries accounted for a significant portion of fixed costs (85%) and the fact that they could not be calculated per patient was a limitation of the study. Salaries for all staff members are all considered as one cost centre in the hospital expenditure report. There is no way of knowing from the expenditure report how much each category of staff earns. The hospital does have payroll system but to access this system one would need the staff numbers of all the staff members who were involved in the management of each patient and information on the time spent on each patient would also be required. This information is not available in over 90% of cases.

- The study looked at the cost of the first admission episode and not at subsequent admissions or OPD visits and these would have shown added costs.

- Finally the study was done at tertiary hospital due to the data collection mechanisms that are in place for trauma patients specifically, however tertiary hospital are known to be more expensive to run than lower level hospitals. Patients managed at a tertiary hospital are usually more complicated and this limits the generalizability of these findings.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Motorization is an important component of an emerging economy like South Africa. Roads and transportation are essential for the movement of goods and people within the country and beyond the borders. An estimated one million people commute daily in Johannesburg alone (152). In this environment road traffic accidents often occur despite most being avoidable and preventable. This affects the most economically active individuals in the population leading to an increased economic burden on the country, the health system and on individual households (5).

This study showed how the young and vulnerable road users such as pedestrians are most at risk of suffering non-fatal injuries as a result of road traffic accidents. These non-fatal injuries are of varying degrees sometimes leading to permanent disability and prolonged hospitalization. The cost analysis showed that injury severity and having a disability were significantly associated with higher hospitalization costs, supporting the need for prevention strategies that not only reduce the number of road traffic injuries but also the degree of severity of injuries and associated disability.

The study further highlighted the need to review the billing system in place at the hospital as it showed a significant under claiming for hospital services provided for insured patients with the hospital potentially losing over R10 million in revenue annually. Despite costing of services being more labour intensive, RTIs accounted for 62% of private patients making revenue generation from these groups of patients through the RAF worthwhile. Claims for

RTIs are made to the RAF making collection of this revenue easier than tracing individual private patients.

5.2 Recommendations

5.2.1 Cost Accounting

- The hospital needs to invest in more detailed costing of RTIs as this is a source of revenue. The hospital has to use the UPFS at the moment for charging patients as required by the Department of Health, however even this system can be optimized by not only charging for fixed costs but including a fee for variable costs. Accurate data will be necessary to carry out this exercise.

- Although salaries have been identified as one of the primary cost drivers constituting 85% of the total annual hospital expenditure, it is not clear which category of patients or which units use this resource the most. Salaries for the different categories of staff and the clinic unit they are attached to needs to be separated in the expenditure report in order to trace costs either to a clinical unit or to a patient. The hospital would benefit from introducing cost centers so that costs can be more readily traced to a specific cost centre.

5.2.2 Road traffic injury data sources

- The hospital has a trauma data sheet that is used in the casualty unit to capture resource utilization and injuries. This tool can be used to charge for services and it can be expanded to included treatment during the entire length of stay. This would allow for easier data retrieval to allocate costs or charges for services.

- Identifying resource use at the hospital using patient records is dependent on the level of medical knowledge the individual allocating costs has. There is a drive at the hospital to implement the International Disease Coding system recommended by the WHO, ICD-10. This coding should be aligned to the billing to ensure that the data that is used to allocate costs is standardized. This would allow for more accurate comparisons with other countries and even between public hospitals.

- The Department of Health would benefit from setting up proper trauma surveillance system in health facilities in order to have a standard method of quantifying non-fatal injuries, morbidity and mortality related to RTIs accurately and to supplement the current sources of injury data that are limited in South Africa and predominantly based on mortality figures from mortuaries.

5.2.3 Injury prevention

Despite the health system not being traditionally involved in injury prevention strategies the amount of resources that are consumed by RTIs in hospitals is significant and could be channeled towards other priority health programmes. This consumption of health care resources by RTIs necessitates the involvement of the department of health across all levels of injury prevention efforts.

- **Primary prevention -** Advocacy to the Department of Transport to implement necessary interventions that are targeted predominantly at the young, males and vulnerable road users such as pedestrians as this study showed how these groups had the highest admission rates. The department could also invest in further research on the causes of road traffic accidents. Knowledge of causes of RTIs will enable more targeted interventions.

- **Secondary prevention –** the Department of Health could also play an advocacy role. They could advocate to the ministry of transport to ensure that there are crash protective road safety devices on South African roads to ensure that even in the event of an accident the injuries sustained can be minimized. Research has shown that the severity of injuries is related to the body region involved, the degree of restraint and severity of the impact (117;153).

- **Tertiary prevention -** According to the Haddon Matrix, the Department of Health can also be involved in tertiary prevention by making an investment in an efficient pre-hospital care system that administers the necessary interventions to reduce morbidity and mortality (120). Most patients were brought to hospital by EMS in the study and service could be harnessed to ensure that the system provides appropriate care. The Department of Health can also invest in rehabilitation services to reduce the long term adverse effects of RTIs.

5.3 Further research areas

1. The implementation of a costing system in the public sector will not be an easy task due to high volumes of patients that have to be served and the limited availability of human resources. A study looking at the feasibility of implementing costing methods is necessary.

2. The study showed how RTIs can lead to disability. A study looking at the full economic costs of RTIs would be important including such costs as of loss of income due to a disability.

3. The feasibility of setting up a trauma surveillance system needs to be investigated at different hospital levels. The capacity is not expected to be the same as in a tertiary academic hospital and hence the need for further investigation.

4. There needs to be an investigation into causes of road traffic accidents. This would include the more downstream factors such as road infrastructure, safety mechanisms in cars, road worthiness of vehicles and human behaviour such as drinking and speeding. The upstream factors should also be included in the research.

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Annexure 1: Data Collection Tool

ESTIMATING THE BURDEN OF ROAD TRAFFIC INJURIES IN A TERTIARY HOSPITAL IN GAUTENG

Date of data collection: dd/ mm/ yyyy

STUDY NO.			

I. Demographic Information

a. Sex: Male ☐ Female ☐
b. Age: ______

II. Accident details

a. Date: dd/ mm/ yyyy
b. Type:
   i. Motor Vehicle Accident ☐
   ii. Pedestrian Vehicle Accident ☐
   iii. Motorbike Accident ☐
   iv. Other: (please specify)________________

c. Use of EMS: Yes ☐ No ☐

III. Admitting Unit

a. General surgery
b. Orthopaedics
c. Neurosurgery
d. Paediatric surgery
e. Other: (please specify)________________

IV. Admission dates

a. General ward - dd/ mm/ yyyy
b. High care unit - dd/ mm/ yyyy
c. Intensive care unit - dd/ mm/ yyyy

V. Discharge dates:

a. General ward - dd/ mm/ yyyy
b. High care unit - dd/ mm/ yyyy
c. Intensive care unit - dd/ mm/ yyyy

VI. Past Medical History

a. Diabetes ☐
b. Epilepsy ☐
c. Hypertension ☐
d. Tuberculosis ☐
e. HIV/AIDS ☐

VII. Injury details

a. ICD-10 code diagnosis 1: _ _ _ _ _
b. ICD-10 code diagnosis 2: _ _ _ _ _
c. ICD-10 code diagnosis 3: _ _ _ _ _
d. ICD-10 code diagnosis 4: _ _ _ _ _
e. ICD-10 code diagnosis 5: _ _ _ _ _

VIII. Area of injury

a. Head and neck ☐
b. Chest ☐
c. Abdomen ☐
d. Extremity ☐

IX. Surgical treatment

a. Received: Yes ☐ No ☐

b. Surgical procedure(s)

i. Procedure 1:______________________
ii. Procedure 2:______________________
iii. Procedure 3:______________________
iv. Procedure 3:______________________

X. Allied medical services

a. Physiotherapy: Yes ☐ No ☐ Number of visits:_ _
b. Occupational Therapy: Yes ☐ No ☐ Number of visits:_ _
c. Dietician: Yes ☐ No ☐ Number of visits:_ _
d. Speech and hearing: Yes ☐ No ☐ Number of visits:_ _
e. Social worker: Yes ☐ No ☐ Number of visits:_ _

XI. Medication

Treatment	Name	Dose	Number of Days
Antibiotics			
Analgesics			
Anticoagulants			
Blood products			
Fluids			

XII. Laboratory investigations

a. FBC ☐ Number of tests:_ _
b. U and E ☐ Number of tests:_ _
c. CRP ☐ Number of tests:_ _
d. LFT ☐ Number of tests:_ _
e. Trop T ☐ Number of tests:_ _
f. CK ☐ Number of tests:_ _

XIII. Radiological investigations and number of investigations done:

a. CT Scan

i. Abdomen ☐
ii. Brain ☐
iii. Chest ☐
iv. Neck ☐
v. Other: ________________

b. X-ray

i. Abdomen ☐
ii. Chest ☐
iii. Foot ☐
iv. Lower limb ☐
v. Upper limb ☐
vi. Skull ☐
vii. Other:________________

c. Ultrasound

i. Pelvic
ii. Abdominal

d. Other radiological services:__________________________________

XIV. Outcome

a. Discharge: Yes ☐ No ☐
b. Death: Yes ☐ No ☐
c. Transfer: Yes ☐ No ☐
d. Step down: Yes ☐ No ☐

Annexure 2: Abbreviated Injury Scale

Liver Injury Scale

Grade*		Description	AIS-90
I	Hematoma	Subcapsular, <10% surface area	2
	Laceration	Capsular tear, <1 cm parenchymal depth	2
II	Hematoma	Subcapsular, 10-50% surface area	2
		Intraparenchymal, <10 cm in diameter	2
	Laceration	Capsular tear, 1-3 cm parenchymal depth, <10 cm length	2
III	Hematoma	Subcapsular, >50% surface area or expanding	3
		Ruptured subcapsular or parenchymal hematoma	3
		Intraparenchymal hematoma >10 cm or expanding	3
	Laceration	>3 cm parenchymal depth	3
IV	Laceration	Parenchymal disruption involving 25-75% of hepatic lobe or 1-3 Couinaud's segments within a single lobe	4
V	Laceration	Parenchymal disruption involving >75% of hepatic lobe or >3 Couinaud's segments within single lobe	5
	Vascular	Juxtahepatic venous injuries; i.e., retrohepatic vena cava/central major hepatic veins	5
	Vascular	Hepatic avulsion	6

* Advance one grade for multiple injuries up to grade III

Spleen Injury Scale

Grade*		Description	AIS-90
I	Hematoma	Subcapsular, <10% surface area	2
	Laceration	Capsular tear, <1 cm parenchymal depth	2
II	Hematoma	Subcapsular, 10-50% surface area	2
		Intraparenchymal, <5 cm in diameter	2
	Laceration	Capsular tear, 1-3 cm parenchymal depth which does not involve a trabecular vessel	2
III	Hematoma	Subcapsular, >50% surface area or expanding	3
		Ruptured subcapsular or parenchymal hematoma	3
		Intraparenchymal hematoma >5 cm or expanding	3
	Laceration	>3 cm parenchymal depth or involving trabecular vessels	3
IV	Laceration	Laceration involving segemental or hilar vessels producing major devascularization (>25% of spleen)	4
V	Laceration	Completely shattered spleen	5
	Vascular	Hilar vascular injury which devascularizes spleen	5

* Advance one grade for multiple injuries up to grade III

Small Bowel Injury Scale

Grade*		Description	AIS-90
I	Hematoma	Contusion or hematoma without devascularization	2
	Laceration	Partial thickness, no perforation	2
II	Laceration	Laceration <50% of circumference	3
III	Laceration	Laceration >50% of circumference without transection	3
IV	Laceration	Transection of small bowel	4
V	Laceration	Transection of small bowel with segmental tissue loss	4
	Vascular	Devascularized segment	4

* Advance one grade for multiple injuries up to grade III

Colon Injury Scale

Grade*		Description	AIS-90
I	Hematoma	Contusion or hematoma without devascularization	2
	Laceration	Partial thickness, no perforation	2
II	Laceration	Laceration <50% of circumference	3
III	Laceration	Laceration >50% of circumference without transection	3
IV	Laceration	Transection of the colon	4
V	Laceration	Transection of the colon with segmental tissue loss	4

* Advance one grade for multiple injuries up to grade III

Rectum Injury Scale

Grade*		Description	AIS-90
I	Hematoma	Contusion or hematoma without devascularization	2
	Laceration	Partial thickness laceration	2
II	Laceration	Laceration <50% of circumference	3
III	Laceration	Laceration ≥50% of circumference	4
IV	Laceration	Full-thickness laceration with extension into the perineum	5
V	Laceration	Devascularized segment	5

* Advance one grade for multiple injuries up to grade III

Diaphragm Injury Scale

Grade*	Description	AIS-90
I	Contusion	2
II	Laceration ≤2 cm	3
III	Laceration 2-10 cm	3
IV	Laceration >10 cm with tissue loss ≤25 cm^2	3
V	Laceration with tissue loss >25 cm^2	3

* Advance one grade for bilateral injuries up to grade III

Duodenum Injury Scale

Grade*		Description	AIS-90
I	Hematoma	Involving single portion of duodenum	2
	Laceration	Partial thickness, no perforation	3
II	Hematoma	Involving more than one portion	2
	Laceration	Disruption <50% circumference	4
III	Laceration	Disruption 50-75% circumference of 2nd portion	4
		Disruption 50-100% circumference of 1st, 3rd, 4th portion	4
IV	Laceration	Disruption >75% circumference of 2nd portion	5
		Involving ampulla or distal common bile duct	5
V	Laceration	Massive disruption of duodenopancreatic complex	5
	Vascular	Devascularization of duodenum	5

* Advance one grade for multiple injuries up to grade III

Pancreas Injury Scale

Grade*		Description	AIS-90
I	Hematoma	Minor contusion without duct injury	2
	Laceration	Superficial laceration without duct injury	2
II	Hematoma	Major contusion without duct injury or tissue loss	2
	Laceration	Major laceration without duct injury or tissue loss	3
III	Laceration	Distal transection or parenchymal / duct injury	3
IV	Laceration	Proximal transection or parenchymal injury involving ampulla	4
V	Laceration	Massive disruption of pancreatic head	5

* Advance one grade for multiple injuries up to grade III

Kidney Injury Scale

Grade*		Description	AIS-90
I	Contusion	Microscopic or gross hematuria	2
	Hematoma	Subcapsular, nonexpanding without parenchymal laceration	2
II	Hematoma	Nonexpanding perirenal hematoma confined to renal retroperitoneum	2
	Laceration	<1 cm parenchymal depth of renal cortex without urinary extravasation	2
III	Laceration	<1 cm parenchymal depth of renal cortex without collecting system rupture or urinary extravasation	3
IV	Laceration	Parenchymal laceration extending through the renal cortex, medulla, and collecting system	4
	Vascular	Main renal artery or vein injury with contained hemorrhage	4
V	Laceration	Completely shattered kidney	5
	Vascular	Avulsion of renal hilum which devascularizes kidney	5

* Advance one grade for multiple injuries up to grade III

Ureter Injury Scale

Grade*		Description	AIS-90
I	Hematoma	Contusion or hematoma without devascularization	2
II	Laceration	<50% transection	2
III	Laceration	>50% transection	3
IV	Laceration	Complete transection with <2 cm devascularization	3
V	Laceration	Avulsion with >2 cm devascularization	3

* Advance one grade for multiple injuries up to grade III

Bladder Injury Scale

Grade*		Description	AIS-90
I	Hematoma	Contusion, intramural hematoma	2
	Laceration	Partial thickness	3
II	Laceration	Extraperitoneal bladder wall laceration <2 cm	4
III	Laceration	Extraperitoneal (>2 cm) or intraperitoneal (<2 cm) bladder wall laceration	4
IV	Laceration	Intraperitoneal bladder wall laceration >2 cm	4
V	Laceration	Intraperitoneal or extraperitoneal bladder wall laceration extending into the bladder neck or ureteral orifice (trigone)	4

* Advance one grade for multiple injuries up to grade III

Urethra Injury Scale

Grade*	Injury Type	Description	AIS-90
I	Contusion	Blood at urethral meatus; urethrography normal	2
II	Stretch Injury	Elongation of urethra without extravasation on urethrography	2
III	Partial Disruption	Extravasation of urethrography contrast at injury site with contrast visualized in the bladder	2
IV	Complete Disruption	Extravasation of urethrography contrast at injury site without contrast visualization in the bladder; <2 cm of urethral separation	3
V	Complete Disruption	Complete transection with >2 cm urethral separation, or extension into the prostate or vagina	4

* Advance one grade for multiple injuries up to grade III

Abdominal Vascular Injury Scale*

Grade†	Description	AIS-90
I	Non-named SMA or SMV branches	NS
	Non-named IMA or IMV branches	NS
	Phrenic artery / vein	NS
	Lumbar artery / vein	NS
	Gonadal artery / vein	NS
	Ovarian artery / vein	NS
	Other non-named small arterial or venous structures requiring ligation	NS
II	Right, left, or common hepatic artery	3
	Splenic artery/vein	3
	Right or left gastric arteries	3
	Gastroduodenal artery	3
	IMA or IMV trunk	3
	Primary named branches of mesenteric artery or vein	3
	Other named abdominal vessels requiring ligation/repair	3
III	SMV trunk	3
	Renal artery/vein	3
	Iliac artery vein	3
	Hypogastric artery/vein	3
	Vena cava, infrarenal	3
IV	SMA trunk	3
	Celiac axis proper	3
	Vena cava, suprarenal and infrahepatic	3
	Aorta, infrarenal	4
V	Portal vein	3
	Extraparenchymal hepatic vein	3/5
	Vena cava, retrohepatic or suprahepatic	5
	Aorta, suprarenal, subdiaphragmatic	4

* This classification system is application to extraparenchymal vascular injuries. If the vessel injury is within 2 cm of the organ parenchyma, refer to the specific organ injury scale.

† Increase one grade for multiple grade III or IV injuries involving >50% vessel circumference. Downgrade one grade if <25% vessel circumference laceration for grades IV or V.

Chest Wall Injury Scale*

Grade†	Injury Type	Description	AIS-90
I	Contusion	Any size	1
	Laceration	Skin and subcutaneous	1
	Fracture	<3 ribs, closed; nondisplaced clavicle closed	1-2
II	Laceration	Skin, subcutaneous and muscle	1
	Fracture	≥3 adjacent ribs, closed	2-3
		Open or displaced clavicle	2
		Nondisplaced sternum, closed	2
		Scapular body, open or closed	2
III	Laceration	Full thickness including pleural penetration	2
	Fracture	Open or displaced sternum, flail sternum	2
		Unilateral flail segment (<3 ribs)	3-4
IV	Laceration	Avulsion of chest wall tissues with underlying rib fractures	4
	Fracture	Unilateral flail chest (≥3 ribs)	3-4
V	Fracture	Bilateral flail chest (≥3 ribs on both sides)	5

* This scale is confined to the chest wall alone and does not reflect associated internal thoracic or abdominal injuries.

† Advance one grade for multiple injuries up to grade III

Extrahepatic Biliary Tree Injury Scale

Grade*	Description	AIS-90
I	Gallbladder contusion/hematoma	2
	Portal triad contusion/hematoma	2
II	Partial gallbladder avulsion from liver bed; cystic duct intact	2
	Laceration or perforation of the gallbladder	2
III	Complete gallbladder avulsion from liver bed	3
	Cystic duct laceration	2-3
IV	Partial or complete right hepatic duct laceration	2-3
	Partial or complete left hepatic duct laceration	2-3
	Partial common hepatic duct laceration (<50%)	3
	Partial common bile duct laceration (<50%)	3
V	>50% transection of common hepatic duct	4
	>50% transection of common bile duct	4

* Advance one grade for multiple injuries up to grade III

Heart Injury Scale

Grade*	Description	AIS-90
I	Blunt cardiac injury with minor ECG abnormality (nonspecific ST or T wave changes, premature atrial or ventricular contraction or persistent sinus tachycardia)	3
	Blunt or penetrating pericardial wound without cardiac injury, cardiac tamponade, or cardiac herniation	3
II	Blunt cardiac injury with heart block (right or left bundle branch, left anterior fascicular, or atrioventricular) or ischemic changes (ST depression or T wave inversion) without cardiac failure	3
	Penetrating tangential myocardial wound up to, but not extending through, endocardium, without tamponade	3
III	Blunt cardiac injury with sustained (≥5 beats/min) or multifocal ventricular contractions	3-4
	Blunt or penetrating cardiac injury with septal rupture, pulmonary or tricuspid valvular incompetence, papillary muscle dysfunction, or distal coronary arterial occlusion without cardiac failure	3-4
	Blunt pericardial laceration with cardiac herniation	3-4
	Blunt cardiac injury with cardiac failure	3-4
	Penetrating tangential myocardial wound up to, but not extending through, endocardium, with tamponade	3
IV	Blunt or penetrating cardiac injury with septal rupture, pulmonary or tricuspid valvular incompetence, papillary muscle dysfunction, or distal coronary arterial occlusion producing cardiac failure	3
	Blunt or penetrating cardiac injury with aortic mitral valve incompetence	3 5
	Blunt or penetrating cardiac injury of the right ventricle, right atrium, or left atrium	
V	Blunt or penetrating cardiac injury with proximal coronary arterial occlusion	5
	Blunt or penetrating left ventricular perforation	5
	Stellate wound with <50% tissue loss of the right ventricle, right atrium, or left atrium	5
VI	Blunt avulsion of the heart	6
	Penetrating wound producing >50% tissue loss of a chamber	6

* Advance one grade for multiple penetrating wounds to a single chamber or multiple chamber involvement

Lung Injury Scale

Grade*	Injury Type	Description	AIS-90
I	Contusion	Unilateral, <1 lobe	3
II	Contusion	Unilateral, single lobe	3
	Laceration	Simple pneumothorax	3
III	Contusion	Unilateral, >1 lobe	3
	Laceration	Persistent (>72 hrs), air leak from distal airway	3-4
	Hematoma	Nonexpanding intraparenchymal	
IV	Laceration	Major (segmental or lobar) air leak	4-5
	Hematoma	Expanding intraparenchymal	
	Vascular	Primary branch intrapulmonary vessel disruption	3-5
V	Vascular	Hilar vessel disruption	4
VI	Vascular	Total, uncontained transection of pulmonary hilum	4

* Advance one grade for multiple injuries up to grade III
Hemothorax is scored under thoracic vascular injury scale

Thoracic Vascular Injury Scale

Grade*	Description	AIS-90
I	Intercostal artery/vein	2-3
	Internal mammary artery/vein	2-3
	Bronchial artery/vein	2-3
	Esophageal artery/vein	2-3
	Hemiazygos vein	2-3
	Unnamed artery/vein	2-3
II	Azygos vein	2-3
	Internal jugular vein	2-3
	Subclavian vein	3-4
	Innominate vein	3-4
III	Carotid artery	3-5
	Innominate artery	3-4
	Subclavian artery	3-4
IV	Thoracic aorta, descending	4-5
	Inferior vena cava (intrathoracic)	3-4
	Pulmonary artery, primary intraparenchymal branch	3
	Pulmonary vein, primary intraparenchymal branch	3
V	Thoracic aorta, ascending and arch	5
	Superior vena cava	3-4
	Pulmonary artery, main trunk	4
	Pulmonary vein, main trunk	4
VI	Uncontained total transection of thoracic aorta or pulmonary hilum	5

* Increase one grade for multiple grade III or IV injuries if >50% circumference; decrease one grade for grade IV and V injuries if <25% circumference.

Annexure 3: Parts of Hospital Expenditure Report 2009

Summary Per Economic Classification	BUDGET	EXPENSES
COMPENSATION OF EMPLOYEES	R 746,417.00	R 727,952.30
GOODS AND SERVICES	R 76,683.00	R 104,824.66
PAYMENTS FOR FINANCIAL ASSETS	R 0.00	R 97.89
HOUSEHOLDS	R 1,800.00	R 715.91
MACHINERY AND EQUIPMENT	R 31,727.00	R 23,671.63
Total	**R 856,627.00**	**R 857,262.39**
Current	R 824,900.00	R 833,590.76
Capital	R 31,727.00	R 23,671.63
Total	**R 856,627.00**	**R 857,262.39**

Annexure 4: List and prices of laboratory investigations done

TYPE OF TEST	NAME	PRICE (Rands)
Haematology	Full blood count (FBC)	101.36
	International Normalized Ratio(INR)	102.22
	Partial Thromboplastin Time Test (PTT)	52.2
Chemistry	Urea and Electrolytes	152.9
	C-reactive protein	79.95
	Cardiac enzymes	41.40
	Amylase	37.54
Microbiology	Blood culture	46.12

Annexure 5: List and prices of medications given

NAME	DOSE	UNIT PRICE (Rands)
Adalat/Nifedepine	30mg	1.26
Aldactone	100mg	6.21
Aldomet	250mg	0.33
Allergex tab	4mg	0.08
Amikacin injection	100mg	10.44
Amikacin injection	250mg	14.19
Amikacin injection	500mg	11.75
Amikacin injection	1gm	36.29
Aminophylline	250mg/vial	1.55
Amoxil oral	250mg	0.21
Amoxil oral	500mg	0.50
Amoxil syrup	125mg/ml	5.43
Amoxil syrup	250mg/ml	8.27
Amphogel	10ml	0.04
Ampicillin injection	250mg/vial	1.57
Asprin/Disprin	300mg	0.16
Asthma pumps (Becotide)	one spray	19.86
Atenolol tab	100mg	0.57
Atrovent Nebs	Nebs	2.25
Augmentin injection	0.6gm vial	18.67
Augmentin IV	1.2gm	32.25
Augmentin oral	375mg	2.15
Augmentin syrup	5ml	1.06
Berotec syrup	2,5mg	0.79
Betaphen/Penicillin oral	250mg	0.24
Brufen syrup	100mg	0.57
Brufen tab	200mg	0.08
BUSCOPAN	10MG	0.53
Buscopan syrup	5mg	1.49
Cefepime injection	500mg	55.47
Cefotaxime IV	500mg	9.90
Cefoxitin injection	1gm	49.17
Ceftazidime injection	500mg	86.91
Ceftazidime injection	1gm	98.52
Cefuroxime injection	250mg	16.81
Chlorampheniocol/Cloromycetin inj	1gm	12.66
Cloxacillin injection	500mg	5.97
Cloxacillin oral	250mg	0.41
Cloxacillin oral	500mg	0.62
Diclofenac inj	25mg	0.32
Diclofenac/Voltarin	50mg	0.29

Doxycycline oral	100mg	0.19
EPANUTIN ORAL	100MG	0.36
Epanutin oral	100mg	0.36
Epanutin syrup	125mg/ml	4.63
Epanutin/Phenytoin IV	50mg/ml	13.92
Erythromycin IV	1gm	158.70
Erythromycin oral	250mg	0.85
Erythromycin syrup	125mg	0.66
Flagyl IV	500mg/ml	0.07
Flagyl oral	400mg	0.21
Flagyl syrup	40mg/ml	0.20
Folic acid tab	5mg	0.07
HCTZ/RIDAQ	25MG	0.13
Heparin injection	5000u/ml	11.52
Immodium	1 tab	0.12
Insulin/Actraphane	100 UNITS/ML	9.17
Insulin/Actrapid	100u/ml	9.25
Insulin/Humalog	100u/ml	18.24
Iron tablet	one tab	0.08
KCL injection diluted	1 vial (10mls)	2.27
Keflex oral	250mg	0.49
Keflex syrup	250mg	0.74
Kefzol injection	500mg	4.71
Klacid inj	500mg	157.29
Klacid syrup	125mg	0.91
Largactil syrup	25mg	0.66
Largactil tab	50mg	0.13
Lasix	40mg	0.11
Lasix IV	10mg	0.66
Maxalon injection	10mg	1.73
Maxolon oral	10mg	0.05
Morphine injection	15mg/ml	2.29
Multivitamins syrup	one bottle	19.98
NaHCO3 inject	50ml	31.63
Nystatin syrup	1drop	0.36
Panado oral	500mg	0.07
Panado syrup (100ml)	120mg/5ml	0.20
Pen G injection	2.4 MU/vial	4.12
Pen G injection	1.2 MU	4.61
Pethidine inj	50mg	3.16
Prednisone oral	5mg	0.08
Prednisone syrup	15mg/ml	0.93
Rivotril inj	1mg	24.12
Rocephin IV	1gm	17.41
Salbutamol inj	1mg	23.00
Salbutamol syrup	2mg	0.24
Salbutamol tab	2mg	0.12
Salbutamol/Ventolin spray	one spray	18.93

Seranace inj	5mg	23.02
Solucortef injection	100mg	9.70
Spectrapain	one tablet	0.19
Tazocin/Piperacillin inj	2gm	51.60
Tegretol/Carbamazepine injection	100mg/5ml in 250ml	110.44
Tegretol/Carbamazepine oral	200mg	0.22
Theophylline syrup/Neulin	25mg	0.46
Thiamine injection	100mg/ml	1.72
Thiamine oral/Vit B complex	100mg	0.01
Tramadol oral	50mg	0.63
Tryptanol/amitriptyline oral	25mg	0.13
Vancomycin inj	500mg	67.32
Vit B complex tab	one tab	0.03
Vit B syrup	one bottle	3.03
Vit C injection	100mg/ml	0.07
Vit C tab	500mg	0.20
Vit K tab	10mg	5.42
Zinnat syrup	125mg	0.61
Whole blood (per unit)	1 unit	1030.15
Packed cells/red cell concentrate	1 unit	2130.96
Fresh frozen plasma	1 unit	750.08
Platelets (adult)	1 unit	4771.84
Pediatric Platelet concentrate	1 unit	3352.32
Autologous blood	1 unit	1085.44
Stem cell concentrate	1 unit	6488.32
Vaculitre (1 litre)	1 unit	49.58
Vaculitre (2 litre)	1 unit	55.07
Jelco	1	3.78

Aannexure 6: List and prices of radiological investigations done on patients in the study

TYPE OF INVESTIGATION	BODY REGION	PRICE (Rands)
CT scan	Brain	1,979
	Neck	1,355
	Cervical spine	1,355
	Thoracic spine	1,355
	Abdomen	1,961
	Pelvis	1,820
	Upper limb	1,820
	Lower limb	1,820
	Angiogram	1,682
Ultrasound	Chest	487
	Neck	487
	Pelvis	611
	Abdomen	611
X-rays	Skull	287
	Vertebrae (thoracic and cervical)	223
	Vertebrae (lumbar)	264
	Upper limb	218
	Lower limb	218
	Pelvis	398
	Chest	285
	Mandible	272

Annexure 7: Human Research Ethics Committee (Medical) Approval Letter

MMED 08

M10

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Dr Nonkululeko Mthembu

CLEARANCE CERTIFICATE	**M10352**
PROJECT	Estimating the Burden of Road Traffic Injuries in a Tertiary Hospital in Gauteng (Title Change as per PGC recommendation)
INVESTIGATORS	Dr Nonkululeko Mthembu.
DEPARTMENT	School of Public Health
DATE CONSIDERED	26/03/2010
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 02/02/2011 **CHAIRPERSON** ....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : Dr R Jina

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**
PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

Annexure 8: Post Graduate Committee Approval Letter

Faculty of Health Sciences
Medical School, 7 York Road, Parktown, 2193
Fax: (011) 717-2119
Tel: (011)717-2075/6

Reference: Ms Tania van Leeve
E-mail: tania.vanleeve@.wits.ac.za
20 October 2010
Person No: 9902470Y
PAG

Dr N Mthembu
P O Box 4508
Johanneburg
2000
South Africa

Dear Dr Mthembu

Master of Medicine in the specialty of Community Health: Approval of Title

We have pleasure in advising that your proposal entitled "*Estimating the burden of road traffic injuries in a tertiary hospital in Gauteng*" 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

Annexure 9: Letter of permission - Charlotte Maxeke Johannesburg Academic Hospital

Ranaka, Mable (GPHEALTH)

From: Williams, Valerie (GPHEALTH)
Sent: Monday, January 25, 2010 12:34 PM
To: Ranaka, Mable (GPHEALTH)
Subject: PERMISSION REQUIRED FROM DR.N. MTHEMBU

Hi Mable,

As discussed – Dr. Nkuli Mthembu is requesting the following :-

She is interested in doing a costing study at Medico – legal for her Masters. There are many claim forms which come in and she feels it would be interesting to find out the cost of treating patients who were involved in car accidents and to look at morbidity and mortality. She also feels it would be very useful for the Hospital to have such information if it's not there already.

Please request Dr. Mofokeng's permission for Dr. Mthembu to proceed with the costing study.

Regards,

Val
25/01/2010

Approved.
PS The information will assisting in recovering some of our costs from RAF.

Clinical Director
25/1/2010

1/25/2010

Annexure 10: List of Surgical Procedures performed on the patients under study

SPECIALTY	TYPE OF PROCEDURE
Orthopaedics and spinal unit	Open reduction and internal fixation
	Nailing
	External fixation
	Limb amputation
	Debridement
	Manipulation under anaesthesia (MUA)
	Fusion of vertebrae
	Insertion of K-wires
	Skin grafting
	Fasciotomy
	Osteotomy
General surgery	Laparotomy
	Debridement
	Excision and drainage
	Fasciotomy
	Tracheostomy
	Percutaneous endoscopic gastrostomy (PEG)
	Pigtail drainage
	Splenectomy
Neurosurgery	Drainage and evacuation
	Burr holes
	VP shunt
	Cranioplasty
	Craniotomy
Ophthalmology	Eye repair
	Suturing under anaesthesia
	Removal of segments embedded in the eye
Plastic surgery	Suturing under anaesthesia
	Hand repair