

https://dspace.org/

An assessment of the impact of injuries due to assaults, gunshots and motor vehicle accidents on the admissions and costs of the Orthopaedic department at Addington hospital in Durban

Lutge, Elizabeth Eleanor

2004

https://hdl.handle.net/10539/33059

Lutge, E. E. An assessment of the impact of injuries due to assaults, gunshots and motor vehicle accidents on the admissions and costs of the Orthopaedic department at Addington hospital in Durban. University of the Witwatersrand, Johannesburg

Downloaded from a DSpace repository. https://dspace.org/

AN ASSESSMENT OF THE IMPACT OF INJURIES DUE TO ASSAULTS, GUNSHOTS AND MOTOR VEHICLE ACCIDENTS ON THE ADMISSIONS AND COSTS OF THE ORTHOPAEDIC DEPARTMENT AT ADDINGTON HOSPITAL IN DURBAN

ELIZABETH ELEANOR LUTGE

STUDENT NUMBER 8901658M

DEGREE OF MASTERS IN PUBLIC HEALTH BY COURSEWORK AND RESEARCH REPORT

A RESEARCH REPORT SUBMITTED TO THE FACULTY OF HEALTH SCIENCES, UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS IN PUBLIC HEALTH

DURBAN, 2004

SUPERVISOR : MS. DEBBIE MUIRHEAD

DECLARATION

I, Elizabeth Eleanor Lutge, declare that this research report is my own work. It is being submitted for the degree of Masters in Public Health in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

Signed: E Lutge

This 19th day of May 2004

DEDICATION

For Damian, Isabella and Christina, with love

ABSTRACT

This research report examined the epidemiology of trauma in the orthopaedic ward at Addington hospital, Durban, over the year 2000. It also quantified the financial cost of trauma to this ward over the same period of time, using the "bottom up" costing method. The cost of trauma was also calculated using the "top down" method, as well as using tariff charges (used to bill patients with medical aid attending public hospitals). The overall cost of trauma to this ward for 2000 was found to be R5 440 964.20. A constant relationship was found between the costs as calculated using the three methods above.

ACKNOWLEDGEMENTS

I would like to thank the following people for their generous help in completing this study:

1. Firstly, my supervisor, Ms Debbie Muirhead, for her constant support and invaluable help and advice over the duration of this study. I am privileged to have worked with someone with her expertise and dedication.
2. Mr R Govender who assisted with the retrieval of patients' files
3. Ms Sue Meyer, who went beyond the call of duty to provide me with information from her computerised billing system and patients' database
4. Mr Senoge and Mr Wood (head of department and consultant respectively in the Orthopaedic ward, Addington hospital) and Dr Neville Rutherford-Jones (consultant anaesthetist at Addington) for patiently providing me with their clinical knowledge
5. Sr Aboo and the nursing staff in the Orthopaedic ward at Addington, for allowing me to sit in the ward and observe patients' care, and for filling in the time-consuming time-flow charts
6. Mr Honest Kagoro and Ms Cathy Connolly of the MRC in Durban, for assisting me with statistical calculations
7. Ms Eleanor Conner for generous assistance with formatting the final document
8. Finally Damian, who has supported and encouraged me in all my endeavours, taken up the domestic reins when I let them fall, and been an example to me in his determination, commitment and hard work, and Isabella and Christina, who are joyous inspirations always.

TABLE OF CONTENTS

		Page
DECLARATION		ii
DEDICATION		iii
ABSTRACT		iv
ACKNOWLEDGEMENTS		v
TABLE OF CONTENTS		vi
LIST OF APPENDICES		ix
LIST OF FIGURES		xi
LIST OF TABLES		xii
DEFINITION OF TERMS		xiii
AIMS		1
OBJECTIVES		2
LITERATURE REVIEW		3
3.1	Literature review	3
	3.1.1 Epidemiology of trauma	3
3.2	Costs of trauma	5
3.3	Costing methods	8
METHODS		12
4.1	Study site	12
4.2	Study period	13
4.3	Ethical clearance and permission to conduct study	13
4.4	Phase one: epidemiological study	14
	4.4.1 Sampling frame and sampling method	14
	4.4.2 Variables collected	16
	4.4.3 Data entry and analysis	17
	4.4.4 Pilot study	17
	4.4.5 Data quality	18

4.4.5.1 Analysis of data quality 18

4.5 Phase two: costing study 19
4.5.1 Scope of costing study 19
4.5.2 Methods of cost calculation used 20
4.5.2.1 Bottom up method 20
4.5.2.2 Top down method 24
4.5.2.3 Tariff charges 24
4.5.3 Variables collected 25
4.5.4 Creating the "typical case" profile 25
4.5.5 Cost collection methods 27
4.5.5.1 Costs of staff time 27
4.5.5.2 Drug costs 27
4.5.5.3 Laboratory costs 28
4.5.5.4 Overhead costs 29
4.5.5.5 Costs of prosthesis 30
4.5.5.6 Tariffs based calculation 31
4.5.6 Cost calculations 32
4.5.6.1 Unit costs for treatment of one patient as a result of trauma 32
4.5.6.2 Total costs for treatment of a category of injury due to trauma 32

RESULTS **33**

5.1 Phase one: epidemiological study 33

5.2 Phase two: costing study 39
5.2.1 Bottom up method 39
5.2.2 Top down method 40
5.2.3 Costing using tariff charges 41
5.2.4 Comparison of costing methods 43

DISCUSSION **47**

6.1 Phase one: epidemiological study 47
6.1.1 Trauma epidemiology 47

6.2 Phase two: costing study 53
6.2.1 Total cost of trauma to orthopaedic ward 53

6.2.2 Components of total cost of trauma 54
6.2.2.1 Components of unit costs of fractured femur 54

6.3 Top down method 57
6.4 Tariff charges 59

LIMITATIONS OF STUDY 61

7.1 Both phases 61
7.2 Phase one: epidemiological study 62
7.3 Phase two: costing study 62

CONCLUSIONS 65

RECOMMENDATIONS 67

REFERENCES 70

APPENDICES 76

LIST OF APPENDICES

Appendix 1	Process of care for trauma victim at Addington Hospital From entry to exit	77
Appendix 2	Age of patients per year of admission	79
Appendix 3	Data entry form	80
Appendix 4	Overview of data collected	81
Appendix 5	Epidemiological comparisons between those patients whose files were found and those whose files were not found	82
Appendix 6	Theatre time – comparison between files found and files not found	84
Appendix 7	Total number of cases caused by trauma, 2000	86
Appendix 8	Time flow chart – staff time spent with representative patient with fractured femur (minutes)	83
Appendix 9	Bottom up costing – fractured femur	89
Appendix 10	Time flow chart – staff time spent with representative patient with injury to ankle (minutes)	93
Appendix 11	Time flow chart – staff time spent with representative patient with injury to elbow (minutes)	95
Appendix 12	Time flow chart – staff time spent with representative patient with injury to foot (minutes)	97
Appendix 13	Time flow chart – staff time spent with representative patient with injury to hand (minutes)	99
Appendix 14	Time flow chart – staff time spent with representative patient with fractured humerus (minutes)	101
Appendix 15	Time flow chart – staff time spent with representative patient with fractured radius/ulna (minutes)	103

Appendix 16	Time flow chart – staff time spent with representative patient with injury to tibia/fibula (minutes)	105
Appendix 17	Bottom up costing – ankle	107
Appendix 18	Bottom up costing – elbow	111
Appendix 19	Bottom up costing – foot	115
Appendix 20	Bottom up costing – hand	119
Appendix 21	Bottom up costing – humerus	123
Appendix 22	Bottom up costing – radius/ulna	127
Appendix 23	Bottom up costing – tibia/fibula	131
Appendix 24	X ray costs	135
Appendix 25	Overhead costs for the orthopaedic ward at Addington Hospital	137
Appendix 26	Costs of staff time in ZAR, derived from annual	139
Appendix 27	Drug treatment	144
Appendix 28	Cause of injury in each age group in 2000	145
Appendix 29	Percentage of admissions caused by trauma per year	146
Appendix 30	Trauma as a cause for admission	150
Appendix 31	Trends of cause of injury vs. gender	152
Appendix 32	Trends of cause of injury vs. race	156
Appendix 33	Tariff costs	160

LIST OF FIGURES

Figure 5.1	Persons injured in MVA's	34
Figure 5.2	Reasons for surgery: 10-19 years	36
Figure 5.3	Reasons for surgery: 20-35 years	37
Figure 5.4	Reasons for surgery: 35-60 years	38
Figure 5.5	Reasons for surgery: over 60 years	38
Figure 5.6	Unit costs using various methods	45
Figure 5.7	Components of bottom up unit cost (fractured femur)	46

LIST OF TABLES

Table 4.1	Type of costing variable and source of variable and costing information	15
Table 4.2	Type of costing variable and source of variable and costing information	21
Table 5.1	Percentage of total costs due to trauma constituted by each category of injury	39
Table 5.2	Costs of hospital treatment of each pathological category of injury due to trauma in 2000, bottom up method (in ZAR)	40
Table 5.3	Unit costs for each pathological category, using top down costing method	41
Table 5.4	Unit costs for various injury categories for the year 2000, using tariff charges	42
Table 5.5	Unit costs for various categories of injury using all costing methods	43
Table 5.6	Total costs for injuries due to trauma in each pathological category, 2000	44
Table 6.1	Relationship between unit costs of bottom up, top down and tariff costing methods	57

DEFINITION OF TERMS

Trauma: assault, gunshot or motor vehicle accident. Although other studies have included other forms of trauma such as falls, burns, organized violence, suicide and accidents in the home and in the workplace, these were excluded here because the focus is on the most common injuries that present to South African hospitals.

Assault: physical attack with a blunt or sharp instrument with the intention to do bodily harm

Motor vehicle accident (also termed road traffic injury): collision between any two motorised vehicles which run on roads, including cars, kombi's, buses, trucks, bakkies and motor cycles, or collision between any one of these vehicles and a pedestrian

Bottom up costing (also called micro-costing): every input used for the treatment of a patient is identified, a cost attached to each input and each cost added to form a total. This is the most precise costing method and therefore considered to be the "gold standard".

Top down costing (also called gross or step-down costing): overall costs are broken down to the smallest unit of preference, which is commonly the cost of treating an inpatient for a day (*per diem* cost). This is the least precise costing method but is simple and cheap to use.

Tariff charges: the charges paid by private[1] patients attending public hospitals, based on the Uniform Patient Fee Schedule for Externally Funded Patients attending Public Hospitals (UPFS) User Guide 2002.

[1] "Private" patients are those who have medical aid, or the private means to pay for health care

AIMS

Trauma[a] in South Africa is indeed a "malignant epidemic (Muckart 1991). Approximately 70 000 South Africans die every year, and a further 3.5 million seek care at health care facilities, as a result of trauma[b] (Peden & Butchart 1999). The public health impact and the costs of trauma, to the individual, the state and society, are considerable.

1. To describe the epidemiology of trauma in the orthopaedic ward at Addington Hospital over the year 2000, in order to identify groups particularly vulnerable to trauma, and to identify the most important types of trauma, for targeted prevention interventions.
2. To estimate the financial cost of trauma to this ward over the same period of time, as a proportion of the hospital's budget, in order to inform the allocation of funds from Provincial level, and within the hospital itself.
3. To compare the results of the "gold standard" bottom up costing method with the top down costing method, in order to assess the accuracy of the top down method and hence its utility as a management tool.
4. To compare the results of the bottom up costing method with the calculation of charges based on the UPFS guidelines, in order to determine the potential sustainability of the UPFS as a financing system for trauma patients.

[a] For the purposes of this study at Addington hospital, trauma is defined injuries arising from assaults, gunshots or motor vehicle accidents.

[b] The definition of trauma which applies to these figures includes assaults, gunshots, homicides, suicides and motor vehicle accidents as well as other accidents in the home and in the workplace.

OBJECTIVES

1. To describe the demographic profile of trauma victims.
2. To describe the types of trauma necessitating admission.
3. To identify groups that present particularly commonly with trauma-related problems.
4. To determine the case load of trauma as a percentage of total patients.
5. To perform a financial costing of trauma from the hospital's perspective, using the "gold standard" bottom up method.
6. To estimate the percentage of the hospital's budget that is taken up by trauma patients in the orthopaedic ward.
7. To calculate the charges for private trauma patients based on the UPFS billing system.
8. To compare the results of the top down and the bottom up costing methods.
9. To ascertain whether the top down method is sufficiently accurate (when compared to the bottom up method) to be used as a tool for hospital management.
10. To assess the comparability of the UPFS billing system with the above costing methods.
11. To determine whether the charges of the UPFS billing system are sufficiently higher than the costs paid by the hospital (according to the bottom up costing method) to result in significant cost recovery by the hospital.

3.1 LITERATURE REVIEW

3.1.1 Epidemiology of trauma

South Africa has one of the highest rates of injuries in the world[c] (Peden & Butchart 1999). In 1994, injuries were one of the leading causes of death in South Africa, accounting for 20% of all registered deaths (National Department of Health 1997). A study in Cape Town in the same year showed an even higher rate of 30% (Lerer *et al* 1997). Alarmingly, these look set to increase even further. From 1990–2020, there is likely to be a significant increase in the injury-related burden of disease[d] in Sub-Saharan Africa, unless effective prevention measures are put in place (Murray & Lopez 1997). Because the HIV/AIDS epidemic is changing the pattern of mortality in this country (UNAIDS, 2002), injuries may no longer be the leading cause of death. However, the incidence of injuries is increasing and they are almost certainly one of the top three causes of death in South Africa (Peden & Butchart 1999).

Addressing a public health problem of this significance requires sound knowledge of its epidemiology. An understanding of the epidemiology of trauma is one of the keys to preventing, or at least reducing, its occurrence.

The data on injuries in South Africa has hitherto been scanty, but with the establishment of the South African National Non-natural Mortality Surveillance system (NMSS), more detailed and comprehensive information on deaths due to trauma will be available in the

[c] This definition of injuries also includes assaults, gunshots, homicides, suicides and motor vehicle accidents as well as other accidents in the home and in the workplace.

[d] This includes both intentional and unintentional injuries.

future (Butchart 2000). Preliminary data from the NMSS shows the epidemiology of trauma in South Africa nationally, and in certain participating provinces. In the first quarter of 1999, homicide accounted for 47.1% of non-natural deaths in South Africa, motor vehicle accidents for 28.4%, and suicide for 8.0%. (Peden & Butchart 1999). These data show a clear relationship between race and manner of death, with black and coloured men more likely to die as a result of homicide, and white men as a result of suicide. Women are less likely than men to die by homicide and suicide in all but the over-65 year age group.

Approximately 9 000 people are killed on South Africa's roads every year, and 33,000 seriously injured (*ibid*). Our road traffic death rate of 11.7 per 100 million kilometers traveled ranks in the top 10 in the world. (International Road Federation, 1991) Nationally, 39% of those killed are pedestrians, although this figure has decreased from 47% in 1987 (Peden & Butchart 1999).

An analysis of non-natural deaths in Durban, Johannesburg, Pretoria and Cape Town in 1999 showed that almost half of all non-natural deaths (46%) in these provinces were due to violence (Butchart 2000). Seventy two percent of patients fatally injured in homicides were black and 87% were male. More than half of those who died by homicide were between the ages of 15 and 34 years. In Durban, most homicide victims were killed by guns (59.4%), whilst 22.2% were killed by sharp and 14.6% by blunt instruments (*ibid*).

Useful as the NMSS data is, it by definition only considers fatal injuries. The epidemiology of non-fatal injuries in South Africa is still an area that requires further attention. There is a need for further research into who is affected by non-fatal trauma,

where trauma is particularly prevalent, when the trauma occurs and finally, why it occurs. Only when these questions are answered can the problem be meaningfully addressed.

3.2 Costs of trauma

The effects of trauma on the individual, the family, society and the state are profound. The physical and psychological effects of trauma can be debilitating for the individual and the family (Lu *et al* 2001). Society at large is disrupted by widespread trauma, and therefore so is the state. Because the majority of people dying as a result of interpersonal violence are young men (Butchart 2000), trauma has a disproportionate effect on the economically active population and therefore on the country's economy as a whole.

The health care system is particularly affected by trauma. Every year 3.5 million South Africans seek health care as a result of trauma (Peden & Butchart 1999). This imposes a burden on both financial and human resources. In health institutions that also function as training centers (such as Addington Hospital), a predominance of trauma may limit the range of other health problems with which the staff come into contact, and therefore limit the learning experience of the students. Such a phenomenon has occurred in the paediatric wards of the main teaching hospital in KwaZulu-Natal due to the HIV/AIDS epidemic (Clarke 2000), and it is reasonable to consider that trauma may be having the same effect. If this is indeed so, a conscious effort needs to be made by the teachers and trainers of health professionals, to ensure a broad experience of health problems for a complete practical training.

Health service costs have been shown to constitute a major part of the financial costs of treating trauma victims (Hall & Mooney 1990). The competition for health care resources

means that the priorities for the allocation of these resources need to be carefully thought out and based on relevant and accurate epidemiological and costing data in order to ensure the best health gains for our population within the budgets available. Other pressing issues in health in South Africa, such as the strengthening of primary health care services and the provision of antiretroviral drugs to HIV positive patients, may be crowded out by the overwhelming burden of trauma-related problems, or vice versa. Costing the provision of various types of care is an essential part of fairly and effectively allocating scarce resources to a variety of important health problems.

Since most South Africans use public, as opposed to private, hospitals (Doherty *et al* 2002), a public hospital is one of the institutions on which most of the costs of trauma falls. It is therefore appropriate to consider the financial costs of trauma at a public hospital, such as Addington Hospital, as one perspective from which to cost the trauma epidemic.

An inherent function of any costing study (economic or financial) is to provide information which helps with the management of the institution or activity being costed. Budgeting is one of the fundamental management activities of a health institution. The relationship between the costs of the activity and the budget of the institution determines the affordability of the activity. Because a hospital needs to provide appropriate services to its catchment population on an on-going basis, assessing the affordability of these services is a vital and valuable exercise.

Financial information is essential for the efficient running of a hospital, both within the micro-economic environment of the institution itself, and within its broader macro-

economic environment. On a micro level, the hospital needs to know how its expenditure is distributed between departments and why. This will help the management of the institution to budget intelligently, to remain accountable for monies spent, to assess and improve efficiency in the use of resources, to set and pursue priorities, and to make cost projections (Creese & Parker 1994). On a broader level, the hospital needs to function within an environment where resources are scarce and the funding of health care variable. The 1998/99 national per capita expenditure on health was R29 lower than in 1997/98, but R10 higher than in 1996/97 (Thomas *et al* 2000). It is therefore an intrinsic part of the mandate of the hospital management, to know how costs are distributed within the hospital, to understand why this is so and to be able to adjust and alter these if necessary, in response to changes in the external economic environment.

Knowledge of the costs of a service is also necessary in order to plan for cost recovery by means of user charges (Creese & Parker 1994). The billing of patients with medical aids (or with the means to pay) who attend public hospitals is one way in which more funds may be bought into public sector health care. This is one way of encouraging the "public-private mix" in health care, to which the government has expressly committed itself (White Paper for the Transformation of the Health System in South Africa, 1997). Hospital patients with the means to pay are billed according to the UPFS billing system, where fees are charged in accordance with the private health sector in South Africa (UPFS National Project Team, 2002). Unfortunately however, very few patients who can afford private health care use public facilities, and the public institutions themselves have frequently failed to bill those who do (Goudge 1999). A study looking at the recovery of costs for the treatment of trauma patients in the orthopaedic wards at Groote Schuur hospital in Cape Town showed that only 5.5% of the costs of acute hospital care were

recovered by the time the accounts had been finalised. Even if patients had been charged private rates for their care (and had paid these in full), only 55.4% of costs would have been recovered (van der Spuy 1996). At Addington Hospital, only 3-5% of all hospital patients have medical aids, or the means to pay for their treatment themselves (personal communication: Head of Informatics, Addington Hospital, Durban). However, this percentage may increase in the future as co-operation between the private and public health sectors improves. Therefore the potential for cost recovery in public hospitals by the treatment and billing of private patients does merit exploration.

A number of international studies have looked at the costs of treating trauma victims. (Weaver *et al* 1995; Kakarlpudi *et al* 2000; Thompson *et al* 2001; Yanchar 2001). Studies looking at the costing of health care in South Africa are numerous (Broomberg & Price 1990; De Beer & Broomberg 1990; Kane-Berman & Taylor 1990; McIntyre & Dorrington 1990, Soderlund 1999) and do provide a valuable background to the costing of trauma in this country. Some studies in South Africa have focused on the costs of trauma specifically (Dickinson *et al* 1990; De Wet *et al* 1994; van der Spuy 1996; Peden & van der Spuy J, 1998; Quarmby 1999).[e] This is an important area of research, both in order to assign a concrete value to this "malignant epidemic" and also to inform the budgeting for health care in this country.

1.3 Costing methods

For the purposes of this study, a cost can be defined as "the value of resources used to produce something" (Creese & Parker 1994) and costing as being "the activity that estimates the cost of an action either in the future or in the past" (Green 1997). There are

[e] The above studies are referred to specifically in the text below.

two main components of a costing study: the "measurement of the quantities of resources used... and the assignment of unit costs or prices" to these (Drummond *et al* 1997). A costing must be defined in terms of three criteria – whether it is financial or economic, total or incremental, and from whose perspective it is done.

A financial costing includes only those inputs that are actually paid for by the institution. In addition to these costs, an economic costing also takes into account so-called "opportunity costs". Opportunity costs recognise that even when an item is not paid for, the consumption of this resource means that it cannot be used elsewhere for other productive purposes. This value of it in its best alternative use is known as the opportunity cost. Examples of opportunity costs are volunteers who work for free, and donated goods. Other opportunity costs include social costs such as loss of productivity on the part of the patient due to the health problem. An economic costing is more comprehensive than a financial costing, and a better tool for assessing the long-term sustainability of a programme or activity. However, a financial costing is useful for short-term management and budgeting.

A total costing includes all items which are necessary to provide the service being costed, whereas an incremental costing excludes those which would have been paid for by the institution anyway, whether the service in question were being provided or not.

The perspective from which the costing is being conducted determines to a large extent what costs are included in the study. For example, costing health care from the perspective of a South African public hospital means that emergency transport is not included in the analysis, since ambulances fall outside of the budgets of these hospitals.

Similarly, costs borne by the patient, such as drug treatment brought privately, would not be included in a study conducted from the perspective of a hospital. Other possible perspectives include society, the Department of Health, non-governmental organizations et cetera (Drummond *et al* 1997).

In addition to the above, there are a number of variables that need to be considered before embarking on the costing study.

1. The duration of the study must be determined. For example, the costing may focus on the acute hospital care of the patient only, excluding outpatient treatment pre- and post-discharge (Kane-Berman & Taylor 1990; Peden & van der Spuy 1998). Alternatively, all treatment including, for example, rehabilitation after discharge, can be included (Kakarlapudi *et al* 1999; Herbst 2002).
2. The level of precision required in the costing must be determined, and a suitable method chosen on this basis. The most precise method is the bottom up or micro-costing. Using this method, each component of a patient's care is enumerated, costed, and the costs added up to a total. The least precise method is the top down method using average *per diem* cost, where the average cost of treating a patient for a day is applied to a variety of different patient categories (patients may differ in terms of age, gender, disease type and severity et cetera). Methods of intermediate precision include case mix costing, or disease-specific *per diem* costing (Drummond *et al* 1997). The bottom up costing method is more time-consuming and resource-intensive to do (Kakarlapudi *et al* 1999; Herbst 2002) and so for management purposes is used less frequently than the top down method which is simpler, cheaper and more practical to perform (de Wet *et al* 1994; Peden & van der Spuy 1998;

Quarmby 1999). Thus as a management tool the top down method is the more convenient to use, but is only useful if sufficiently accurate (compared with the gold standard bottom up method) to yield reliable results.

3. The study may entail following patients prospectively from admission to discharge (Kakarlapudi *et al* 1999), or retrospectively reviewing patients' records (de Wet *et al* 1994; Weaver *et al* 1995; Peden & van der Spuy 1998; Quarmby 1999). The latter is the most popular option, probably because it is the quickest and most convenient. However, if the costing is done significantly later than the patients are treated, inflation and general cost increases may affect the accuracy of the cost calculations. This limitation should always be borne in mind for costing studies using this methodology (Drummond *et al* 1997).

4. An individual patient's care may be costed (Kakarlapudi *et al* 1999), or alternatively, groups of patients who experience similar care may be aggregated to form an "average" patient, whose treatment costs are then calculated (Qualls & Robertson 1989; Herbst 2002). Although the latter method may obscure important differences between patients, if the health profile and treatment of patients within categories are very similar, this is an accurate and convenient method to use.

METHODS

4.1 Study site

Addington Hospital, a public hospital on Durban's South Beach, was chosen as the site of the study because it has a good medical records system. Since this study was to be based on a retrospective record review, this was crucial to its success. Also, from the experience of the principal investigator, and from personal communications with staff in the orthopaedic and surgical wards at Addington, trauma is a common cause of admission to the hospital.

Until December 2001, Addington was classified as a secondary level hospital and the referral center for Osindisweni and Mahatma Ghandi hospitals and clinics in the following areas: Durban central, Wentworth, Newlands East, Newlands West, Clare Estate, Sydenham, Bluff, Red Hill, Greyville, the Point, Albert Park and Sea Cow Lake. Although the classification of Addington changed in December 2001, for the duration of the study it provided specialist orthopaedic care to these areas and health facilities.

Trauma victims are, because of the nature of their injuries, admitted to either the surgical or the orthopaedic wards at Addington. The orthopaedic ward was chosen for this study because:

1. Patients involved in motor vehicle accidents are very likely to have orthopaedic injuries. For example, orthopaedic injuries are sustained by the majority (72.4%) of pedestrians involved in motor vehicle accidents. (Van der Spuy 1996). Pedestrian injuries are a numerically important component of all injuries resulting

from trauma with 39% of all those killed in motor vehicle accidents being pedestrians (Peden & Butchart 1999).

2. Patients who sustain only orthopaedic injuries are more likely to survive long enough to be admitted to and discharged from hospital than those who sustain abdominal and chest injuries (Muckart *et al* 1995). Since the hospital was to be used to sample trauma patients, it was more likely that the largest sample would be found here, without having to access mortuary records, which would be the case if general surgical patients were studied.

The movement of patients through the hospital, from admission to discharge, is outlined in Appendix 1. This outline is intended to give non-clinicians an idea of the components of a patient's care, which can be related to the elements that are included in the costing study (see Appendix 1: Process of care for trauma victim at Addington Hospital, from entry to exit).

4.2 Study period

The study period was defined as 01 January - 31 December 2000. The study was divided into two phases. Phase one was a descriptive study based on the record review, providing epidemiological and demographic data on trauma victims over the study period. Phase two was a financial costing, done from the perspective of the hospital, of admissions due to trauma to the orthopaedic ward over the study period.

4.3 Ethical clearance and permission to conduct study

Before commencing with the study, ethical approval was obtained from the Ethics Committee at the University of the Witwatersrand, and permission from KwaZulu-Natal

Department of Health and the Medical Superintendent of Addington Hospital. Being a retrospective record review, the main ethical issue relevant for this study was patient confidentiality. This was completely preserved as no patient names were recorded or appear in any stage of this study.

4.4 Phase one: epidemiological study

4.4.1 Sampling frame and sampling method

Theatre Books were chosen as the sampling frame for this study as they provided the greatest coverage of all patients admitted to the orthopaedic ward. These contain records of all operations done at Addington with details of, among other things, the nature of the operation, and the patient's hospital number. For further information on the patient, his or her file was sought in the Medical Records Department at Addington Hospital. There were thus two rounds of data collection:

1. The Theatre Books
2. Individual patient files

On the advice of a statistician, and based on a count of orthopaedic operations done in 2001 (1 500 operations), it was decided that a sample of 300 patients per year would be representative of the total patient population. However, in order to maximize the chances of finding the necessary 300 files, a systematic sample of one in every three instead of one in every five patients was chosen from the Theatre Books. A random starting point was chosen by blindly identifying a block in the Theatre Book with a pencil. Two thousand one hundred and sixty records of patients undergoing orthopaedic operations were sampled in the first round of data collection from the Theatre Books of Addington

Hospital. These records spanned the years 1995-2000 (inclusive) which was originally planned as the study period.

In the second round of data collection, the patients' hospital numbers were used to retrieve their files from the Medical Records Department (see Table 4.1).

Table 4.1. Variables collected in two phases of data collection.

Theatre books	Patients' files
1. Gender	1. Date of admission and discharge
2. Age	2. Length of stay in hospital
3. Race	3. Cause of injury/problem
4. Type of surgical procedure	4. Drugs prescribed during hospital stay
5. Site of problem	5. Laboratory tests done during hospital stay
6. Time in theatre	6. X rays performed during hospital stay.

(See also Appendix 3: data entry form

4.4.2 Variables collected

Data on gender and age were collected because it is well established internationally and in South Africa that both are important influences on the patterns and rates of injury due to trauma. (Peden & Butchart 1999; Butchart 2000). The precise age of the patient (in years) was recorded, but subsequently re-coded into categories to facilitate data analysis (see Appendix 2: Age vs. year of admission). The categories used were as follows: 0-9 years, 10-19 years, 20-35 years, 36-60 years, over 61 years.

Although race is no longer used for classification purposes in South Africa, it is still an important indicator of social, economic and educational status (Friedman 1999). Because trauma affects different socio-economic groups differently, it is vital to consider race in any South African study on trauma.

The race of an individual patient was determined by his/her surname as recorded in the Theatre Books. Although this is an imprecise way to measure race, it was the only method available in this study (being a retrospective record review) and has been used in a similar study for the same reason (Matteuci *et al* 1995). However, although black and Asian names were fairly recognisable, white and coloured names were indistinguishable. Therefore all "coloured" or "white" surnames were classified as "other". The blurring of the socio-economic distinctions between these two groups was regrettable, but conclusions could still be drawn from the patterns in the three categories.

Those patients for whom data on these variables were missing were excluded from the analysis.

4.4.3 Data entry and analysis

Data was entered manually onto a data entry form (see Appendix 3: data entry form), and then transferred into EpiInfo 2000. This database was subsequently converted to and analysed in SPSS.

The epidemiological analysis consisted of quantification of the types of trauma resulting in admission, as well as relating demographic characteristics such as age, race and gender, to the type of trauma.

4.4.4 Pilot study

The pilot study was performed in order to identify any possible problems with access to the Theatre Books, to the patients' files in the Medical Records Department, or to costs of resources from the hospital or the relevant Provincial departments, and to assess the completeness of the data that could be gathered from these sources.

The Theatre Book from 2001 was used to perform the pilot study. The patients' hospital numbers were recorded from this book, and the files found in the hospital's Medical Records department. Seventy percent of the patients' files were found, which amounts to an excess of the required sample of 300 per year, systematically chosen over the year. Data was entered into EpiInfo and analysed in SPSS. There were no problems experienced with access to any of the data sources. Data on all the variables was found from these sources, although some of the patients' files were organized in such a way that some time had to be spent in finding the information required. On the basis of this successful pilot study, no changes were made to the protocol.

4.4.5 Data quality

Due to lack of data availability for the years 1995-1999, 2000 only was chosen for the focus of this study (see Appendix 4: Overview of data collected). Even for the year 2000, only 50% of the patients' files were retrieved from the Medical Records Department. However, on discussion with a statistician, this was considered to be fair, since a generally acceptable response rate for a questionnaire is 50-60% (personal communication: Cathy Connolly, Medical Research Council, Durban).

4.4.5.1 *Analysis of data quality*

Complete data for the years 1995-2000 was available on the following parameters for each patient

- Gender
- Race
- Age
- Type of surgical procedure
- Site of problem
- Time spent in theatre

In order to check for selection bias, these variables were used to compare the data for the patients whose files were found with those whose files were not found.

Comparison showed no significant difference between the groups for gender or time spent in theatre. However, only for the year 2000 was there no significant difference in terms of race. There was a significant difference for all years for the age variable. For the year 2000, this was due to the small percentage of files of children under the age of nine years that were found (see Appendix 5: Epidemiological comparisons between those patients

whose files were found and those whose files were not found and Appendix 6: Theatre time – comparison between files found and files not found).

Because of the poorer data quality for the years 1995-1999, it was decided to focus on data from the year 2000 for this study.

4.5 Phase two: costing study

4.5.1 Scope of costing study

The costing of trauma undertaken was financial from the perspective of the hospital. Any resources consumed by the hospital in the treatment of trauma for which it did not pay were excluded and prices used to value costs were those as faced by Addington Hospital. Any costs faced by the patient (such as transport costs) or by wider society (such as productivity losses due to injury) were therefore outside the scope of this study.

The cost analysis was extended to the inpatient treatment of trauma on the orthopaedic ward and theatre only. Costs of treatment before admission (such as in the trauma unit), any treatment in intensive care and after discharge (such as in the outpatient unit) were not included in this study.

Eleven different types of injury were considered separately for the cost analysis. These were ankle, elbow, foot, femur, hand, hip, humerus, knee, radius/ulna, shoulder, and tibia/fibula. Costs for ankle, elbow, foot, femur, hand, humerus, radius/ulna, and tibia/fibula injuries were ultimately calculated as hip, knee and shoulder injuries, comprising 2% or less of all trauma seen on the orthopaedic ward respectively, were

excluded from the analysis (see Appendix 7: Total number of cases caused by trauma, 2000).

Costs from the financial year 2001/2002 were used to prevent inaccuracies from arising as a result of inflation and cost increases.

4.5.2 Methods of cost calculation used

4.5.2.1 *Bottom up method*

Three methods of cost calculation were used and contrasted. Firstly, a bottom up or ingredients based approach was used to cost a "typical case" or "average patient" in each of the above categories of injury. This involves the detailing of all quantities of resources consumed in the treatment of each type of case and multiplying this by the number of cases seen in each category of injury over the period of the study. Table 4.2 outlines the cost items included and the data sources from which details on use were obtained.

Table 4.2. Type of costing variable and source of variable and costing information.

Variable	Source of information	Source of costing information
Length of hospital stay	Patient's file	For bottom up costing, all sources below were used. For top down costing, source of costs of patient day equivalent (PDE) was eThekwini District: Summary of Situational Analysis. Durban 2001
Drugs administered in the ward	Patient's file and the Head of the orthopaedic ward and consultant orthopaedic surgeon at Addington Hospital	Pharmacy, Addington Hospital and a senior lecturer in pharmacology at Nelson R Mandela School of Medicine
Drugs administered in theatre	Consultant anaesthetist at Addington Hospital	Pharmacy, Addington Hospital
Consumables used in the ward	Sister-in-charge, orthopaedic ward at Addington Hospital	Surgical stores department, Addington Hospital
Consumables used in theatre	Consultant anaesthetist at Addington Hospital	Surgical stores department, Addington Hospital
Laboratory tests done	Patient's file and the Head of the orthopaedic ward and consultant orthopaedic surgeon at Addington Hospital	Provincial Laboratory Services, Addington Hospital
X rays performed	Patient's file, the Head of the orthopaedic ward and consultant orthopaedic surgeon at Addington Hospital, and the Chief Radiographer, X ray Department, Addington Hospital	Surgical Stores Department, Addington Hospital
Time spent in theatre	Theatre Books	Medical staffing department, Human Resources department and Matrons' Office, Addington Hospital
Number and category of staff attending each patient	Observation by principal investigator, and Sister-in-charge, orthopaedic ward at Addington Hospital	Medical staffing department, Human Resources department and Matrons' Office, Addington Hospital
Running costs of the hospital for a year	Chief accountant, Financial Department, Addington Hospital	Chief accountant, Financial Department, Addington Hospital
Total number of patient days provided by the hospital in a year	Head of Informatics Department, Addington Hospital	Chief accountant, Financial Department, Addington Hospital
Prostheses used for each site of injury	Consultant orthopaedic surgeon at Addington Hospital	Surgical stores department, Addington Hospital
Tariff costs	Uniform Patient Fee Schedule (UPFS) for Externally Funded Patients attending Public Hospitals (2002) – User Guide, Code Book and Approved Code Fee Scale	UPFS User Guide, Code Book and Approved Code Fee Scale, with assistance from the Head of the Informatics Department at Addington Hospital and Professor Kobus Herbst of the Africa Centre.

The resources consumed in the treatment of 124 patients with femoral injuries and 17 patients with humeral injuries were quantified in order to calculate the costs of a "typical" case of each. Treatment profiles for ankle, elbow, foot, hand, radius/ulna, and tibia/fibula injuries were developed through adjustments to the central femur and humerus profiles through discussion with the orthopaedic consultant, anaesthetic consultant and ward sister. Little variation occurred in drug treatment and laboratory tests for these categories of patients, as trauma victims are often young and therefore not on medical treatment, and do not require sophisticated investigations before undergoing surgery. The main variation occurred in the number of days spent in hospital, and the amount of time spent in theatre (see Appendices 8 and 10-16: time flow charts for various categories of injury and Appendices 9 and 17-23: Bottom up costings for various categories of injury).

High cost items most likely to contribute significantly to the overall cost of the treatment of trauma victims were focused on in this study. These were staff time costs, which constitute approximately 60% of health care costs in the public sector (Folb 1990; Doherty *et al* 2002), and consumable costs, which constitute 27%. The most expensive component within the category of "consumables" in health care is drugs (Folb 1990). However, laboratory tests, and other consumables (such as drip sets, gloves etc) also fall into this category and these costs were also carefully calculated for this study. Thus these two items together constitute 87% of health care costs in a public hospital. X rays are a composite cost, comprising both consumables and staff time, and were calculated as such (see Appendix 24: X ray costs, and Appendices 9 and 17-23: Bottom up costings for various categories of injury).

Other costs, such as equipment (constituting 7% of public sector health costs) and operating costs (such as electricity, water, communication, catering, administration et cetera, constituting 4% of public sector health costs) were calculated per patient per day in the orthopaedic ward from the total annual expenditure on these items at Addington (see Appendix 25: Overhead costs for the orthopaedic ward).

Intensive care costs were not included in the bottom up method. This was because only three patients in the sample for which files were found, had stayed in ICU, and it was therefore not considered to be an important component of the cost. This finding was supported by the statistics for the intensive care unit (ICU) at Addington for the year 2002. Of a total of 296 patients admitted to ICU in this year, there were only three (1.01%) with purely orthopaedic pathology (Personal communication: Head of Informatics Department, Addington Hospital). This reflects the reality that patients who are admitted to an ICU as a result of injury usually have multiple injuries and these usually involve internal organs as well as the skeleton. However, because the calculation of a Patient Day Equivalent includes ICU costs, as does the facility cost which is included in the UPFS tariff charges, this may have contributed to the relative lowness of the bottom up costs compared to the other methods (see Discussion section).

It is important to note that the costs used for the bottom up costing were those paid by the hospital, and not market costs. These were used because this costing is a financial one, taken from the hospital's perspective, and represents the costs that the hospital will face in the short term. This is important to bear in mind when interpreting these costing results.

4.5.2.2 *Top down method*

Secondly a top down approach was used. This method involves the use of a general cost and applies this cost to a specific condition, in this case, trauma. The top down costs were calculated using the cost of a patient day equivalent (PDE) (eThekwini (Durban) District Situational Analysis of 2001) multiplied by the number of days spent in hospital, a method used in a number of studies calculating the costs of trauma (de Wet *et al* 1994; Peden & van der Spuy 1998; Quarmby 1999). Due to lack of ward specific costs, a hospital wide PDE (or per diem) cost was used. This was calculated according to the following formula:

Total Expenditure (hospital) / (Total Inpatient days + 1/3 Outpatient visits)[f]

(Although there is a debate as to the ratio of inpatients : outpatients in a secondary hospital, the traditional use of 1:3 was considered to be acceptable in this case).

This PDE cost excludes the scheduled maintenance and replacement of buildings and equipment. These costs were included in the overhead costs of the bottom up costing, and for the purposes of comparison, this may prove problematic (see "Overhead costs" below for further discussion).

4.5.2.3 *Tariff charges*

Lastly, charges as outlined in the Uniform Patient Fee Schedule were used to value the treatment of trauma at Addington (UPFS National Project Team, 2002). Although it is well established that costs do not equal charges (Green 1997), and these charges to the

[f] This is the standard formula used in South Africa (Doherty 2002).

patients with medical aids are therefore not an accurate measurement of the costs to the hospital, this analysis was done to determine how closely costs are related to charges in this instance. The ability of the hospital to recover costs by billing private patients using this system could then be determined.

For all three calculation methods, costs for the 2001/2002 financial year were used.

4.5.3 Variables collected

The variables necessary to perform a financial costing (using all three methods) and the sources from which information on these variables were obtained are listed in the Table 4.2.

All the prices necessary for this method were obtained from Addington Hospital itself, and corroborated if necessary by provincial departments (who dictate the prices to Addington).

4.5.4 Creating the "typical case" profile

The profile of a "typical case" was used for each of the three costing methods, so that costs could be compared for each method.

This same method was used to calculate the cost of care of MVA victims for the Road Accident Fund (Herbst 2002). In this study, a profile of the "average" patient in each diagnostic category was created and costed, and then the costs for all the patients in that category were added to get a total cost of care for all the patients with that injury. Although Herbst's study included costs such as ICU, outpatient and trauma unit costs, the

methodology was essentially the same. This method has also been used in the costing of the Expanded Programme on Immunisation (World Health Organisation 1979; Qualls & Robertson 1989). This method is intrinsically useful as a costing tool, but also has added benefits in that it enables an assessment of the efficiency of the service being provided, as well as comparison of costs between facilities or areas.

Three sources were used to create this "typical case" profile. These were:

a) The record review

b) A detailed record of an individual patient's stay in hospital

c) Intensive discussions with all levels of staff in the orthopaedic ward.

It was hoped that by using three different sources, potential biases in each would be ironed out, and a reliable profile of a "typical case" patient created.

a) The record review was used as a basis for the following calculations for each category of patient: the average length of stay in hospital, the average time spent in theatre, the average time (if any) spent in the intensive care unit (ICU), the drugs used and laboratory tests most commonly done, and the type of internal fixation used.

b) Details of the time staff spent with a patient in the ward on various activities were recorded on a time flow chart (see Appendix 8: Time flow chart)

c) Discussions with staff were used to confirm or deny these findings (most commonly there was general agreement, as can be seen below). Discussions also served to elaborate on details of the patient's care in the ward.

4.5.5 Cost collection methods

4.5.5.1 *Costs of staff time*

On the advice of ward staff, an individual "representative" patient with a fractured femur was chosen on which to base an average patient profile. Fractured femurs were the most common injury encountered in this study, comprising just over 20% of all admissions to the orthopaedic ward. This patient's treatment in the ward was observed for two days by the principal investigator, and amount of staff time spent with the patient on each activity was recorded. This process was continued by ward staff for the duration of the patient's stay in hospital. The total amount of time spent by each category of staff with the patient was calculated, and the information collated onto one data sheet (see Appendix 8: Time flow chart for patient with fractured femur). This process was repeated for a patient with a fractured humerus, so that the time spent with a patient with an upper limb injury was also recorded (see Appendix 14: Time flow chart for patient with fractured humerus). The gross annual salaries of staff, as well as their benefits and the average number of weeks per year worked for each category of staff were obtained from the medical and nursing staffing office and Human Resources Department at Addington Hospital. Using this information, the costs of the time spent by each category of staff with this representative patient were calculated (see Appendix 26: Costs of staff time).

4.5.5.2 *Drug costs*

Drug costs were calculated for the "typical case" with a fractured femur, based both on the findings of the record review and discussions with the Head of the Orthopaedic Department at Addington Hospital (a specialist in orthopaedic surgery). Most patients with a fracture for which they have surgery are given cefril (a first generation cephalosporin), as a prophylactic antibiotic. This was confirmed by the record review

which revealed that, of the patients for whom antibiotic treatment was known, 67.7% received cefril (see Appendix 27: Drug treatment). The prophylactic regimen that was costed (on discussions with the orthopaedic consultant and a consultant pharmacist) was 500mg cefril daily, qid. The record review revealed that indocid and paracod were the most commonly used analgesics in the later post-operative phase, so these were the analgesics that were costed. (see Appendix 27: Drug treatment).

As discussed above, this drug protocol is followed for most patients who require orthopaedic surgery for trauma (as defined for the purposes of this study). If "falls" had been included in the costing study, the drug regimens would have been markedly different since a large proportion of patients who present with an injury as a result of a fall are elderly and therefore frequently on treatment for other medical conditions (see Appendix 28: Cause of injury in each age group in 2000).

4.5.5.3 *Laboratory costs*

Discussions with the orthopaedic consultant at Addington, revealed that most patients admitted for trauma require only a ward Haemoglobin to test their fitness for surgery, since most are young and healthy. However, what is generally done is one full blood count, one urea and electrolytes and one random glucose, which are all tests done by the laboratory. This was confirmed by the record review, and therefore the "typical case" for the purposes of the costing study was assumed to have had these blood tests only. As discussed above, elderly patients, who require more investigative tests, are usually not admitted as a result of trauma as defined by this study (see Appendix 28: Cause of injury in each age group in 2000). Patients who are more severely injured, with substantial blood loss requiring transfusion, have injuries in addition to orthopaedic and are admitted to

other wards (most often general surgical). They are therefore not treated on the orthopaedic ward and therefore their more complex investigations and treatments were not included in this costing study. This is discussed further as a limitation of this costing study.

The costs of these blood tests were obtained from the laboratory at Addington Hospital, and the total laboratory costs for the "average" patient were calculated accordingly (see Appendices 9 and 17-23: Bottom up costings for various categories of injury).

4.5.5.4 *Overhead costs*

As described above, those costs which were part of a patient's treatment were calculated individually for each category of injury. These costs were subtracted from the overall operating expenses of the hospital and the remainder of the operating expenses were classified as overhead costs.

The overhead costs for one patient day provided by Addington were calculated as a percentage of the annual costs of administration, equipment, maintenance and outsourced services borne by the orthopaedic ward. This percentage was calculated by dividing the number of patient days provided by the orthopaedic ward by the number of patient days provided by the hospital in a year. An alternative method could have been to use the area of the orthopaedic ward (in m^2) divided by the total area of the hospital (in m^2).

The allocation of overhead costs to the orthopaedic ward was calculated as follows:

- Total annual expenditure of hospital (excluding persal costs) for 2001/2002 financial year = R29785616

- Percentage of patient days provided by orthopaedic ward = 13017 divided by 151161 = 8.62%
- Therefore 8.62% of total expenditure of Addington in a year allocated to orthopaedic ward = R2567520.10
- Therefore overhead costs for the orthopaedic ward for one day = R7034.30
- For an average of 35 patients in the ward on any day in the year (13017/365), the overhead costs for one patient per day in the orthopaedic ward are R200.98

(For more detail see Appendix 25: Overhead costs)

Persal (being staff salaries) and stores and livestock (which includes drugs) costs were excluded to prevent duplication of costs which were included in the staff time and drugs costs (see Results and Discussion sections). This exclusion of staff other than clinical staff and porters would have had an important role in lowering the costs of trauma as calculated by the bottom up method. It would also have resulted in greater discrepancies between bottom up and top down costing methods, and between the bottom up costing and the calculation of charges to patients using the UPFS tariff costs. However, it was not possible to factor out the remuneration of health workers from the persal data, and therefore impossible to be sure that costs were not being duplicated. It was considered preferable to consciously underestimate the costs of trauma, than to unconsciously overestimate them. This is an important limitation of the study though and is discussed further in the Results, Discussion and Limitations sections below.

4.5.5.5 *Costs of prosthesis*

Many patients requiring orthopaedic surgery have some form of internal fixation inserted. For example, most patients in the database who had a fractured femur required internal

fixation (see Appendix 9: Bottom up costs for fractured femur). Since the costs of prostheses are high in relation to other treatment costs for a fractured femur, these were included in the costing. The percentage of patients who required various kinds of internal fixation, when the type was known, was applied to all the patients with a fractured femur who had internal fixation, the total costs for patients with various types of internal fixation calculated, and the total added to the total costs for patients who did not require internal fixation. Costs for prostheses were obtained from the Stores Department at Addington Hospital, and are State prices including VAT.

4.5.5.6 *Tariffs based calculation*

Tariff based costs for all categories of fractures were calculated according to the Uniform Patient Fee Schedule (UPFS) for Externally Funded Patients attending Public Hospitals (2002) – User Guide, Code Book and Approved Code Fee Scale (UPFS National Project Team 2002). However, injuries which were not fractures could not be costed using this method because of the discrepancies in diagnosis of injury between the UPFS and the database created for the purposes of this study. This limitation notwithstanding, this method still proved useful as a comparison to the above methods (see Results and Discussion sections). Assistance was obtained in the use of this method from the head of the Informatics department at Addington Hospital, where the method is used to bill hospital patients who have medical aid. The costs of treatment for a patient with a fractured femur (the most common injury encountered in this study) were calculated in real time, and within the hospital's live computer system. Costs for other injury categories were calculated manually using the various UPFS books.

4.5.6 Cost calculations

4.5.6.1 *Unit costs for treatment of one patient injured as a result of trauma*

The unit costs for the treatment of a patient with a certain category of pathology were calculated as follows:

Costs of staff time (theatre and ward) + costs of drugs + costs of laboratory tests + costs of x rays + costs of consumables (theatre and ward) + costs of prosthesis + overhead costs (see appendices 9 and 17-23: Bottom up costings for various categories of injury).

4.5.6.2 *Total costs for treatment of a category of injury due to trauma*

In order to calculate the total costs of treating injuries that occurred as a result of trauma, it was first necessary to calculate the total number of injuries that were due to trauma (see Appendix 29: Percentage of admissions caused by trauma per year). This was derived by applying the percentage of injuries in the sample that were due to trauma, to the total population.

This number was then simply multiplied by the unit cost of each pathological category. This process was repeated for each category of pathology. Then the totals for each category of pathology were added, giving the overall cost of trauma for the period in question.

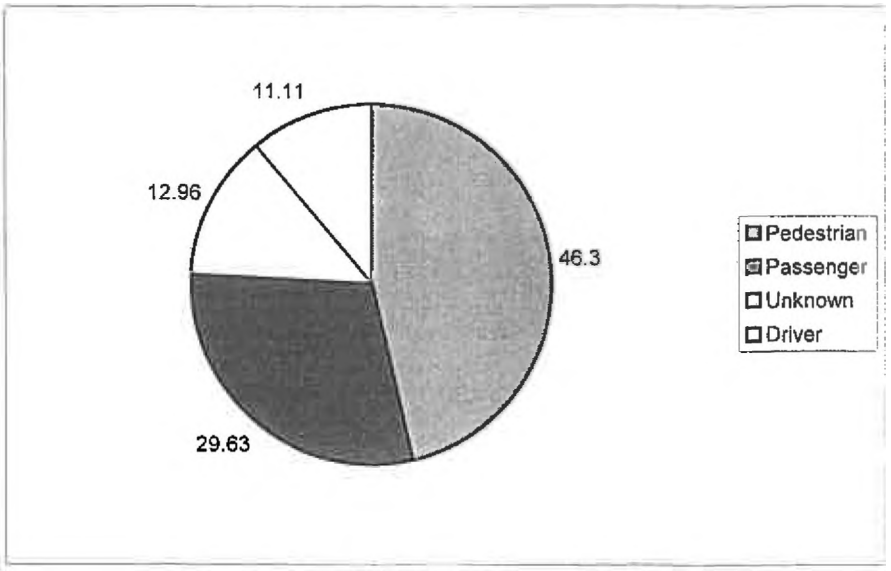
RESULTS

5.1 Phase one: epidemiological study

Assaults, gunshots and motor vehicle accidents accounted for 62.91% of all orthopaedic operations performed at Addington hospital during 2000.

Motor vehicle accidents (MVA's) were responsible for 35.76% of all orthopaedic operations for which the cause of injury was known during that year (see Appendix 30: Trauma as a cause for admission). Within this category of trauma, the person most commonly injured in a MVA was the pedestrian, accounting for almost 50% (46.30%) of all MVA injuries, and 26.32% of all injuries due to trauma (see Figure 5.1). The person next most commonly injured in a MVA was the passenger, accounting for 29.63% of all MVA injuries and 16.84% of all injuries due to trauma. Drivers were relatively infrequently admitted for surgery, accounting for only 11.11% of all MVA injuries and 6.32% of all injuries due to trauma. Where the role of the patient in the MVA (that is, pedestrian, passenger or driver) was not specified, this was coded simply as MVA. This category accounts for 12.96% of all injuries due to MVA, and 7.37% of all injuries due to trauma. Motor vehicle accidents as a whole accounted for more operations than assaults and gunshots combined.

Figure 5.1 Persons injured in MVA's.



The next most common cause of trauma in 2000 was gunshots, accounting for 14.56% of all orthopaedic surgery performed during that year, and 23.16% of all injuries due to trauma. Slightly less common than gunshot injuries were those due to assault, which necessitated 12.59% of all orthopaedic operations done in 2000, and 20.00% of all injuries due to trauma.

"Other"[g] causes constituted only 3.97% of all orthopaedic surgery performed in 2000 and tumours only 2.00%. Rheumatoid and osteo-arthritis, which did contribute to the total orthopaedic operations done between 1995 and 1999, were not represented in the year 2000.

[g] Reasons for orthopaedic surgery encapsulated in the category "other" included club feet, Dupuytren's contracture, carpal tunnel syndrome, recurrent dislocations, removal of ganglia et cetera.

For trauma involving intentional interpersonal violence (that is for gunshots and assaults), the number of men far exceeded the number of women (see Appendix 31: Trends of cause of injury vs. gender). Thirteen out of the 17 in the sample (76.47%) who had surgery as a result of assault were men, as were 21 out of the 23 (91.30%) who had surgery as a result of gunshots. Even for motor vehicle accidents, the proportion of men outweighed that of women, with 39 of the 53 (73.58%) patients in the sample being men. This gender discrepancy was most marked for drivers of vehicles involved in accidents, with no women drivers being admitted for orthopaedic surgery, not only for the year 2000, but also from 1995 to 1999!

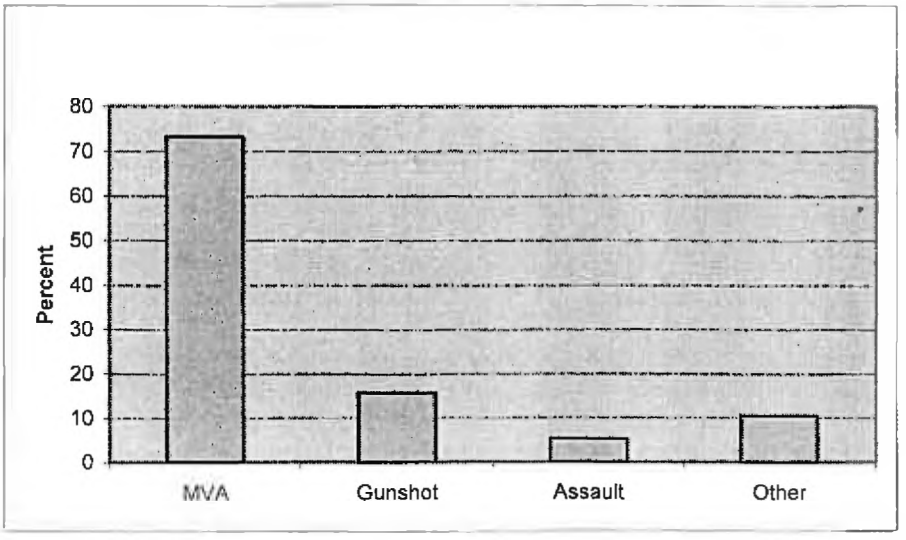
Again for trauma involving intentional interpersonal violence, the vast majority of victims in the sample were black (see Appendix 32: Trends of cause of injury vs. race). Of the 19 people who had surgery for assault, 14 (73.68%) were black. Of the 23 who had surgery for gunshot wounds, 18 (78.26%) were black. This pattern is similar for pedestrians injured in MVA's, where 19 out of 25 (76.00%) were black. However, for other types of injury due to MVA's, the racial pattern is different. Of the six drivers in the sample admitted for orthopaedic surgery, four (66.67%) were Asian. Of the 16 passengers admitted for surgery, eight (50.00%) were black and six (37.50%) were Asian. Whites and coloureds accounted for the smallest proportion of all three categories (assaults, gunshots and motor vehicle accidents), accounting for only 13.54% of the total operations done as a result of motor vehicle accidents in 2000.

In 2000, the only orthopaedic surgical procedure performed on a child less than 9 years of age was for the reason "other".[h] In the 10-19 year age group, trauma accounted for

[h] Reasons for orthopaedic surgery encapsulated in the category "other" included club feet, Dupuytren's contracture, carpal tunnel syndrome, recurrent dislocations, removal of ganglia et cetera.

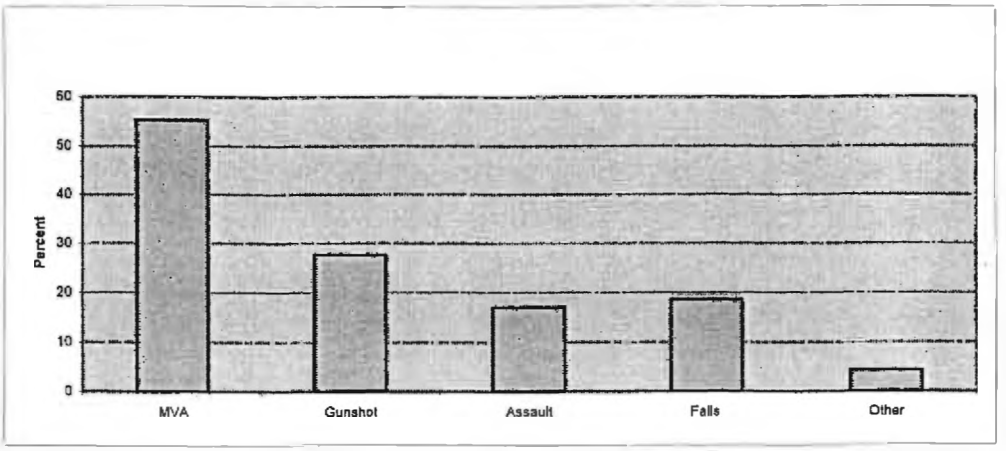
78.95% of surgical procedures, the bulk of these (73.33%) being due to motor vehicle accidents, which were equally distributed between pedestrian and passenger injuries (see Appendix 28: Cause of injury in each age group in 2000). Assault accounted for 5.26% and gunshots for 15.79% of all orthopaedic operations done in this age group. "Other" causes accounted for only 10.53% of all operations, and tumours did not feature as a cause in this age group (see Figure 5.2).

Figure 5.2 Reasons for surgery: 10-19 years.



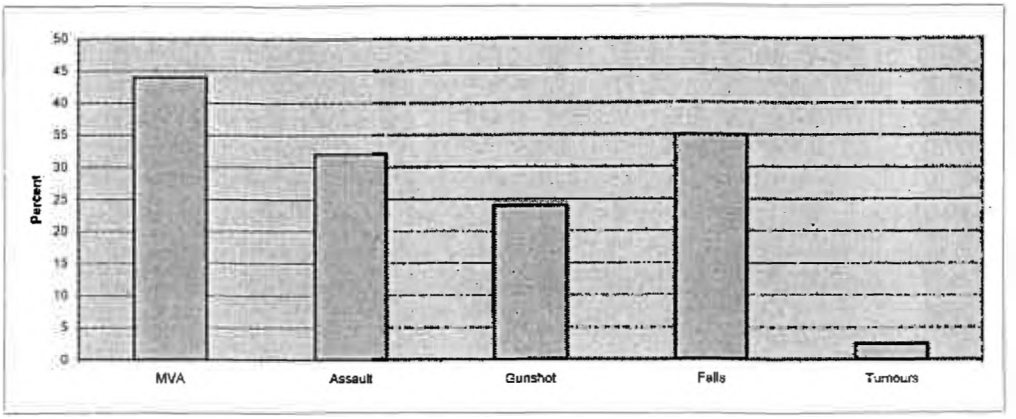
In the 20-35 year age group, assaults, gunshots and motor vehicle accidents remained the predominant cause of surgery, accounting for 75.71% of all operations. Of the operations resulting from trauma, motor vehicle accidents again accounted for the majority (55.32%), followed by gunshots (27.66%) and assault (17.02%). Falls accounted for 18.57% of all operations done in this age group in 2000. "Other" causes accounted for only 4.29%, whilst tumours accounted for 1.43% of the operations performed (see Figure 5.3).

Figure 5.3 Reasons for surgery: 20-35 years.



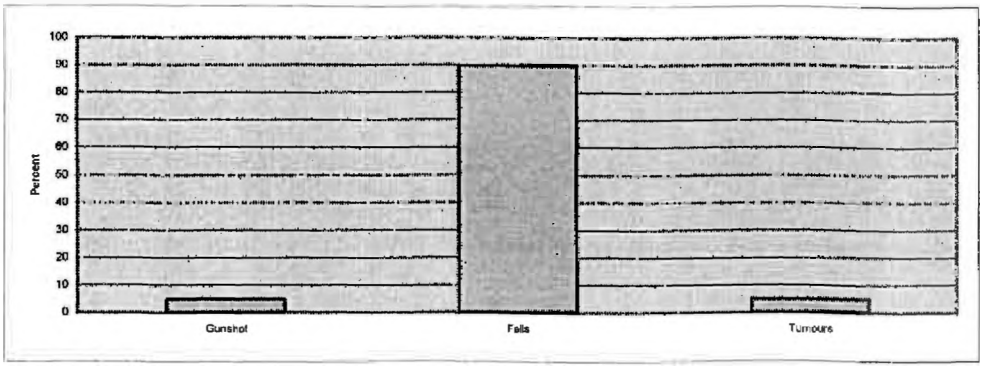
Assaults, gunshots and motor vehicle accidents were again an important cause of injury among the 36-60 year age group, although less so than in younger groups, accounting for 62.50% of all orthopaedic operations performed during 2000. Forty four percent of trauma operations were due to motor vehicle accidents, whilst 32.00% were due to assault and 24.00% to gunshots. Falls accounted for an increased proportion of all orthopaedic surgery in this age group, accounting for 35.00% of all operations performed in this year. "Other" causes didn't feature in this age group, but tumours were responsible for 2.5% of all orthopaedic surgery performed (see Figure 5.4).

Figure 5.4 Reasons for surgery: 35-60 years.



People older than 60 years were far less likely to be injured as a result of assaults, gunshots and motor vehicle accidents than their younger counterparts. In this age group, trauma accounted for only 5% of all orthopaedic surgery performed, and was solely due to gunshots. Ninety percent of all operations done in this age group were due to falls, with the other 5% being accounted for by tumours (see Figure 5.5). As in another study, this study showed that age has a powerful effect on the likelihood of sustaining a fracture – men below the age of 60 are much more likely to break a bone than women are, but over the age of 60 this risk is reversed (Singer *et al* 1998).

Figure 5.5 Reasons for surgery: over 60 years.



5.2 Phase two: costing study

5.2.1 Bottom up method

The total cost of assaults, gunshots and motor vehicle accidents to the orthopaedic ward for the year 2000 was found to be R5 440 964.20, using the bottom up method.

As can be seen from Table 5.1, fractured femurs accounted for the large majority of hospital costs due to trauma. This was less because the unit costs for fractured femur were the highest in this study (see Table 5.2) than because they constituted by far the largest number of injuries as a result of trauma admitted to the orthopaedic ward in 2000 (see Appendix 29: Percentage of admissions caused by trauma per year).

Table 5.1 Percentage of total costs due to trauma constituted by each category of injury.

Site of injury	% of total bottom up costs due to trauma
Ankle	5.86
Elbow	2.57
Femur	63.62
Foot (including toes)	3.69
Hand (including fingers and thumb)	1.71
Humerus	8.45
Radius/ulna	8.81
Tibia/fibula	5.30

Note: costs for 2001/2002 financial year used

Table 5.2 shows the unit costs of each category of injury, as well as the total costs of these injuries due to trauma, using the bottom up method.

Table 5.2 Costs of hospital treatment of each pathological category of injury due to trauma in 2000, bottom up method (in ZAR).

Site of injury	Unit costs (including internal fixation)♣	Total costs due to trauma
Ankle	10 803.79	324 113.70
Elbow	4 553.48	109 283.52
Femur	12 637.25 (average cost)	3 197 224.30
Foot (including toes)	8 167.91	196 029.84
Hand (including fingers and thumb)	3 925.78	942 18.72
Humerus	11 869.38	569 730.24
Radius/ulna	6 799.06	530 326.68
Tibia/fibula	11 667.70	420 037.20
Average unit cost	8 803.04	Total cost 5 440 964.20

Note: costs for 2001/2002 financial year used

5.2.2 Top down method

The total cost of trauma to the hospital, calculated using the top down method, was R5 847 882.20.

The costs for each pathological category are outlined in Table 5.3.

Table 5.3 Unit costs for each pathological category, using top down costing method.

Site of injury	Average number of days in ward	Unit costs*
Ankle	21	13 253.31
Elbow	7	4 417.77
Femur	21	13 253.31
Foot (including toes)	21	13 253.31
Hand (including fingers and thumb)	7	4 417.77
Humerus	21	13 253.31
Radius/ulna	7	4 417.77
Tibia/fibula	21	13 253.31

* Calculated on basis of Patient Day Equivalent costing R631.11 per day, as per eThekwini District: Summary of Situational Analysis. Durban 2001.
Note: costs for 2001/2002 financial year used

5.2.3 Costing using tariff charges

Using the tariff charges to cost trauma was a fairly simple exercise, with the costs of a patient's care broken down into Anaesthetics, Imaging, Inpatient, Pharmaceutical, Supplementary Health Treatment (Allied Health Practitioner) and Theatre Procedures. All these costs (except for Anaesthetics) were broken down into professional and facility costs, which were dependent on the status of the health professional (specialist or generalist) and the level of the health facility (level 1,2 or 3) respectively. The allocation of costs in each category was determined by the diagnosis of the patient's health problem. This posed a problem in this study, as for some categories of injury, the diagnosis was fairly simplistic and not comparable with the more complex diagnoses tabled in the UPFS

codebook. Thus only the fractures, where the diagnosis is straightforward, could be costed using this method (see Appendix 33: Tariff costs).

Except for fractured femurs, this costing was performed manually, using the UPFS Code Book. In reality, these costs are entered into a computerised billing system at Addington, and the total costs are calculated on the computer.

The unit costs for various categories of injury, calculated using tariff charges, are listed in Table 5.4.

Table 5.4 Unit costs for various injury categories for the year 2000, using tariff charges.

Site of injury	Unit costs
Ankle	18 002.00
Femur	20 086.00
Humerus	18 182.00
Radius/ulna	8 963.00
Tibia/fibula	18 679.00

Note: costs for 2001/2002 financial year used

5.2.4 Comparison of costing methods

Finally, the unit costs for each pathological category of injury, and the total costs due to trauma, were compared for each costing method. These are shown in Table 5.5 and Table 5.6, respectively.

Table 5.5 Unit costs for various categories of injury using all costing methods.

Site of injury	Bottom up method (including internal fixation)♣	Top down method*	Tariff method
Ankle	10 803.79	13 253.31	18 002.00
Elbow	4 553.48	4 417.77	
Femur	12 637.25 (average cost)	13 253.31	20 086.00
Foot (including toes)	8 167.91	13 253.31	
Hand (including fingers and thumb)	3 925.78	4 417.77	
Humerus	11 869.38	13 253.31	18 182.00
Radius/ulna	6 799.06	4 417.77	8 963.00
Tibia/fibula	11 667.70	13 253.31	18 679.00

♣ Only unit costs including internal fixation are shown. These are higher than those excluding internal fixation.

* Calculated on basis of Patient Day Equivalent costing R631.11 per day.

Note: costs for 2001/2002 financial year used

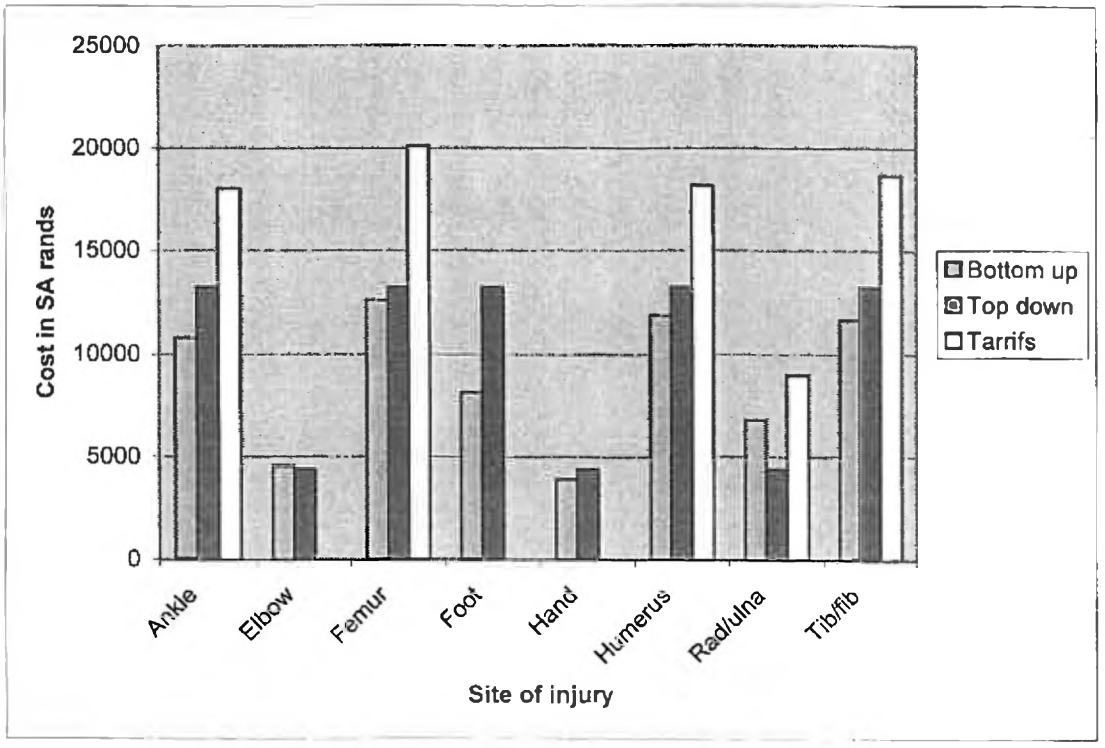
Table 5.6 Total costs for injuries due to trauma in each pathological category, 2000.

Site of injury	Number due to trauma	Bottom up method	Top down method	Tariff method
Ankle	30	324 113.70	397 599.30	540 060.00
Elbow	24	109 283.52	160 626.48	
Femur	253	3 197 224.30	3 353 087.40	5 081 758.00
Foot (including toes)	24	196 029.84	318 079.44	
Hand (including fingers and thumb)	24	94 218.72	160 626.48	
Humerus	48	569 730.24	636 158.88	872 736.00
Radius/ulna	78	530 326.68	344 586.06	699 114.00
Tibia/fibula	36	420 037.20	477 119.16	672 444.00

Note: costs for 2001/2002 financial year used

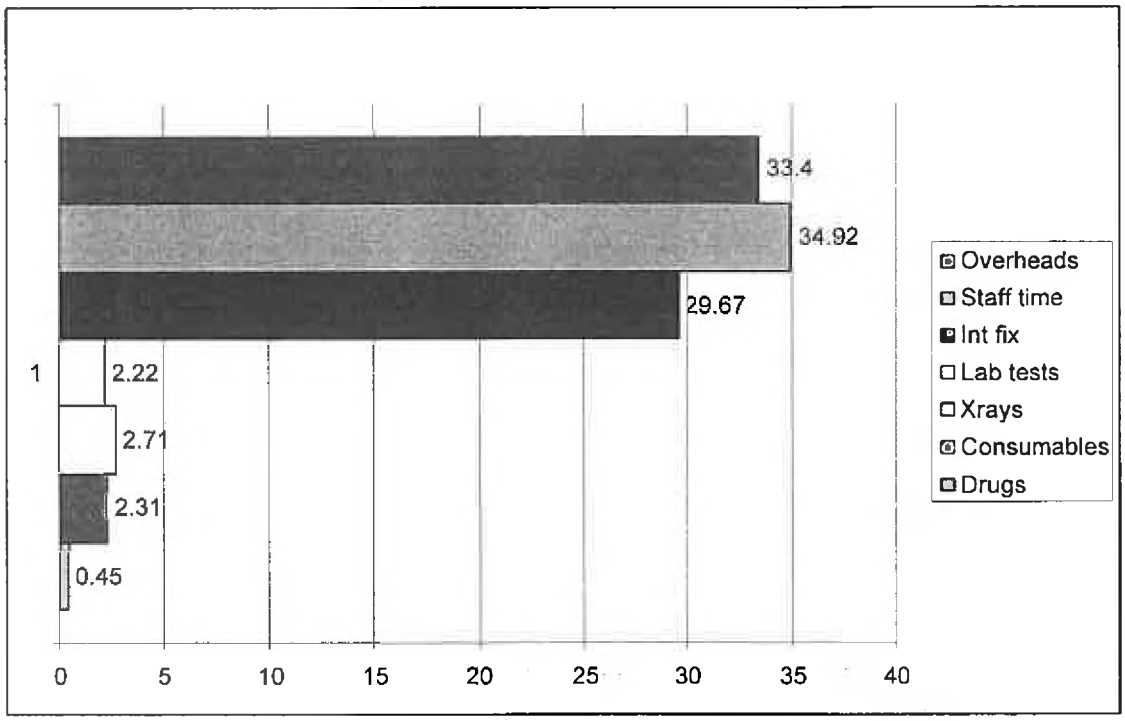
The relationship between the unit costs as calculated by the three methods is illustrated graphically in Figure 5.6.

Figure 5.6 Unit costs using various methods.



The components of the unit costs using the bottom up methods were different from those anticipated (Folb 1990) and were slightly different for upper and lower limb injuries (see Discussion section). The components of the unit cost for a fractured femur are illustrated in Figure 5.7.

Figure 5.7 Components of bottom up unit cost (fractured femur).



DISCUSSION

6.1 Phase one: epidemiological study

6.1.1 Trauma epidemiology

The pattern of trauma uncovered by the analysis of patients undergoing orthopaedic surgery during 2000 reflected in many ways that of other parts of South Africa (Peden & Butchart 1999). In a microcosm, it confirmed that trauma is indeed a "malignant epidemic"[i] in this country (Muckart 1991).

Trauma, (defined as motor vehicle accidents, assault and gunshots for the purposes of this study) accounted for almost 63% of all orthopaedic operations done at Addington during the year 2000. Any health problem which so dominates a health institution demands intense and urgent enquiry and action. The fact that the response to the modern epidemic of trauma has been disproportionately small (Baker 1987) means that the tragedy of avoidable deaths and disability is likely to continue, and even to increase in the future (Murray & Lopez 1997).

The proportion of surgical procedures necessitated by trauma found by this study mirrors those found elsewhere in Durban. In 1988, 60% of emergency admissions to the general surgical ward at King Edward VIII hospital in Durban were trauma-related (Muckart 1991). In 1992, 66% of all admissions to the ICU, and 14.4% of all hospital admissions at the same hospital were due to gunshot injuries (Muckart *et al* 1995). Although the definition of trauma and the populations from which samples are drawn differ from study to study, comparisons can be made between them. For example, in analysing the non-

[i] This term is defined in Muckart's article as "a widely diffuse and rapidly spreading condition affecting many people in any one region at the same time and tending to become progressively worse and to result in death"

natural causes of death at certain South African mortuaries, the national Non-natural Mortality Surveillance System has found that 72.8% of all deaths from non-natural causes resulted from homicide or motor vehicle accidents (Butchart 2000). This is comparable to this study's definition of trauma as including gunshots, assault and motor vehicle accidents, and the proportion found by the NMSS to be caused by trauma is probably only higher because the population from which the sample is drawn is that of non-natural deaths (as opposed to all surgical procedures, which includes a number of operations for benign conditions).

In this study, motor vehicle accidents were the cause of the majority (56.84%) of operations conducted among trauma patients. This preponderance of motor vehicle accidents as a cause of trauma is not reflected in the Non-natural Mortality Surveillance System, where it was found that, of non-natural deaths nationally, 45% were due to homicide and 27.8% to motor vehicle accidents. This may be because victims of motor vehicle accidents are less likely to die than victims of homicide (who, by definition, always die). For example, in a study of trauma at King Edward VIII hospital in Durban, 66% of patients who sustained gunshot wounds to the torso died before receiving hospital attention (Muckart *et al* 1995). This is in contrast to only 2.1% of pedestrians involved in motor vehicle accidents dying before admission to a hospital ward (Sukhai *et al* 2000). Therefore an analysis of non-natural deaths would show a relatively higher proportion of homicides than motor vehicle accidents. The preponderance of motor vehicle accidents as a cause of trauma is understandable for other reasons also. Many more people in South Africa use roads, in whatever capacity (whether pedestrian, passenger or driver), than have access to firearms. Also, most motor vehicle accidents are unintentional and

therefore far more likely to occur than gunshots or assaults, which require a deliberate intention (whether premeditated or otherwise) to do harm.

Pedestrians were found to be the most commonly injured in motor vehicle accidents in this study, comprising 46.30% of all these injuries. This fact is eminently understandable since pedestrians do not have the mechanical protection of a vehicle and thus are physically exposed and vulnerable. Passengers were the next most likely to be injured, accounting for 29.63% of all motor vehicle accident injuries. Drivers only comprised 11.11%. This pattern is reflected in the findings of the Non-Natural Mortality Surveillance System (NMSS), where 41.9% of people who died in traffic accidents were pedestrians, 14.6% were passengers and 13.1% were drivers. The discrepancies are again perhaps due to the fact that NMSS only collects information on people who have died in accidents, whereas this study looked only at people who reached hospital alive and survived to have surgery for their injuries. In addition, both this study and the NMSS are constrained by paucity of data – the traffic-user category was not specified in 12.96% of MVA injuries in this study and almost a third of MVA injuries of the NMSS. This large pool of unspecified data may well contribute to the discrepancies between this study and the NMSS.

Just over 73% of all injuries due to motor vehicle accidents were sustained by men. Approximately 70% of pedestrians, 68.75% of passengers and 100% of drivers in this study were men. This is comparable with figures from the NMSS, which were 72.5%, 63.9% and 86.7% respectively. It has been shown that men are more likely to take risks and demonstrate aggressive behaviour than women, which would account for their predominance in this category of trauma victims (Turner & McClure 2003).

The predominance of men in the other categories is harder to explain. It is perhaps partly due to the fact that men are more likely to use alcohol and other drugs, than women are (Carlini-Marlatt *et al* 2003), and use of alcohol and other illicit substances has been strongly linked to experience of trauma (*ibid* and Sukhai *et al* 2000). Although this explanation is convincing for pedestrian victims of motor vehicle accidents, it is less so for passengers. A third explanation may be that women spend more time at home than men do, since they are still traditionally homemakers, and carers of children and the elderly. This decreases their risk of being involved in a motor vehicle accident.

Of all those injured as a result of motor vehicle accidents in 2000, 20.37% were between the ages of 10 and 19 years. This corresponds well with the NMSS figure of 20.1% of pedestrians and 18.0% of passengers fatally injured in car accidents being less than 20 years old. Almost 60% (59.25) of those injured in MVA's in this study were between 21 and 35 years, and another 20.37% were between 36 and 60 years. These figures make reflect the current reality that the people most frequently using the roads are those who are most active outside the home. However, the percentage of children and adolescents injured and killed in motor vehicle accidents is disturbingly large, and more tragic that this avoidable loss of life should occur in people so young.

Most pedestrians (76.00%) identified as injured in MVA's in the year 2000 were black. This is explainable by the fact that black people constitute the majority of the South African population (Statistics South Africa 2001). An additional explanation is that, since black people are still more likely than those in other race groups to have incomes below the minimum living level of R900 per month (Hirschowitz & Orkin 1995) they are less

likely to own their own cars, and by necessity have to walk to their destinations more often.

Just over 66% of drivers injured in MVA's were Asian, about 16% were black and the same percentage white or coloured. Asians are perhaps more likely to earn enough to own their own cars than people in the black population, but less likely to earn enough to use private health care facilities than members of the white population (*ibid*). The low percentage of white or coloured drivers admitted for surgery at Addington can perhaps be explained by the more frequent use of private health care facilities by whites, who generally have higher incomes than other population groups and can therefore afford private care (*ibid*).

A high proportion of all orthopaedic operations in 2000 were the result of interpersonal violence – either gunshots (14.56%) or assault (12.59%). The figure for gunshots is almost identical to that found in an inner city trauma center in the United States (Brown *et al* 1997). Of all trauma-related injuries in 2000, gunshots made up 23.16% and assault 20.00%. The NMSS confirmed the finding that guns are more frequently used as a weapon in Durban, than are other instruments used for assault (Butchart *et al* 2001). This surveillance system has, in addition, found that sharp instruments are more commonly used for assault in Durban than are blunt instruments, but this study did not investigate this aspect of assault.

Men were far more likely to be shot than women were. The strong association between gender and cause of death was confirmed by Bradshaw *et al* (2002), who, in an analysis of non-natural deaths for 1996, found that the major cause of injury death for men was

homicide, whilst for women it was unintentional injuries. This study found that 91.30% of all gunshot injuries in 2000 were sustained by men. This percentage is comparable with figures from Cape Town (Peden M & van der Spuy J, 1998), nationally (Butchart *et al* 2001), and in certain countries around the world ((Brown *et al* 1997; Porteous *et al* 1997; Yinusa & Ogirima 2000). The figures are similar for assault, with 76.47% of all injuries due to assault being sustained by men. This is probably because men are more likely than women to engage in physical violence (Cunningham *et al* 2003), and are also more likely to abuse substances such as alcohol which is associated with an increased propensity for violence (*ibid* and Carlini-Marlatt *et al* 2003). The reasons for this are complex and difficult to address. Perhaps the most meaningful and most effective intervention for South Africa at the moment would be to establish strict gun control laws in this country, and to enforce them absolutely. Although gun control would not decrease the number of injuries due to assault, the latter do not carry the same fatality rates as do gunshot wounds (Muckart *et al* 1995) and therefore the need for intervention is not as urgent.

The large majority of people injured as a result of interpersonal violence were black, with 78.26% of gunshot victims and 73.68% of victims of assault being black. Although blacks did constitute a large percentage of the total patient population in the year 2000, this was not quite a majority (49.45%), and therefore the percentage injured by interpersonal violence is still disproportionately large. The above figures are also evident in the United States (Brown *et al* 1997) and the reasons for them are complex. Again, stricter gun control laws and better enforcement of these is probably the most effective remedy for the unnecessary suffering and loss of life in the short term.

Most victims of interpersonal violence were below the age of 60, with 21.05%, 30.00% and 35.00% occurring in the age groups 10-19, 20-35 and 36-60 years respectively. It is reassuring to note that there were no injuries due to interpersonal violence under the age of 9 years. The fact that young adults are more likely to be violent is well known and has been documented elsewhere in the literature (Peden & Butchart 1999) Although creating jobs and improving prospects for young people may be the solution to curtailing this epidemic in the long term, in the short term it is again only strict enforcement of gun control laws that will limit the damage done to young lives by the increasing use of guns in this country.

6.2 Phase two: costing study

6.2.1 Total cost of trauma to orthopaedic ward

The total cost of trauma to the orthopaedic ward for the year 2000, using the bottom up method which is generally thought to be superior (Drummond *et al* 1997) was calculated to be R5 440 964.20. This was more than the total annual expenditure of the hospital on maintenance (R4 792 879.00 in the 2001/2002 financial year) and far exceeded that spent on administration (R2 343 799.00) and equipment (R1 682 024) for the same year. It constituted almost 2% (1.96%) percent of total hospital expenditure, using 2001/2002 expenditure data. Taking into account that this was only for one discipline within the hospital, and excluded ICU, outpatient and trauma unit costs, the impact of trauma on this hospital's budget was significant.

6.2.2 Components of total cost of trauma

Of this total of R5 440 964.20, 63.62% was a result of fractured femurs. In this study, as in another (Hou *et al* 2002), the most common site of fractures was the lower extremities. The unit cost of a fractured femur, calculated using the bottom up method, was R12 637.25 (average cost including internal fixation) and R9 608.34 (excluding internal fixation). The cost including internal fixation was used for comparisons since 96.71% of all fractured femurs in the study required some form of internal fixation.

6.2.2.1 *Components of unit costs of fractured femur*

The internal fixation was, in fact, one of the most expensive items in the treatment of a fractured femur, constituting 29.67% of the unit cost (calculated using pin and plate, the most common form of internal fixation). Although this was a significant proportion, the total costs of care of patients with fractured femurs has probably not increased due to the introduction of the various forms of internal fixation. This is because internal fixation results in far more rapid stabilisation of the fracture, and much earlier mobilisation (personal communication: consultant orthopaedic surgeon and head of the orthopaedic ward at Addington Hospital). This in turn results in a far shorter duration of hospital stay, which reduces costs.

The most important contributor to the cost of hospital treatment of any orthopaedic problem, including a fractured femur, was the cost of staff time. This constituted 34.92% of the unit cost. This was lower than the 60% cited in other studies (Folb 1990) but a probable cause of this was the exclusion of persal (personal salary) costs when calculating the overhead costs for running the orthopaedic ward for a day. These costs were excluded because the costs of staff time for various categories of staff (mainly health professionals)

had already been added to the bottom up costing, and it was feared that some staff costs might inadvertently be duplicated. If so, the error may not have been recognized, leading to a biased and inflated estimation of costs of staff time. By excluding persal costs, at least there is conscious acknowledgement that these costs are lower than they should be.

Laboratory tests accounted for a negligible 2.22% of overall costs for the treatment of a fractured femur, and drugs (including anaesthetic drugs) an even lower 0.46% (see Appendix 9: bottom up costs fractured femur). These traditionally important costs of hospital care may have been low in this case because patients who present with orthopaedic trauma are generally young and healthy, and do not require intensive investigative tests or expensive long term drug treatment (personal communication: Head of the orthopaedic ward and consultant orthopaedic surgeon at Addington). A similar exercise conducted in a medical ward would probably have revealed very different results. Also, the cost of a spinal anaesthetic, which has been performed for most patients requiring surgery to the lower limb since the early 1990's (personal communication: Consultant anaesthetist at Addington Hospital) is much less than that of a general anaesthetic, which is done for all patients requiring upper limb surgery (R9.98 vs. R83.35). For this reason, the percentage of treatment for upper limb fractures (using the same duration of hospital stay) made up by drugs was double that for lower limb surgery – 1.12% (see Appendix 21: bottom up costing fractured humerus). A third reason for the low proportion of total cost made up by drug treatment is that the prices used to calculate laboratory and drug costs were those paid by the government, which are significantly lower than the market costs that are used in economic costings. Market costs represent the broad economic cost, rather than the financial cost to the institution.

The cost of ward and theatre consumables for a fractured femur was also low, constituting only 2.31% of the unit cost. If consumables used for x rays are added, this amounted to 2.76% (see Appendix 9: Bottom up costing femur). Including drugs and laboratory tests, this still resulted in a far lower percentage than that mentioned by Folb (1990). Considering that drugs make up the majority of consumable costs, the low costs of drugs in this study was probably the reason for the resultant low proportion of consumable costs.

The remainder of the costs for the hospital treatment was overhead costs, constituting 33.40% of the unit cost. Overhead costs included administration, equipment, contract services, communications, electricity and water and maintenance (see Appendix 25: Overhead costs). The weight given to overhead costs in this bottom up study was much lower than that using the tariff charges, where facility costs form a high proportion of most cost components (for example total facility costs for hospital treatment of fractured femur constitute 77.89% of the unit cost) (see Appendix 33: Tariff costs).

For injuries which required shorter durations of hospital stay, the percentage of overall costs made up by staff time, drugs, laboratory tests and other consumables were higher. For example, for fractured radius/ulna, these were 37.39%, 1.81%, 4.13%, and 3.00% respectively (see Appendix 22: bottom up costing radius/ulna). These still fall short of those anticipated however, for the reasons outlined above.

6.3 Top down method

The unit cost for a fractured femur calculated by the top down method (R13 253.31) closely approximated that using the bottom up method (R12 637.25). For the other injuries, it was generally found that the two methods produced fairly similar costs, between 81-103% of one another, which is a fair estimate and means that the top down method could reasonably be used by management if the level of error is considered. However, two categories of injury extended this range to 61% to 154%, with an average of 95.92% (see Table 6.1). These were the foot (where the top down method overestimated the bottom up costs by 62.26%) and the radius/ulna (where the top down method underestimated the bottom up costs by 35.02%).

Table 6.1. Relationship between unit costs of bottom up, top down and tariff costing methods.

Site of injury	% of tariff unit costs estimated by bottom up method	% of top down unit costs estimated by bottom up method
Ankle	60.01	81.52
Elbow		103.07
Femur	62.92	95.35
Foot		61.63
Hand		88.86
Humerus	65.28	89.56
Radius/ulna	75.86	153.90
Tibia/fibula	62.46	88.04

The reasons for these are difficult to isolate, since treatment for the two categories of injury are not systematically different in any significant way from injuries where the costs of the two methods approximated each other more closely. For example, there was no pattern where the length of hospital stay or cost of internal fixation affected the relationship between the costs in any direction. It is perhaps only due to chance that the costs of these injuries deviated so much for the two methods. Certainly comparing the bottom up costing to that using the tariff charges, the costs for the treatment of a fractured radius/ulna followed a similar relationship to the other costs (see below). (The costs of treatment of foot injuries were not calculated using the tariffs as the diagnostic categories used in this study were not always comparable to those used in the UPFS code book).

However, excluding these outliers, the top down method generally overestimated the bottom up unit costs by, on average, 4.76%. This was to be expected, since the bottom up method did not include the costs of ICU, outpatient or trauma unit treatment, all of which were included in the calculation of the top down method. The scheduled maintenance and replacement of buildings was excluded in both this method and the bottom up method, which would have bought the estimates closer, although the bottom up method did include the maintenance of equipment, which was excluded by the top down method. The inclusion of the costs of internal fixation (for many categories of injury an important contributor to overall costs) in the bottom up method, compensated for the lack of ICU, outpatient and trauma unit costs and bought the estimates of the two methods closer together.

6.4 Tariff charges

There was a fairly constant relationship between the unit costs calculated using tariff charges and the bottom up method, with the bottom up method constituting on average 65.31% of tariff costs, and under-estimating the tariff costs by 24.14% - 39.99% (see Table 6.1). This was entirely anticipated, since the tariff costs are calculated on the basis of those set by the Board of Healthcare Funders, a private not-for-profit company in South Africa to which many medical aids belong and which, among other things, assists in setting the tariffs (charges) for all aspects of private health care (www.bhfglobal.com). In other words, using UPFS tariffs estimates the costs of care according to the prices set by the private health care sector, where the bottom up method estimates costs based on prices charged to the state. Just considering the salaries of health professionals, these differ widely between the private and the public sectors and would have a major impact on the discrepancies between the two methods.

The unit cost of treating a fractured femur calculated manually by the tariff method was R20 086.00. Using the bottom up method it was calculated to be R12 637.25, an underestimate of 37.08%. It was found that the injury necessitating the shortest duration of hospital stay (fractured radius/ulna) was responsible for the widest variation between these two methods, but that excluding this category does not result in a significant change in the average discrepancy between the two methods.

The difference between the two methods was expected (since one used government prices and the other prices charged in the private sector), but the fact that it was fairly consistent for all categories of injury for which diagnoses were comparable means that the

calculations of the two methods were reliable and accurate. It also means that the one can be used to calculate the other fairly easily, which may be useful to management.

The fact that tariff charges are significantly higher than the costs of treatment as calculated by the bottom up method means that there is potential for the recovery of costs for the treatment of trauma victims at Addington. This of course will depend on whether private patients are billed for their care, whether they pay their bills in full, and whether the numbers of private patients using the hospital increases.

LIMITATIONS OF STUDY

7.1 Both phases

1. The primary limitation of both phases of this study was the lack of data for the years 1995-1999, which would have been used to describe an epidemiological pattern of trauma for these years, and to cost trauma to the hospital over this time. The selection bias that could have arisen from this lack of data was, however, avoided by only using data from the year 2000.

2. Because the Ward books, in which all the admissions to the orthopaedic ward are recorded, were not available for patient sampling, Theatre books had to be used. Although these books contained all the information necessary to classify the patient as an orthopaedic patient, as well as to retrieve the patient's file for further information, they by definition included only patients who had been operated upon. Patients who were managed conservatively, that is, without surgical intervention, were excluded from the study. Although it has been shown that the majority of orthopaedic injuries require surgery (Peng & Bongard 1999), some important categories of injury may have been excluded. The most important of these is spinal injuries, which require intensive and long term treatment in the orthopaedic ward. This may have affected the epidemiological pattern of trauma and would have affected the costs due to trauma calculated by this study.

3. The restriction of this study to the orthopaedic ward would have resulted in the exclusion of a large number of patients admitted as a result of trauma to other wards in the hospital. Thus the total burden of trauma care borne by the hospital would have been underestimated. However, because only one person was involved in this study, it would not have been feasible to extend the study to other wards.

4. Because the severity of the injuries sustained due to trauma was not quantified, for example by using an injury severity scoring system (Peden 1998a,b), the epidemiology and costs of trauma could not be broken down into different categories of severity of injuries.

7.2 Phase one: epidemiological study

5. The amalgamation of the two categories "white" and "coloured" resulted in loss of detail in the analysis of race relating to trauma, and may have obscured important trends in the epidemiology of trauma affecting either of these two races.

6. The fact that children's files were less likely to be found than adults' files may have resulted in biased results regarding the epidemiology of trauma in children relative to adults.

7.3 Phase two: costing study

7. A limitation of the bottom up costing study was the absence of ICU costs. Using these would have created a more complete picture of the total costs of treatment for injuries due to trauma. However, due to the paucity of orthopaedic patients treated in ICU, and due to the additional workload that calculating these costs would have entailed, their exclusion was considered justified.

8. Similarly, the inclusion of outpatient and trauma unit costs would have provided a much more comprehensive picture of the total costs of treatment for each injury category. In addition, the relative costs of outpatient treatment for each category may have been very different from the inpatient costs – for example, an injury which required fairly intensive and expensive inpatient treatment may have required very little follow up treatment and vice versa. This would have affected

the overall cost of treatment of the injury and may well have changed the relationship between the costs of different injury categories. However, the inclusion of these costs was not possible given that one person was performing this study in a limited time period.

9. The fact that patients from only two injury categories were observed in detail, and the staff time charts for the other categories based on advice from ward staff and others, may have introduced errors in the calculation of staff time spent with each category of patient. However, since there was only one investigator in this study, it was not possible to observe more than two categories of patient. Also, since the ward staff were busy and since this study was external to their work and their own interests, it was not likely that they would have spent more time on documenting time spent with each category of patient.

10. The absence of certain categories of staff costs resulting from the exclusion of persal costs in the bottom up costing is thought to have reduced the unit costs, and therefore the total costs, calculated by this method. The costs per category of staff is not delineated in the total annual persal costs at Addington and duplication of costs would have been a distinct possibility were persal costs to have been included in the bottom up method. Therefore, it was thought preferable to consciously underestimate staff costs than to unconsciously duplicate and therefore overestimate costs,

11. The uniformity of drug, laboratory test and consumable costs for all diagnostic categories may have masked the differences in costs between the different categories of injury in the bottom up costing. However, because of the similarity of treatment of the traditionally healthy patients who experience trauma, and because of the small percentage of total costs comprised by these costs, their

uniformity is not considered to have affected the results of the study in a meaningful way.

12. The simplistic diagnostic categories used in the bottom up costing made comparison between this method and the tariff charges difficult, and the categories which could be compared were limited. More detailed diagnostic categories may have highlighted the complexity of treatment of different categories of injury, and the diversity of costs that they entailed, as well as facilitating comparison between the bottom up costing and tariff charge calculations.

13. Only single injuries were costed. A certain percentage of traumatised patients present with multiple injuries which are more expensive to treat. This focus on single injuries will have underestimated the total burden of trauma to the orthopaedic ward as well as the costs involved in the treatment of patients in the ward.

14. For the top down costing, a condition-specific PDE would have been more accurate than a hospital wide PDE, since these costs would have approximated more closely the true costs of orthopaedic injuries. The hospital-wide PDE would overestimate the real costs of a relatively inexpensive condition (likely to be the case in the study), and underestimate those of an expensive condition. However, the information necessary for a condition-specific PDE was not available and therefore the hospital-wide PDE had to be used.

CONCLUSIONS

This study found that the demography of trauma victims and the epidemiology of trauma is similar in Durban to other cities in South Africa, as well as those world wide where traffic and gun control laws, and adherance to these, do not keep these avenues for trauma in check. Trauma is an ever-present threat to society, because of the inherent capacity of humans to be negligent (and therefore cause motor vehicle accidents), or violent (and therefore to do intentional physical harm). Socio-economic upliftment, education and empowerment will do much to stem the epidemic of trauma in this country, but these are slow processes and may not ever materialise. It is therefore only through strict traffic and gun control laws, and effective enforcement of these, that we can hope to see a decrease in the incidence of trauma in this country, and the suffering that it causes.

The costs of trauma to the state, even when limited to public hospitals, are considerable. This study has confirmed the findings of others elsewhere in South Africa where the occurrence of trauma and the costs associated with this, are high. Even on the basis of prices paid by the state, which are generally lower than those of the private sector, trauma costs this country millions of rands a year (van der Spuy 1996). At one hospital alone, in one clinical discipline and looking only at ward treatment for one year, it cost R5 440 964.20. There are a myriad of worthwhile projects upon which this money could be spent in Durban, and its consumption by an avoidable health problem is indeed tragic.

The financial costing of trauma in South Africa's health sector is important, not only in order to quantify the financial impact of trauma on the health services, but also to facilitate planning and budgeting. The top down method, a relatively simple and practical

method, is sufficiently precise when compared with the gold standard bottom up method, to be used reliably as a management tool. There is potential for cost recovery by the public health sector by means of the billing of private patients who attend public hospitals. By encouraging private patients to attend public hospitals, this potential can be exploited.

RECOMMENDATIONS

Institutions dealing with victims of violence should receive additional funding in order to deal with the increased workload imposed by trauma. For example, Addington Hospital should request funding from the Department of Transport to cope with the additional patient load as a result of motor vehicle accidents.

The state should recognise the significance of trauma as a health problem and as a threat to the well-being of society. It should dedicate more funds to research into all aspects of this epidemic, with the intention of, in the short term, understanding it better and treating its victims more effectively, and in the long term, of curtailing it.

Addington Hospital should consider changing its status to that of a trauma center, since, in one and probably both of its surgical disciplines, it carries a disproportionate load of trauma patients. This may make the treatment of trauma patients from admission to discharge, more efficient.

Registrars in orthopaedic surgery who are limited in their learning experience at public hospitals due to the disproportionate percentage of traumatised patients they treat, should rotate through hospitals and institutions where trauma features low on the list of causes of admission. Partnerships for the training of these registrars, involving both private and public institutions, should be created to ensure a comprehensive and full learning environment for registrars.

Hospitals should implement efficient and useful health information systems, to enable optimal use of the wealth of data generated in these institutions. Where possible, these information systems should be computerised to allow for ease of access to and analysis of, data. This will not only facilitate academic research but enable management to be based on real and relevant information.

In view of the relative accuracy of the top down costing method when compared with the bottom up method, managers should use the top down method in order to calculate the financial burden imposed by certain categories of patient, in order to inform more detailed planning and budgeting.

A concerted effort should be made to attract private patients to public hospitals, so that the charges paid by these patients subsidise the treatment of indigent patients.

The socio-economic influences on trauma should be tackled urgently. Although these take years, even generations, to change, a concerted effort must be made to alter the factors that predispose to trauma in society. The most important of these, is poverty. The current discussions around economic assistance by the government to the poor (such as the Basic Income Grant) are a step in the right direction, but need to be followed by action which is considered and sustainable. Other factors which may help on the short term would be education, which should be free for all, and recreation facilities for inner city areas. In the longer term, jobs should be created on a massive scale. Although these socio-economic influences on trauma are extremely complex, time-consuming and difficult to address, a start must be made on them or there will be no lasting change in the pattern of trauma.

Gun control laws should be passed and implemented, which will reduce the fatalities due to interpersonal violence, if not the acts of interpersonal violence themselves.

Traffic laws should be more strictly enforced. Speed is the most important determinant of injury in a motor vehicle accident (Muckart 1991), and therefore the penalties imposed on speeding motorists should be severe enough to limit their propensity to speed again. Penalties such as removal of a driver's license for a certain period should be considered.

Further studies should look into the disturbingly large percentage of children and adolescents injured and killed in motor vehicle accidents with the aim of developing dedicated and targeted interventions to reduce this.

REFERENCES

Baker SP. Injuries: the neglected epidemic. J Trauma 1987; 27:343-48

Bradshaw D, Schneider M, Dorrington R, Bourne DE, Laubscher R. South African cause-of-death profile in transition – 1996 and future trends. S Afr Med J 2002 Aug;92(8):618-23.

Brown TD, Michas P, Williams RE, Dawson G, Whitecloud TS, Barrack RL. The impact of gunshot wounds on an orthopaedic surgical service in an urban trauma center. Journal of Orthopaedic Trauma 1997 Apr;11(3):149-53

Broomberg J, Price M. The impact of fee for service reimbursement system on the utilisation of health services: II. A review of the determinants of doctors' practice patterns. S Afr Med J 1990; 78. 130-2

Butchart A (Ed) (2000). A profile of fatal injuries in South Africa 1999: First Annual Report of the National Injury Surveillance System. Johannesburg: The Violence and Injury Surveillance Consortium, with Participating Forensic Pathologists and the State Forensic Chemistry Laboratories

Butchart A, Peden M, Matzopoulos R, Phillips R, Burrows S, Bhagwandin N, Saayman G, Cooper A and participating forensic pathologists. The South Africa Non-Natural Mortality Surveillance System – rationale, pilot results and evaluation. S Afr Med J 2001; 91:408-417

Carlini-Marlatt B, Gazal-Carvalbo C, Gouveia N, Souza Mde F. Drinking practices and other health-related behaviours among adolescents of Sao Paulo City, Brazil. Subst Use Misuse. 2003 Jun;38(7):905-32

Clarke E. The Impact of HIV on children's health services. In Update, issue 52. Health Systems Trust. Durban, May 2000

Creese A, Parker D. Cost Analysis in Primary Health Care. World Health Organisation, United Nations Children's Fund and the Aga Khan Foundation. Geneva, 1994

Cunningham R, Walton MA, Maio RF, Blow FC, Weber JE, Mirel L. Violence and substance use among an injured emergency department population. Acad Emergency Med. 2003 Jul;(10):764-75

De Beer C, Broomberg J. Financing health care for all – is national health insurance the first step? S Afr Med J 1990; 78. 125-9

De Wet B, van Schalkwyk D, van der Spuy J et al. Paraffin poisoning in childhood – is prevention affordable in South Africa? S Afr Med J 1994; 84. 735-8

Dickinson D, Rodriques A, Bass D. The cost of treating motor vehicle accident victims. CAPFSA conference. Cape Town. 1990

Doherty J, Thomas S, Muirhead D. National Health Accounts. Consolidated Public Sector Report to National Department of Health, 2002

Drummond MF, O'Brien BJ, Stoddart GL, Torrance GW. Cost analysis. In Methods for the Economic Evaluation of Health Care Programmes (second edition). Oxford University Press. Oxford 1997

Folb PI. A time to choose. S Afr Med J 1990 Aug 4; 78: 120

Friedman I. Poverty, human rights and health. In Crisp N, Ntuli A (Eds). The South African Health Review 1999. The Health Systems Trust. Durban, 1999

Green A. Costs and Costing. In: An Introduction to Health Planning in Developing Countries: 188-211. Oxford University Press 1997

Goudge J. The public-private mix. In Crisp N, Ntuli A (Eds). The South African Health Review 1999. The Health Systems Trust. Durban, 1999

Hall J, Mooney M. What every doctor should know about economics. The Medical Journal of Australia 1990 vol 152: 129-31

Herbst AJ. The cost of medical and rehabilitation care for Road Accident Victims at public hospitals. Report of the Road Accident Fund Commission, 2002, Volume 3. Ministry of Transport, Pretoria, 2002

Hirschowitz R, Orkin M. A National Household Survey of Health Inequalities in South Africa. The Henry J Kaiser Family Foundation. October 1995

Hou S, Zhang Y, Wu W. Study on characteristics of fractures from road traffic accidents in 306 cases. Chin J Traumatol 2002 Feb;5(1):52-4

International Road Federation. World Road Statistics. Washington DC. 1991

Kakarlpudi TK, Santini A, Shashane SA, Douglas D. The cost of treatment of distal radial fractures. Injury 2000 May;31(4):229-32

Kane-Berman J, Taylor S. Containing costs in public sector hospitals – a strategy for the future: Lessons from a large teaching hospital. S Afr Med J 1990; 78. 154-7

Lerer LB, Mazopoulos RG, Philips R. Violence and injury in the Cape Town metropole. S Afr Med J 1997; 87: 298-301

Lu F, Zeng G, Zhong T. Methodological studies on the evaluation of family burden due to injuries. Zhongua Liu Xing Bing Xue Za Zhi 2001 Aug; 22(4): 246-8

Matteuci RM, Holbrook TL, Hoyt DB et al. Trauma among Hispanic Children: A population-based study in Regionalised System of Trauma Care. Am J Public Health 1995;85:1005-8

McIntyre D, Dorrington R. Trends in the distribution of South African health care expenditure. S Afr Med J 1990; 78. 125-9

Muckart DJ. Trauma – the malignant epidemic. S Afr Med J 1991 Jan 19;79(2):93-95

Muckart DJ, Meumann C, Botha JBC. The changing pattern of penetrating torso trauma in KwaZulu-Natal – a clinical and pathological review. S Afr Med J 1995; 85:1172-74

Murray CLJ, Lopez AD. Alternative projections of mortality and disability by cause 1990 – 2020: Global Burden of Disease Study. Lancet 1997; 349: 1498 – 504

National Department of Health, South Africa. Proceedings of the First Essential National Health Research Congress on Priority Setting, Edelweiss Functions Centre, November 14-15, 1996. Pretoria: Department of Health, 1997

Peden M. Injury Severity Scoring Made Easy, Part 1. Trauma Review, April 1998a, 6(1)

Peden M. Injury Severity Scoring Made Easy, Part 2. Trauma Review, August 1998b, 6(2)

Peden M, Butchart A. Trauma and Injury. In Crisp N, Ntuli A (eds). South African Health Review 1999. Health Systems Trust. Durban 1999

Peden M, van der Spuy J. The cost of treating firearm victims. Trauma Review 1998. 6. 4-5

Peng RY, Bongard FS. Paedestrian versus motor vehicle accidents: an analysis of 5 000 patients. J Am Coll Surg 1999 Oct; 189(4):343-8

Porteous MJ, Edwards SA, Groom AF. Inner city gunshot wounds. Injury 1997 Jun-Jul;28(5-6):385-387

Qualls NL, Robertson RL. Potential uses of cost analysis in child survival programmes: evidence from Africa. Health Policy and Planning 1989;4(1):50-61

Quarmby C. Scald burns – is our treatment cost-effective? Trauma Review 1999. 7. 1-8

Singer BR, McLauchlan GJ, Robinson CM, Christie J. Epidemiology of fractures in 15 000 adults: the influence of age and gender. J Bone Joint Surg Br 1998 Mar;80(2):243-8

Soderlund N. An essential hospital package for South Africa – selection criteria, costs and affordability. S Afr Med J 1999 Jul;89(7)757-65

Statistics South Africa. 2000 Stats in brief. Pretoria 2001

Sukhai A, Harris C, Peden M. Sentinel Surveillance of Substance Abuse and Trauma at Addington Hospital 1999-2000. Final Report. A DACST Innovation Fund Project. CSIR, MRC and UNISA. August 2000

Thomas S, Muirhead D, Doherty J, Muheki C. Public Sector Financing. In Crisp N, Ntuli A, Clarke E, Barron P (Eds). South African Health Review 2000. Durban, Health Systems Trust, 2000:127-48

Thompson K, Antony A, Holtzman A. The costs of traumatic brain injury. N C Med J 2001 Nov-Dec;62(6):376-9

Turner C, McClure R. Age and gender differences in risk taking behaviours as an explanation for high incidence of motor vehicle crashes in young males. Inj Control Saf Promot. 2003 Sep;10 (3):123-30

UNAIDS. Report on the global HIV/AIDS epidemic. Geneva: UNAIDS; 2002. Report No.: UNAIDS/02.26E

UPFS National Project Team. Uniform Patient Fee Schedule for Externally Funded Patients attending Public Hospitals (UPFS) User Guide 2002, Code Fee Scale 2002, Code Book – Procedures 2002. National Department of Health. Pretoria, May 2002

Van der Spuy J. The economic impact of trauma. SA Bone and Joint Surgery 1996. 7:2

Weaver LD, Hansraj KK, Idusuyi OB, Akiyama C, Ribeiro JA, Fenison AT, Willoughby DA. Gunshot wound injuries. Frequency and cost analysis in south central Los Angeles. Orthopaedic Clinics of North America 1995 Jan;26(1):1-7

White Paper for the Transformation of the Health System in South Africa, section 2.4. Government Gazette No 17910; 16 April 1997: Notice 667 of 1997

World Health Organisation 1979: Expanded Programme in Immunisation: costing guidelines. EPI/GEN/79/5. Geneva: WHO

Yanchar NL. Cost of paediatric trauma. Can J Surg 2001 Dec;44(6):462

Yinusa W, Ogirima MO. Extremity gunshot injuries in civilian practice: the National Orthopaedic Hospital Igobi experience. West Afr J Med 2000 Oct-Dec;19(4):312-6

APPENDICES

APPENDIX 1. PROCESS OF CARE FOR TRAUMA VICTIM AT ADDINGTON HOSPITAL, FROM ENTRY TO EXIT[1]

1. The patient is bought to the trauma unit by ambulance or family/friend/concerned citizen.
2. The nursing staff assess the patient's condition, and prioritise his/her treatment according to severity. If necessary, they initiate lifesaving treatment.
3. The patient is seen by a doctor, and any necessary lifesaving emergency treatment initiated/continued.
4. Investigations (most commonly x rays or CT scans) are done if the patient's condition warrants this.
5. Based on the results of these investigations, the patient is referred to the relevant specialist registrar (usually orthopaedic or general surgical).
6. If emergency surgery is necessary, the patient is immediately taken to theatre.
7. If surgery can be delayed, the patient is taken to the ward.
8. Further investigations are done if necessary.
9. The patient is operated upon.
10. Depending on the severity of the patient's condition, s/he will be cared for in ICU until stable enough to be transferred to a general ward. Repeat surgery will be performed if necessary at any stage.
11. S/he recuperates in the ward, receiving any treatment that is necessary (usually drug treatment or physiotherapy).
12. When the patient is fit to leave the hospital (whether to resume his/her life or to recuperate further in another institution), s/he is discharged.

[1] This box aims to explain the treatment of trauma victims at Addington, to make sense of the costs that were included in this study.

13. The patient returns to the hospital at regular intervals as an outpatient, for follow up and treatment by the specialist consultant or registrar in the relevant clinical department. When this doctor is satisfied that the patient is well, s/he is discharged from the clinic.

APPENDIX 2. AGE OF PATIENTS PER YEAR OF ADMISSION

Age (years)	Year of admission												Total
	1995		1996		1997		1998		1999		2000		
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
0-9	5	3.52	8	3.45	9	6.44	19	6.44	34	9.50	30	9.01	105
10-19	13	9.15	30	12.93	27	8.39	41	13.90	36	10.06	50	15.02	197
20-35	37	26.06	60	25.86	109	33.85	90	30.51	119	33.24	122	36.64	537
36-60	46	32.39	71	30.60	108	33.54	82	27.80	105	29.33	84	25.23	496
61 +	41	28.87	63	21.43	69	21.43	63	21.36	64	17.88	47	14.11	347
Total	**142**		**232**		**322**		**295**		**358**		**333**		**1682**

% = percentage of total patients admitted in that year

APPENDIX 3. DATA ENTRY FORM

Patient number	Age	Race	Gender	Date of admission	Date of discharge	Diagnosis	Cause of injury	Drug treatment and duration	Laboratory tests	Theatre time	Length of stay in ICU

APPENDIX 4. OVERVIEW OF DATA COLLECTED

1995: 174 patients from theatre books
10 files found
= 5.75% of a sample of one in three

1996: 261 patients from theatre books
22 files found
= 8.43% of a sample of one in three

1997: 462 patients from theatre books
28 files found
= 6.06% of a sample of one in three

1998: 234 patients from theatre books
111 files found
= 47.00% of a sample of one in three

1999: 317 patients from theatre books
149 files found
= 47.00% of a sample of one in three

2000: 312 patients from theatre books
157 files found
= 50.00% of a sample of one in three

APPENDIX 5. EPIDEMIOLOGICAL COMPARISONS BETWEEN THOSE PATIENTS WHOSE FILES WERE FOUND AND THOSE WHOSE FILES WERE NOT FOUND

GENDER			
Files not found			
	1998	**1999**	**2000**
Female	89	103	58
Male	104	130	126
% female	46.11	44.21	31.52
Files found			
	1998	**1999**	**2000**
Female	41	37	48
Male	84	86	91
% female	32.8	30.08	34.53

Chi^2 test: 2.33 at 2 degrees of freedom, p = 0.31

RACE			
Files not found			
Race	**1998**	**1999**	**2000**
Asian	60	69	41
Black	66	94	98
Other	66	75	47
Total	192	238	186
% Asian	31.25	28.99	22.04
% Black	34.38	39.50	52.69
% Other	34.38	31.51	25.27
Files found			
Race	**1998**	**1999**	**2000**
Asian	23	20	42
Black	61	77	81
Other	20	27	28
Total	104	124	151
% Asian	22.12	16.13	27.81
% Black	58.65	62.10	53.64
% Other	19.23	21.77	18.54

Chi^2 tests for race:
1998: Chi^2 = 12.03 at 2 degrees of freedom (df), p = 0.0024
1999: Chi^2 = 10.92 at 2 df, p = 0.0042
2000: Chi^2 = 1.32 at 2 df, p = 0.516

AGE			
Files not found			
Age (years)	**1998**	**1999**	**2000**
0-9	15	32	29
10-19	22	25	31
20-35	50	61	52
36-60	52	68	44
60-100	52	50	27
Total	**191**	**236**	**183**
%0-9	7.85	13.56	15.85
%10-19	11.52	10.59	16.94
%20-35	26.18	25.85	28.42
%36-60	27.23	28.81	24.04
%60-100	27.23	21.19	14.75
Files found			
Age (years)	**1998**	**1999**	**2000**
0-9	4	2	1
10-19	19	11	19
20-35	40	58	70
36-60	30	35	40
60-100	11	14	20
Total	**104**	**120**	**150**
%0-9	3.85	1.67	0.67
%10-19	18.27	9.17	12.67
%20-35	38.46	48.33	46.67
%36-60	28.85	29.17	26.67
%60-100	10.58	11.67	13.33

Chi^2 tests for age:
1998: $Chi^2 = 11.59$ at 4 degrees of freedom (df), $p = 0.02$
1999: $Chi^2 = 18.85$ at 4 df, $p = 0.00008$
2000: $Chi^2 = 19.13$ at 4df, $p = 0.0007$

APPENDIX 6. THEATRE TIME – COMPARISON BETWEEN FILES FOUND AND FILES NOT FOUND

FILES NOT FOUND			
Theatre time (minutes)	**1998**	**1999**	**2000**
0-60	70	78	22
61-120	78	97	88
121-180	27	40	54
181-240	13	13	19
241-300	2	6	1
301-360	3	1	2
361-420	0	2	0
421-600	0	0	0
Total	**193**	**237**	**186**
%0-60	36.30	32.91	11.83
%61-120	40.41	40.93	47.31
%121-180	13.99	16.88	29.03
%181-240	6.74	5.49	10.22
%241-300	1.04	2.53	0.54
%301-360	1.55	0.42	1.08
%361-420	0	0.84	0
%421-600	0	0	0
FILES FOUND			
Theatre time (minutes)	**1998**	**1999**	**2000**
0-60	24	30	13
61-120	50	58	60
121-180	22	22	52
181-240	7	12	18
241-300	1	1	7
301-360	1	0	0
361-420	0	0	0
421-600	0	0	0
Total	**105**	**123**	**150**
%0-60	22.86	24.39	8.67
%61-120	47.62	47.15	40.00
%121-180	20.95	17.89	34.67
%181-240	6.67	9.76	12.00
%241-300	0.95	0.81	4.67
%301-360	0.95	0	0
%361-420	0	0	0
%421-600	0	0	0

1998:
Chi^2 test = 5.32 at 5 degrees of freedom
P = 0.3781

1999:
Chi^2 test = 4.85 at 5 degrees of freedom
P = 0.43397

2000:
Chi^2 test = 5.77 at 5 degrees of freedom
P = 0.32881

APPENDIX 7. TOTAL NUMBER OF CASES CAUSED BY TRAUMA, 2000

Site of injury	Total number caused by trauma	Percentage of total trauma cases
Ankle	30	5.49
Elbow	24	4.39
Femur	253	46.34
Foot	24	4.40
Hand	24	4.40
Hip and NOF*	12	2.20
Humerus	48	8.79
Knee	12	2.20
Radius/ulna	78	14.29
Shoulder	6	1.10
Tibia/fibula	36	6.59
Total	546	100.00

* NOF = neck of femur

APPENDIX 8. TIME FLOW CHART - STAFF TIME SPENT WITH REPRESENTATIVE PATIENT WITH FRACTURED FEMUR (MINUTES).

Staff	Day 1 Admission	Day 2	Day 3	Day 4-12 (9 days)	Day 13 (Theatre)	Day 14	Day 15 (Mobilisation)	Day 16	Day 17-20	Day 21 (Discharge)	Total time
Specialist Orthopaedic surgeon	Examination and ward round: 10	Examination and ward round: 7	Examination and ward round: 5	Examination and ward round: 2 that is, total 18	Surgery: 120	Examination and ward round: 5	Examination and ward round: 5	Examination and ward round: 2	Examination and ward round: 2 that is, total = 8	Examination and ward round: 2	182
Specialist anaesthetist					Anaesthetic: 140 (theatre time plus time to insert and remove spinal needle for regional anaesthetic)						140
Orthopaedic registrar	Examination and lerking on dmission: 20 Ward round: 10	Examination and ward round: 15	Examination and ward round: 5	Examination and ward round: 2 that is,total 18	Surgery: 140 (theatre time plus taking consent from and counseling patient regarding operation)	Examination and ward round: 7	Examination and ward round: 5	Examination and ward round: 2	Examination and ward round: 2 that is, total = 8	Examination and ward round: 2 Discharge summary: 3	235
Orthopaedic intern	Admission bloods: 7 Drip up: 4 Clerking: 7 Ward round: 10	Ward round: 7	Ward round: 5	Ward round: 2 i.e total 18	Receiving back from theatre: 2	Ward round: 5 Re-site drip: 4	Ward round: 5	Ward round: 2	Ward round: 2 that is, total = 8	Ward round: 2 Write up discharge meds: 5	91
Professional nurse	Admission administration: 7 Ward round: 10 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 7 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 5 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 2 Handover: 2 Administration of antibiotics and analgesics: 3 i.e total 63	Theatre sister: 140 (theatre time plus time to set up and dismantle theatre equipment) Observing patient in recovery room: 30 Ward sister receiving back from theatre: 5	Ward round: 5 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 5 Begin mobilization: 3 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 2 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 2 Handover: 2 Administration of antibiotics and analgesics: 3 that is, total = 28	Ward round: 2 Discharge: 3 Administration of antibiotics and analgesics: 3	348
Staff nurse (ward)	Observations: 4 Pressure care: 15 Pressure care: 15	Observations: 4 Pressure care: 15 Pressure care: 15	Observations: 4 Pressure care: 15 Pressure care: 15	Observations: 4 Pressure care: 15 Pressure care: 15 i.e total 306	Wheel patient to and from theatre: 40 Assist in theatre: 140 (theatre time plus time to set up and dismantle theatre equipment) Observations: 6 Pressure care: 15 Pressure care: 15	Observations: 4 Pressure care: 15 Pressure care: 15	Observations: 4 Mobilization: 20 Change dressing: 10	Observations: 4 Mobilization: 20	Observations: 4 Mobilization: 20 that is, total =	Observations: 4 Mobilization: 10	826

Student nurse	Observations: 4 Urinal: 4	Observations: 4 Urinal: 4	Observations: 4 Urinal: 4	Observations: 4 Urinal: 4 i.e total 72	Wheel patient to and from theatre: 40 Observations: 6 Urinal: 4	Observations: 4 Urinal: 4	Observations: 4 Urinal: 4 Mobilization: 20	Observations: 4 Urinal: 4 Mobilization: 20	Observations: 4 Urinal: 4 Mobilization: 20 that is, total =	Observations: 4 Urinal: 4 Mobilization: 10 that is, total = 96	340
Enrolled nursing assistant (ENA)	Pressure care: 15 Bed bath: 30 Urinal: 15 Change sheets: 20	Pressure care: 15 Bed bath: 30 Urinal: 15 Change sheets: 20	Pressure care: 15 Bed bath: 30 Urinal: 15 Change sheets: 20	Pressure care: 15 Bed bath: 30 Urinal: 15 Change sheets: 20 i.e total 720	Pressure care: 15 Bed bath: 30 Urinal: 15 Change sheets: 20	Pressure care: 15 Bed bath: 30 Urinal: 15 Change sheets: 20	Bed bath: 30 Urinal: 15 Change sheets: 20	Bed bath: 30 Urinal: 15 Change sheets: 20	Bed bath: 30 Urinal: 15 Change sheets: 20 that is, total = 260	Bed bath: 30 Urinal: 15 Change sheets: 20	1575
Porter	Bloods to laboratory: 10 Patient to xray: 10 Patient to ward: 30										50
Physiotherapist							Mobilization: 15	Mobilization: 15	Mobilization: 10	Mobilization: 10 that is, total = 40	80
Radiographer	X rays: 30 X 3 = 90 (for femoral, hip and knee x rays to check joints above and below the fracture)					X rays: 30 (to check for alignment of femur)					120
Consultant radiologist	X rays: 14 X 3 (as above)					X rays: 14					56

APPENDIX 9. BOTTOM UP COSTING – FRACTURED FEMUR

Calculated for femur on basis of 21 days in ward and 120 minutes in theatre

Drugs in ward

- Cefril 500mg 4x daily for 5 days as prophylaxis = R1.83 per tablet X 20 doses = R36.60
- Pethedine for 1.5 days = R0.10 X 3 doses per day X 4 days = R1.20
- Indocid suppositories for 2 days = R0.87 X 3 doses per day X 2 days = R5.22
- Indocid tablets for 9 days = R0.05 X 2 doses per day X 9 days = R0.90
- Paracod tablets for 9 days = R0.15 X 3 tablets per day X 9 days = R4.05

Total cost of drugs in ward = R47.97

Consumables in ward

- Cotton wool 100g = R13.61/5 = R2.72 (where one packet of 500g costs R13.61)
- Non-sterile latex gloves = R0.77 X 11 X 21 = R177.87 (where a box of 25 costs R19.35 and, on average, each of the medical staff would use one pair per day and each of the nursing staff 2 pairs per day when dealing with the patient – again, an estimate of the worst case scenario, but in this age of possible cross infection from patients, not a far-fetched one).
- 2 Venflons 18G = R5.59 X 2 = R11.18
- 2 Giving sets = R4.79 X 2 = R9.58
- 2l Ringers lactate over first 24 hours after theatre = R7.07 X 2 = R14.14

Total costs of consumables in ward = R215.49

X rays (AP and lateral views):

(X rays done before and after surgery)
(In practice, when a bone is injured, x ray of the joints above and below the injuries are taken as well as x rays of the bone itself, to check for injuries. After surgery, only the bone itself is x rayed to check for correct alignment (personal communication: Mr Senoge, consultant orthopaedic surgeon).

- Chemicals per x ray = R2.61 X 8 x rays = R20.88
- Films per x ray:
  For femur = 178 X 432mm (2 films used) = R2.89X 2 = R5.78 before surgery and R5.78 after surgery = R11.65
  For knee = 300 X 400mm (AP) + 180 X 240mm (lateral) = R4.51 + R1.63 = R6.14 before surgery
  For hip = 354 X 432mm (AP) + 240 X 300mm (oblique) = R5.77 + R2.71 = R8.48 before surgery

- Radiographer for 90 minutes for admission x rays and 30 minutes for alignment x rays = 2 hours at R41.38 per hour = R82.96
- Specialist radiologist to read x rays at 7 minutes per x ray = 0.93 hours at R227.96 per hour = R212.00

Total x ray costs = R342.11

Drugs in theatre

(Spinal anaesthetic has been performed for all patients with lower limb surgery, since the early 1990's. Source: Dr Neville Rutherford-Jones, consultant anaesthetist at Addington hospital).

- 1 ampoule heavy marcain (4ml) = R6.72
- ½ multidose vial of 1% lignocaine = R3.26

Total costs of drugs in theatre = R9.98

Consumables in theatre

- 2l Ringers lactate = R7.07 per lire = R14.14
- 1 venflon = R5.59
- 1 giving set = R4.79
- 1 5ml syringe = R0.34
- 1 2ml syringe = R0. 35
- 1 21G needle = R0.19 (box of 100 costs R18.81)
- 1 25G needle = R0.43 (box of 100 costs R42.97)
- 1 26G pencil point spinal needle = R36.09
- 10 pairs of sterile latex gloves (5 people double gloving to prevent infection) =
- R14.50 (one box of 25 pairs costs R36.25).

Total costs of consumables in theatre = R76.42

Internal fixation

96.71% of all fractured femurs in the sample from the theatre books (where approximately 98% of the data from 1995-2000 was available), had some form of internal fixation. Generally (in 70.16% of cases) it was not stated which type. Of those for which the type of internal fixation was known, the majority had a pin and plate inserted (see below for percentages). In order to calculate the costs of treatment for all the patients with a fractured femur, the percentage of patients with each type of known internal fixation were applied to the total number of patients with a fractured femur (see Cost for hospital treatment of femurs injured due to trauma in 2000 *below*).

- 53.75% patients had pin and plate inserted at R3 750.03 each (price is the same for different lengths and different number of holes)
- 1.25% patients had unreamed femoral nail inserted at R2440.72 each
- 18.75% patients had Russell Taylor nail inserted at R2996.49 each

- 18.75% had AO screws inserted at R619.88 each (use three at a time, therefore total = R1859.64)[2]
- 7.50% patients had screws inserted at R303.24 per screw (use three at a time, therefore total = R909.72)[h]

Laboratory tests

- Full blood count X 3 = R28.99 X 3 = R86.97
- Urea and electrolytes X 2 = R89.20 X 2 = R178.40
- Glucose (random) X 1 = R15.61

Total cost of lab tests = R280.98

Staff time (in ward and theatre)

- Consultant orthopaedic surgeon:
  182 minutes = 3.03 hours at cost of R227.96 per hour = R691.48
- Orthopaedic registrar
  235 minutes = 3.92 hours at cost of 172.34 per hour = R675.00
- Orthopaedic intern
  91 minutes = 1.52 hours at cost of 104.25 per hour = R158.11
- Professional nurse
  348 minutes = 5.8 hours at cost of 43.32 per hour = R251.26
- Staff nurse
  826 minutes = 13.77 hours at cost of 32.32 per hour = R444.94
- Student nurse
  340 minutes = 5.67 hours at cost of R27.77 per hour = R157.36
- Enrolled nursing assistant
  1575 minutes = 26.25 hours at cost of R25.88 per hour = R1335.60
- Porter
  50 minutes = 0.83 hours at cost of R23.79 per hour = R19.75
- Physiotherapist
  80 minutes = 1.33 hours at cost of R41.38 per hour = R55.04

Additional staff time in theatre:

- Anaesthetic consultant
  140 minutes = 2.33 hours at cost of R227.96 per hour = R531.91

Total costs of staff time in ward and theatre = R4413.51

[2] Personal communication, Dr G Wood, consultant orthopaedic surgeon at Addington hospital.

Overhead costs

- ☼ Overhead costs for running orthopaedic ward for one day per patient = R200.98 (see calculations in fractured femur)
- ☼ Therefore overhead costs for hospital stay of 21 days = R4220.58

Cost for hospital treatment of one patient (unit cost for hospital treatment of injury to femur, excluding internal fixation):

- ☼ Therefore total cost for fracture femur = R9608.34 (excluding internal fixation).

Cost for hospital treatment of femurs injured due to trauma in 2000:
(NB: all calculations for number of patients rounded off to the nearest whole number)

- ☼ There were 324 patients who required femoral surgery in 2000
- ☼ Seventy eight percent of these were as a result of trauma (that is, 253 patients – rounded off to nearest whole number)
- ☼ Of these 253 patients, 96.71% required internal fixation (see above) that is, 245 patients required internal fixation.
- ☼ 53.75% of these would have had a pin and plate that is, 132 patients at a cost of R9608.34 + R3750.03 = R13358.37 = total of R1763304.80
- ☼ 1.25% of these would have had an unreamed femoral nail that is, 3 patients at a cost of R9608.34 + R2440.72 = R12049.06 = total of R36147.18
- ☼ 18.75% of these would have had a Russell Taylor nail that is, 46 patients at a cost of R9608.34 + R2996.49 = R12604.83 = a total of R579822.18
- ☼ 18.75% of these would have had 3 AO screws = 46 patients at a cost of R9608.34 + R1859.64 = R11467.98 = a total of R527527.08
- ☼ 7.5% of these would have had ordinary screws = 18 patients at a cost of R9608.34 + R909.72 = R10518.06 = a total of R189325.08

Therefore the total costs of all patients requiring internal fixation = R3 096 126.30 (the average cost of a patient with a fractured femur requiring internal fixation is therefore R12637.25)

The remaining 28 patients did not require internal fixation and therefore cost R9608.34 each or a total of R269033.52

Therefore, all the patients who had femoral surgery as a result of trauma in the year 2000 cost R3 365 159.80

APPENDIX 10. **TIME FLOW CHART - STAFF TIME SPENT WITH REPRESENTATIVE PATIENT WITH INJURY TO ANKLE (MINUTES)**
Calculated for ankle on basis of 21 days in ward and 240 minutes in theatre

Staff	Day 1 (Admission)	Day 2	Day 3	Day 4-12 (9 days)	Day 13 (Theatre)	Day 14	Day 15 (Mobilisation)	Day 16	Day 17-20	Day 21 (Discharge)	Total time
Specialist Orthopaedic surgeon	Examination and ward round: 10	Examination and ward round: 7	Examination and ward round: 5	Examination and ward round: 2 that is, total 18	Surgery: 240	Examination and ward round: 5	Examination and ward round: 5	Examination and ward round: 2	Examination and ward round: 2 that is, total = 8	Examination and ward round: 2	302
Specialist anaesthetist					Anaesthetic: 260 (theatre time plus time to insert and remove spinal needle for regional anaesthetic)						260
Orthopaedic registrar	Examination and clerking on admission: 20 Ward round: 10	Examination and ward round: 15	Examination and ward round: 5	Examination and ward round: 2 that is,total 18	Surgery: 260 (theatre time plus taking consent from and counseling patient regarding operation)	Examination and ward round: 7	Examination and ward round: 5	Examination and ward round: 2	Examination and ward round: 2 that is, total = 8	Examination and ward round: 2 Discharge summary: 3	455
Orthopaedic intern	Admission bloods: 7 Drip up: 4 Clerking: 7 Ward round: 10	Ward round: 7	Ward round: 5	Ward round: 2 i.e total 18	Receiving back from theatre: 2	Ward round: 5 Re-site drip: 4	Ward round: 5	Ward round: 2	Ward round: 2 that is, total = 8	Ward round: 2 Write up discharge meds: 5	91
Professional nurse	Admission administration: 7 Ward round: 10 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 7 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 5 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 2 Handover: 2 Administration of antibiotics and analgesics: 3 i.e total 63	Theatre sister: 260 (theatre time plus time to set up and dismantle theatre equipment) Observing patient in recovery room: 30 Ward sister receiving back from theatre: 5	Ward round: 5 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 5 Begin mobilization: 3 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 2 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 2 Handover: 2 Administration of antibiotics and analgesics: 3 that is, total = 28	Ward round: 2 Discharge: 3 Administration of antibiotics and analgesics: 3	468

Staff nurse (ward)	Observations: 4	Observations: 4	Observations : 4	Observations : 4 i.e total 36	Wheel patient to and from theatre: 40 Assist in theatre: 260 (theatre time plus time to set up and dismantle theatre equipment) Observations: 6	Observations : 4	Observations: 4 Mobilization: 10 Change dressing: 10	Observations: 4 Mobilization: 10	Observations: 4 Mobilization: 10 that is, total = 44	Observations : 4 Mobilization : 5	449
Student nurse	Observations: 4 Urinal: 4	Observations: 4 Urinal: 4	Observations : 4 Urinal: 4	Observations : 4 Urinal: 4 i.e total 72	Wheel patient to and from theatre: 40 Observations: 6 Urinal: 4	Observations : 4 Urinal: 4	Observations: 4 Urinal: 4	Observations: 4 Urinal: 4	Observations: 4 Urinal: 4 that is, total = 32	Observations : 4 Urinal: 4	210
Enrolled nursing assistant (ENA)	Assistance with bath: 10 Urinal: 15 Change sheets: 20	Assistance with bath: 10 Urinal: 15 Change sheets: 20	Assistance with bath: 10 Urinal: 15 Change sheets: 20	Assistance with bath: 10 Urinal: 15 Change sheets: 20 i.e total 405	Assistance with bath: 10 Urinal: 15 Change sheets: 20	Assistance with bath: 10 Urinal: 15 Change sheets: 20	Assistance with bath: 10 Urinal: 15 Change sheets: 20	Assistance with bath: 10 Urinal: 15 Change sheets: 20	Assistance with bath: 10 Urinal: 15 Change sheets: 20 that is, total = 180	Assistance with bath: 10 Urinal: 15 Change sheets: 20	1025
Porter	Bloods to laboratory: 10 Patient to xray: 10 Patient to ward: 30										50
Physiotherapist							Mobilization: 15	Mobilization: 15	Mobilization: 10 that is, total = 40	Mobilization : 10	80
Radiographer	X rays: 30						X rays: 30				60
Consultant Radiologist	X rays: 7						X rays: 7				

Note: Patients with ankle surgery are fairly mobile and do not require pressure care or bed baths. They receive some minor assistance with learning to walk on crutches, which is included here (personal communication: Sr Aboo, orthopaedic ward, Addington hospital).

APPENDIX 11. **TIME FLOW CHART - STAFF TIME SPENT WITH REPRESENTATIVE PATIENT WITH INJURY TO ELBOW (MINUTES)**
Calculated for elbow on basis of 7 days in ward and 120 minutes in theatre

Staff	Day1 (Admission)	Day2	Day3	Day4 (Theatre)	Day5	Day6 (Mobilisation)	Day7 (Discharge)	Total time (minutes)
Specialist Orthopaedic surgeon	Examination and ward round: 10	Examination and ward round: 7	Examination and ward round: 5	Surgery: 120	Examination and ward round: 5	Examination and ward round: 5	Examination and ward round: 2	154
Specialist anaesthetist				Anaesthetic: 140				140
Orthopaedic registrar	Examination and clerking on admission: 20 Ward round: 10	Examination and ward round: 15	Examination and ward round: 5	Surgery: 130 (theatre time plus taking consent from and counseling patient regarding operation)	Examination and ward round: 7	Examination and ward round: 5	Examination and ward round: 2 Discharge summary: 3	197
Orthopaedic intern	Admission bloods: 7 Drip up: 4 Clerking: 7 Ward round: 10	Ward round: 7	Ward round: 5	Receiving back from theatre: 2	Ward round: 5 Re-site drip: 4	Ward round: 5	Ward round: 2 Write up discharge meds: 5	63
Professional nurse	Admission administration: 7 Ward round: 10 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 7 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 5 Handover: 2 Administration of antibiotics and analgesics: 3	Theatre sister: 140 (theatre time plus setting up and removing instruments) Observing in recovery room: 30 Ward sister receiving back from theatre: 5	Ward round: 5 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 5 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 2 Discharge: 3 Administration of antibiotics and analgesics: 3	247
Staff nurse	Observations: 4	Observations: 4	Observations: 4	Wheel patient to and from theatre: 40 Assist in theatre: 140 (theatre time plus setting up and removing instruments) Observations in ward: 6	Observations: 4	Observations: 4 Change dressing: 10	Observations: 4	220

Student nurse	Observations: 4	Observations: 4	Observations: 4	Wheel patient to and from theatre: 40 Observations: 6	Observations: 4	Observations: 4	Observations: 4	70
Enrolled nursing assistant (ENA)	Assist with bath: 15 Change sheets: 20	Assist with bath: 15 Change sheets: 20	Assist with bath: 15 Change sheets: 20	Assist with bath: 15 Change sheets: 20	Assist with bath: 15 Change sheets: 20	Assist with bath: 15 Change sheets: 20	Assist with bath: 15 Change sheets: 20	245
Porter	Bloods to laboratory: 10 Patient to xray: 10 Patient to ward: 30							50
Radiographer	X rays: 30				X rays: 30			60
Consultant radiologist	X rays: 7				X rays: 7			14

APPENDIX 12. **TIME FLOW CHART - STAFF TIME SPENT WITH REPRESENTATIVE PATIENT WITH INJURED FOOT (MINUTES)**
Calculated for foot on basis of 21 days in ward and 120 minutes in theatre

Staff	Day1 (Admission)	Day2	Day3	Day4-12 (9 days)	Day13 (Theatre)	Day14	Day15 (Mobilisation)	Day16	Day17 – 20	Day21 (Discharge)	Total time
Specialist Orthopaedic surgeon	Examination and ward round: 10	Examination and ward round: 7	Examination and ward round: 5	Examination and ward round: 2 that is, total 18	Surgery: 120	Examination and ward round: 5	Examination and ward round: 5	Examination and ward round: 2	Examination and ward round: 2 that is, total = 8	Examination and ward round: 2	182
Specialist anaesthetist					Anaesthetic: 140 (theatre time plus time to insert and remove spinal needle for regional anaesthetic)						140
Orthopaedic registrar	Examination and clerking on admission: 20 Ward round: 10	Examination and ward round: 15	Examination and ward round: 5	Examination and ward round: 2 that is,total 18	Surgery: 140 (theatre time plus taking consent from and counseling patient regarding operation)	Examination and ward round: 7	Examination and ward round: 5	Examination and ward round: 2	Examination and ward round: 2 that is, total = 8	Examination and ward round: 2 Discharge summary: 3	233
Orthopaedic intern	Admission bloods: 7 Drip up: 4 Clerking: 7 Ward round: 10	Ward round: 7	Ward round: 5	Ward round: 2 i.e total 18	Receiving back from theatre: 2	Ward round: 5 Re-site drip: 4	Ward round: 5	Ward round: 2	Ward round: 2 that is, total = 8	Ward round: 2 Write up discharge meds: 5	89
Professional nurse	Admission administration: 7 Ward round: 10 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 7 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 5 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 2 Handover: 2 Administration of antibiotics and analgesics: 3 i.e total 63	Theatre sister: 140 (theatre time plus time to set up and dismantle theatre equipment) Observing patient in recovery room: 30 Ward sister receiving back from theatre: 5	Ward round: 5 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 5 Begin mobilization: 3 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 2 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 2 Handover: 2 Administration of antibiotics and analgesics: 3 that is, total = 28	Ward round: 2 Discharge: 3 Administration of antibiotics and analgesics: 3	348
Staff nurse	Observations: 4	Observations : 4	Observations: 4	Observations: 4 i.e total 36	Wheel patient to and from theatre: 40 Assist in theatre: 140 (theatre time plus time to set up and dismantle theatre equipment) Observations: 6	Observations: 4	Observations: 4 Mobilization: 10 Change dressing: 10	Observations: 4 Mobilization: 10	Observations: 4 Mobilization: 10 that is, total = 56	Observations: 4 Mobilization: 5	341

Student nurse	Observations: 4 Urinal: 4	Observations : 4 Urinal: 4	Observations: 4 Urinal: 4	Observations: 4 Urinal: 4 i.e total 72	Wheel patient to and from theatre: 40 Observations: 6 Urinal: 4	Observations: 4 Urinal: 4	Observations: 4 Urinal: 4 Mobilization: 10	Observations: 4 Urinal: 4 Mobilization: 10	Observations: 4 Urinal: 4 Mobilization: 10 that is, total = 72	Observations: 4 Urinal: 4 Mobilization: 5	**269**
Enrolled nursing assistant (ENA)	Assistance with bath: 10 Urinal: 15 Change sheets: 20	Assistance with bath: 10 Urinal: 15 Change sheets: 20	Assistance with bath: 10 Urinal: 15 Change sheets: 20	Assistance with bath: 10 Urinal: 15 Change sheets: 20 i.e total 495	Assistance with bath: 10 Urinal: 15 Change sheets: 20	Assistance with bath: 10 Urinal: 15 Change sheets: 20	Assistance with bath: 10 Urinal: 15 Change sheets: 20	Assistance with bath: 10 Urinal: 15 Change sheets: 20	Assistance with bath: 10 Urinal: 15 Change sheets: 20 that is, total = 220	Assistance with bath: 10 Urinal: 15 Change sheets: 20	**1155**
Porter	Bloods to laboratory: 10 Patient to xray: 10 Patient to ward: 30										**50**
Physiotherapist							Mobilization: 15	Mobilization: 15	Mobilization: 10	Mobilization: 10	50
Radiographer	X rays: 30					X rays: 30					60
Consultant radiologist	X rays: 7					X rays: 7					14

NB: patients with foot surgery are fairly mobile and do not require pressure care or bed baths. They receive some minor assistance with learning to walk on crutches, which is included here (personal communication: Sr Aboo, orthopaedic ward, Addington hospital).

APPENDIX 13. **TIME FLOW CHART - STAFF TIME SPENT WITH REPRESENTATIVE PATIENT WITH INJURY TO HAND (MINUTES)**
Calculated for hand (including fingers and thumbs) on basis of 7 days in ward and 60 minutes in theatre

Staff	Day1 (Admission)	Day2	Day3	Day4 (Theatre)	Day5	Day6 (Mobilisation)	Day7 (Discharge)	Total time (minutes)
Specialist Orthopaedic surgeon	Examination and ward round: 10	Examination and ward round: 7	Examination and ward round: 5	Surgery: 60	Examination and ward round: 5	Examination and ward round: 5	Examination and ward round: 2	94
Specialist anaesthetist				Anaesthetic: 80				80
Orthopaedic registrar	Examination and clerking on admission: 20 Ward round: 10	Examination and ward round: 15	Examination and ward round: 5	Surgery: 80 (theatre time plus taking consent from and counseling patient regarding operation)	Examination and ward round: 7	Examination and ward round: 5	Examination and ward round: 2 Discharge summary: 3	147
Orthopaedic intern	Admission bloods: 7 Drip up: 4 Clerking: 7 Ward round: 10	Ward round: 7	Ward round: 5	Receiving back from theatre: 2	Ward round: 5 Re-site drip: 4	Ward round: 5	Ward round: 2 Write up discharge meds: 5	63
Professional nurse	Admission administration: 7 Ward round: 10 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 7 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 5 Handover: 2 Administration of antibiotics and analgesics: 3	Theatre sister: 80 (theatre time plus setting up and removing instruments) Observing in recovery room: 30 Ward sister receiving back from theatre: 5	Ward round: 5 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 5 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 2 Discharge: 3 Administration of antibiotics and analgesics: 3	187
Staff nurse	Observations: 4	Observations: 4	Observations: 4	Wheel patient to and from theatre: 40 Assist in theatre: 80 Observations in ward: 6	Observations: 4	Observations: 4 Change dressing: 10	Observations: 4	160

Student nurse	Observations: 4	Observations: 4	Observations: 4	Wheel patient to and from theatre: 40 Observations: 6	Observations: 4	Observations: 4	Observations: 4	70
Enrolled nursing assistant (ENA)	Assist with bath: 15 Change sheets: 20	Assist with bath: 15 Change sheets: 20	Assist with bath: 15 Change sheets: 20	Assist with bath: 15 Change sheets: 20	Assist with bath: 15 Change sheets: 20	Assist with bath: 15 Change sheets: 20	Assist with bath: 15 Change sheets: 20	245
Porter	Bloods to laboratory: 10 Patient to xray: 10 Patient to ward: 30							50
Radiographer	X rays: 30				X rays: 30			60
Consultant radiologist	X rays: 14				X rays: 14			28

APPENDIX 14. **TIME FLOW CHART - STAFF TIME SPENT WITH REPRESENTATIVE PATIENT WITH FRACTURED HUMERUS (MINUTES)**
Calculated on the basis of 21 days in ward and 180 minutes in theatre

Staff	Day1 Admission	Day2	Day3	Day4-12 (9 days)	Day13 Theatre	Day14	Day15	Day16	Day17-20	Day21 Discharge	Total time
Specialist Orthopaedic surgeon	Examination and ward round: 10	Examination and ward round: 7	Examination and ward round: 5	Examination and ward round: 2 that is, total 18	Surgery: 180	Examination and ward round: 5	Examination and ward round: 5	Examination and ward round: 2	Examination and ward round: 2 that is, total = 8	Examination and ward round: 2	242
Specialist anaesthetist					Anaesthetic: 200 (theatre time plus time to insert and remove spinal needle for regional anaesthetic)						200
Orthopaedic registrar	Examination and clerking on admission: 20 Ward round: 10	Examination and ward round: 15	Examination and ward round: 5	Examination and ward round: 2 that is,total 18	Surgery: 200 (theatre time plus taking consent from and counseling patient regarding operation)	Examination and ward round: 7	Examination and ward round: 5	Examination and ward round: 2	Examination and ward round: 2 that is, total = 8	Examination and ward round: 2 Discharge summary: 3	295
Orthopaedic intern	Admission bloods: 7 Drip up: 4 Clerking: 7 Ward round: 10	Ward round: 7	Ward round: 5	Ward round: 2 i.e total 18	Receiving back from theatre: 2	Ward round: 5 Re-site drip: 4	Ward round: 5	Ward round: 2	Ward round: 2 that is, total = 8	Ward round: 2 Write up discharge meds: 5	91
Professional nurse	Admission administration: 7 Ward round: 10 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 7 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 5 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 2 Handover: 2 Administration of antibiotics and analgesics: 3 i.e total 63	Theatre sister: 200 (theatre time plus time to set up and dismantle theatre equipment) Observing patient in recovery room: 30 Ward sister receiving back from theatre: 5	Ward round: 5 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 5 Begin mobilization: 3 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 2 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 2 Handover: 2 Administration of antibiotics and analgesics: 3 that is, total = 28	Ward round: 2 Discharge: 3 Administration of antibiotics and analgesics: 3	408
Staff nurse	Observations: 4	Observations: 4	Observations: 4	Observations: 4 i.e total 36	Wheel patient to and from theatre: 40 Assist in theatre: 200 (theatre time plus time to set up and dismantle theatre equipment) Observations: 6	Observations: 4	Observations: 4 Change dressing: 10	Observations: 4	Observations: 4 that is, total = 16	Observations: 4	336

Student nurse	Observations: 4	Observations: 4	Observations: 4	Observations: 4 i.e total 36	Wheel patient to and from theatre: 40 Observations: 6	Observations: 4	Observations: 4	Observations: 4	Observations: 4 that is, total = 16	Observations: 4	126
Enrolled nursing assistant (ENA)	Assist with bath: 20 Change sheets: 20	Assist with bath: 20 Change sheets: 20	Assist with bath: 20 Change sheets: 20	Assist with bath: 20 Change sheets: 20 i.e total 360	Assist with bath: 20 Change sheets: 20	Assist with bath: 20 Change sheets: 20	Assist with bath: 20 Change sheets: 20	Assist with bath: 20 Change sheets: 20	Assist with bath: 20 Change sheets: 20 i.e total = 160	Assist with bath: 20 Change sheets: 20	840
Porter	Bloods to laboratory: 10 Patient to xray: 10 Patient to ward: 30										50
Radiographer	X rays: 3 X 30 = 90					X rays: 30					120
Consultant radiologist	X rays: 3 X 14 = 21					X rays: 14					56

APPENDIX 15. TIME FLOW CHART - STAFF TIME SPENT WITH REPRESENTATIVE PATIENT WITH FRACTURED RADIUS/ULNA (MINUTES)

Calculated on the basis of 7 days in hospital and 120 minutes in theatre

Staff	Day1 (Admission)	Day2	Day3	Day4 (Theatre)	Day5	Day6 (Mobilisation)	Day7 (Discharge)	Total time (minutes)
Specialist Orthopaedic surgeon	Examination and ward round: 10	Examination and ward round: 7	Examination and ward round: 5	Surgery: 120	Examination and ward round: 5	Examination and ward round: 5	Examination and ward round: 2	154
Specialist anaesthetist				Anaesthetic: 140				140
Orthopaedic registrar	Examination and clerking on admission: 20 Ward round: 10	Examination and ward round: 15	Examination and ward round: 5	Surgery: 130 (theatre time plus taking consent from and counseling patient regarding operation)	Examination and ward round: 7	Examination and ward round: 5	Examination and ward round: 2 Discharge summary: 3	197
Orthopaedic intern	Admission bloods: 7 Drip up: 4 Clerking: 7 Ward round: 10	Ward round: 7	Ward round: 5	Receiving back from theatre: 2	Ward round: 5 Re-site drip: 4	Ward round: 5	Ward round: 2 Write up discharge meds: 5	63
Professional nurse	Admission administration: 7 Ward round: 10 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 7 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 5 Handover: 2 Administration of antibiotics and analgesics: 3	Theatre sister: 140 (theatre time plus setting up and removing instruments) Observing in recovery room: 30 Ward sister receiving back from theatre: 5	Ward round: 5 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 5 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 2 Discharge: 3 Administration of antibiotics and analgesics: 3	247
Staff nurse	Observations: 4	Observations: 4	Observations: 4	Wheel patient to and from theatre: 40 Assist in theatre: 140 (theatre time plus setting up and removing instruments) Observations in ward: 6	Observations: 4	Observations: 4 Change dressing: 10	Observations: 4	220
Student nurse	Observations: 4	Observations: 4	Observations: 4	Wheel patient to and from theatre: 40 Observations: 6	Observations: 4	Observations: 4	Observations: 4	70
Enrolled nursing assistant (ENA)	Assist with bath: 15 Change sheets: 20	Assist with bath: 15 Change sheets: 20	Assist with bath: 15 Change sheets: 20	Assist with bath: 15 Change sheets: 20	Assist with bath: 15 Change sheets: 20	Assist with bath: 15 Change sheets: 20	Assist with bath: 15 Change sheets: 20	245

Porter	Bloods to laboratory: 10 Patient to xray: 10 Patient to ward: 30							50
Radiographer	X rays: 3 X 30 = 90				X rays: 30			120
Consultant radiologist	X rays: 3 X 14 = 42				X rays: 14			56

APPENDIX 16. **TIME FLOW CHART - STAFF TIME SPENT WITH REPRESENTATIVE PATIENT WITH INJURY TO TIBIA/FIBULA (MINUTES)**
Calculated for fractured tibia/fibula (including tibia alone) on basis of 21 days in ward and 120 minutes in theatre

Staff	Day1 (Admission)	Day2	Day3	Day4-12 (9 days)	Day13 (Theatre)	Day14	Day15 (Mobilisation)	Day16	Day17 - 20	Day21 (Discharge)	Total time
Specialist Orthopaedic surgeon	Examination and ward round: 10	Examination and ward round: 7	Examination and ward round: 5	Examination and ward round: 2 that is, total 18	Surgery: 120	Examination and ward round: 5	Examination and ward round: 5	Examination and ward round: 2	Examination and ward round: 2 that is, total = 8	Examination and ward round: 2	182
Specialist anaesthetist					Anaesthetic: 140 (theatre time plus time to insert and remove spinal needle for regional anaesthetic)						140
Orthopaedic registrar	Examination and clerking on admission: 20 Ward round: 10	Examination and ward round: 15	Examination and ward round: 5	Examination and ward round: 2 that is,total 18	Surgery: 140 (theatre time plus taking consent from and counseling patient regarding operation)	Examination and ward round: 7	Examination and ward round: 5	Examination and ward round: 2	Examination and ward round: 2 that is, total = 8	Examination and ward round: 2 Discharge summary: 3	335
Orthopaedic intern	Admission bloods: 7 Drip up: 4 Clerking: 7 Ward round: 10	Ward round: 7	Ward round: 5	Ward round: 2 i.e total 18	Receiving back from theatre: 2	Ward round: 5 Re-site drip: 4	Ward round: 5	Ward round: 2	Ward round: 2 that is, total = 8	Ward round: 2 Write up discharge meds: 5	91
Professional nurse	Admission administration: 7 Ward round: 10 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 7 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 5 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 2 Handover: 2 Administration of antibiotics and analgesics: 3 i.e total 63	Theatre sister: 140 (theatre time plus time to set up and dismantle theatre equipment) Observing patient in recovery room: 30 Ward sister receiving back from theatre: 5	Ward round: 5 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 5 Begin mobilization: 3 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 2 Handover: 2 Administration of antibiotics and analgesics: 3	Ward round: 2 Handover: 2 Administration of antibiotics and analgesics: 3 that is, total = 28	Ward round: 2 Discharge: 3 Administration of antibiotics and analgesics: 3	348
Staff nurse (ward)	Observations: 4 Pressure care: 15 Pressure care: 15	Observations: 4 Pressure care: 15 Pressure care: 15	Observations: 4 Pressure care: 15 Pressure care: 15	Observations: 4 Pressure care: 15 Pressure care: 15	Wheel patient to and from theatre: 40 Assist in theatre: 140 (theatre time plus time to set up and	Observations: 4 Pressure care: 15 Pressure care: 15	Observations: 4 Mobilization: 20 Change dressing: 10	Observations: 4 Mobilization: 20	Observations: 4 Mobilization: 20 that is, total = 96	Observations: 4 Mobilization: 10	826

				i.e total 306	dismantle theatre equipment) Observations: 6 Pressure care: 15 Pressure care: 15						
Student nurse	Observations: 4 Urinal: 4	Observations: 4 Urinal: 4	Observations: 4 Urinal: 4	Observations: 4 Urinal: 4 i.e total 72	Wheel patient to and from theatre: 40 Observations: 6 Urinal: 4	Observations: 4 Urinal: 4	Observations: 4 Urinal: 4 Mobilization: 20	Observations: 4 Urinal: 4 Mobilization: 20	Observations: 4 Urinal: 4 Mobilization: 20 that is, total = 112	Observations: 4 Urinal: 4 Mobilization: 10	340
Enrolled nursing assistant (ENA)	Pressure care: 15 Bed bath: 30 Urinal: 15 Change sheets: 20	Pressure care: 15 Bed bath: 30 Urinal: 15 Change sheets: 20	Pressure care: 15 Bed bath: 30 Urinal: 15 Change sheets: 20	Pressure care: 15 Bed bath: 30 Urinal: 15 Change sheets: 20 i.e total 720	Pressure care: 15 Bed bath: 30 Urinal: 15 Change sheets: 20	Pressure care: 15 Bed bath: 30 Urinal: 15 Change sheets: 20	Bed bath: 30 Urinal: 15 Change sheets: 20	Bed bath: 30 Urinal: 15 Change sheets: 20	Bed bath: 30 Urinal: 15 Change sheets: 20 that is, total = 260	Bed bath: 30 Urinal: 15 Change sheets: 20	1575
Porter	Bloods to laboratory: 10 Patient to xray: 10 Patient to ward: 30										50
Physiotherapist							Mobilization: 15	Mobilization: 15	Mobilization: 10 that is, total = 40	Mobilization: 10	80
Radiographer	X rays: 30 X 3 = 90 (for femoral, hip and knee x rays to check joints above and below the fracture)					X rays: 30 (to check for alignment of femur)					120
Consultant radiologist	X rays: 14 X 3 (as above)					X rays: 14					56

APPENDIX 17. BOTTOM UP COSTING - ANKLE

Calculated for ankle on basis of 21 days in ward and 240 minutes in theatre

Drugs in ward

- Cefril 500mg 4x daily for 5 days as prophylaxis = R1.83 per tablet X 20 doses = R36.60
- Pethedine for 1.5 days = R0.10 X 3 doses per day X 4 days = R1.20
- Indocid suppositories for 2 days = R0.87 X 3 doses per day X 2 days = R5.22
- Indocid tablets for 9 days = R0.05 X 2 doses per day X 9 days = R0.90
- Paracod tablets for 9 days = R0.15 X 3 tablets per day X 9 days = R4.05

Total cost of drugs in ward = R47.97

Consumables in ward

- Cotton wool 100g = R13.61/5 = R2.72 (where one packet of 500g costs R13.61)
- Non-sterile latex gloves = R0.77 X 11 X 21 = R177.87 (where a box of 25 costs R19.35 and, on average, each of the medical staff would use one pair per day and each of the nursing staff 2 pairs per day when dealing with the patient – again, an estimate of the worst case scenario, but in this age of possible cross infection from patients, not a far-fetched one).
- 2 Venflons 18G = R5.59 X 2 = R11.18
- 2 Giving sets = R4.79 X 2 = R9.58
- 2l Ringers lactate over first 24 hours after theatre = R7.07 X 2 = R14.14

Total costs of consumables in ward = R215.49
NB number of venflons used in the ward is the same for all categories of injury costed, irrespective of length of stay in hospital. This is because patient is usually taken off iv line within a few days after surgery.

X rays (AP and lateral view ankle):
(X rays done before and after surgery)

- Chemicals per x ray = R2.61 X 2 x rays = R5.22 before surgery and R5.22 after surgery = R10.44
- Films per x ray = 180 X 240mm (2 films used) = R1.63 X 2 = R3.26 before surgery and R3.26 after surgery = R6.52
- Radiographer for 30 minutes each time = 1 hour at R41.38 per hour = R41.38
- Specialist radiologist to read x rays at 7 minutes per x ray = 0.47 hours at R227.96 per hour = R107.14

Total x ray costs = R165.48

Drugs in theatre

(Spinal anaesthetic, as opposed to general anaesthetic, has been performed for all patients with lower limb surgery, since the early 1990's. Personal communication: Dr Neville Rutherford-Jones, consultant anaesthetist at Addington hospital)

- One ampoule heavy marcain (4ml) = R6.72
- ½ multidose vial of 1% lignocaine = R3.26

Total costs of drugs in theatre = R9.98

Consumables in theatre

- 2l Ringers lactate = R7.07 per lire = R14.14
- 1 venflon = R5.59
- 1 giving set = R4.79
- 1 5ml syringe = R0.34
- 1 2ml syringe = R0. 35
- 1 21G needle = R0.19 (box of 100 costs R18.81)
- 1 25G needle = R0.43 (box of 100 costs R42.97)
- 1 26G pencil point spinal needle = R36.09
- 10 pairs of sterile latex gloves (5 people double gloving to prevent infection) = R14.50 (one box of 25 pairs costs R36.25).

Total costs of consumables in theatre = R76.42

Internal fixation

(NB: percentage requiring internal fixation calculated on sample from Theatre Books, 1995-2000, where on average 98% of the data was available)

- Of the 97 patients in the total sample (1995 – 2000) requiring ankle surgery, 51 (52.58%) required internal fixation. Although the type was not specified in the theatre books, on discussions with Mr Senoge and Dr Wood (orthopaedic consultant and head of the orthopaedic ward orthopaedic consultant respectively at Addington), the fixation most commonly used in the ankle is plate and screws. Therefore the costs of plate and screws were included for 52.58% of all cases of ankle surgery. The other surgical treatments required by patients in the sample were: tendon release (12), removal of fixation (11), debridement (8), and arthroscopy, biopsy, manipulation under anaesthesia, tendon repair et cetera
- Plate most commonly used has 6 to 8 holes (Dr Wood), therefore 8 hole plate costed for worst case scenario
- Cost of plate = R624.72
- Cost of screws = R45.94 X 8 = R367.52

Laboratory tests

- Full blood count X 3 = R28.99 X 3 = R86.97
- Urea and electrolytes X 2 = R89.20 X 2 = R178.40
- Glucose (random) X 1 = R15.61

Total cost of lab tests = R280.98

Staff time (in ward and theatre)

- Consultant orthopaedic surgeon:
  302 minutes = 5.03 hours at cost of R227.96 per hour = R1147.40
- Orthopaedic registrar
  455 minutes = 7.58hours at cost of 172.34 per hour = R1306.91
- Orthopaedic intern
  91 minutes = 1.52 hours at cost of 104.25 per hour = R158.11
- Professional nurse
  468 minutes = 7.8 hours at cost of 43.32 per hour = R337.90
- Staff nurse
  449 minutes = 7.48 hours at cost of 32.32 per hour = R241.86
- Student nurse
  210 minutes = 3.5 hours at cost of R27.77 per hour = R97.195
- Enrolled nursing assistant
  1025 minutes = 17.08 hours at cost of R25.88 per hour = R442.12
- Porter
  50 minutes = 0.83 hours at cost of R23.79 per hour = R19.75

Additional staff time in theatre:

- Anaesthetic consultant
  260 minutes = 4.33 hours at cost of R227.96 per hour = R987.06
- Physiotherapist
  80 minutes = 1.33 hours at cost of at R41.38 per hour = R55.04

Total costs of staff time in ward and theatre = R4793.35

Overhead costs

- Overhead costs for running orthopaedic ward for one day per patient = R200.98 (see calculations appendix 26)

Therefore overhead costs for hospital stay of 21 days = R4220.58

Cost of treatment for one patient

Therefore unit cost for hospital treatment of one patient with injured ankle (including internal fixation) = R10803.79
And unit cost for hospital treatment of one patient with injured ankle (excluding internal fixation) = R9811.55

Cost of treatment for all victims of trauma
(NB: all calculations for number of patients rounded off to the nearest whole number)

- ☼ There were 66 patients who required ankle surgery in 2000
- 15 45% of these were as a result of trauma (that is, 30 patients)
- ☼ Of these 30 patients, 52.58% required internal fixation (see above) that is, 16 patients required internal fixation and therefore cost R10803.79 each, or a total of R172860.64
- ☼ The remaining 14 patients did not require internal fixation and therefore cost R9811.55 each or a total of R137361.70

Therefore, all the patients who had ankle surgery as a result of trauma in the year 2000 cost R310222.34

APPENDIX 18. BOTTOM UP COSTING – ELBOW

Calculated for elbow on basis of 7 days in ward and 120 minutes in theatre

Drugs in ward

- Cefril 500mg 4x daily for 5 days as prophylaxis = R1.83 per tablet X 20 doses = R36.60
- Pethedine for 1.5 days = R0.10 X 3 doses per day X 4 days = R1.20
- Indocid tablets for 3 days = R0.05 X 2 doses per day X 3 days = R0.30
- Paracod tablets for 3 days = R0.15 X 3 tablets per day X 3 days = R1.35

Total cost of drugs in ward = R39.45

Consumables in ward

- Cotton wool 50g = R13.61/10 = R1.36 (where one packet of 500g costs R13.61)
- Non-sterile latex gloves = R0.77 X 11 X 7 = R59.29 (where a box of 25 costs R19.35 and each of the medical staff would use one pair per day and each of the nursing staff 2 pairs per day when dealing with the patient – again, an estimate of the worst case scenario, but in this age of possible cross infection from patients, not a far-fetched one).
- 2 Venflons 18G = R5.59 X 2 = R11.18
- 2 Giving sets = R4.79 X 2 = R9.58
- 2l Ringers lactate over first 24 hours after theatre = R7.07 X 2 = R14.14

Total costs of consumables in ward = R109.41

X rays (AP and lateral view ankle):

(X rays done before and after surgery)

- Chemicals per x ray = R2.61 X 2 x rays = R5.22 before surgery and R5.22 after surgery = R10.44
- Films per x ray = 180 X 240mm (2 films used) = R1.63 X 2 = R3.26 before surgery and R3.26 after surgery = R6.52
- Radiographer for 30 minutes each time = 1 hour at R41.38 per hour = R41.38
- Specialist radiologist to read x rays at 7 minutes per x ray = 0.47 hours at R227.96 per hour = R107.14

Total x ray costs = R165.48

Drugs in theatre

(General anaesthetic done in all upper limb injuries. Personal communication: Dr Neville Rutherford-Jones, consultant anaesthetist at Addington hospital).

☼	Induction:	propofol 1 ampoule = R17.96
☼	Muscle relaxants:	rocuronium 1 ampoule = R39.70
		Morphine 1 ampoule = R0.95
		Fentanyl 1 ampoule = R8.41
☼	Reversal:	Neostigmine 1 ampoule = R1.09
		Glycopyrolate 2 ampoules = R4.21 X 2 = R8.42
☼	Prophylactic antibiotic:	Ranzol 2 ampoules = R3.41 X 2 = R6.82

Total cost of drugs in theatre = R83.35

Consumables in theatre:

- ☼ Laryngeal mask (re-usable for 50 patients) = R70 (one mask costs R3500.00)
- ☼ Venflon = R5.59
- ☼ Giving set = R4.79
- ☼ 2l Ringers lactate = R7.07 X 2 = R14.14

Total cost of consumables in theatre = R94.52

Internal fixation

(NB: percentage requiring internal fixation calculated on sample from Theatre Books, 1995-2000, where on average 98% of the data was available)

- ☼ 56 of the 80 (70%) in the sample who had surgery to the elbow required internal fixation. Although the type of internal fixation was specified in only 5.30% of cases, discussions with Dr Wood of Addington hospital reveal that k wires are most often used in the elbow, a minimum of 2. Therefore these were added to the costs of 70% of the patients requiring elbow surgery. Other surgical procedures performed on the elbow were: debridement (3), excision of bursa (1), incision and drainage (1), manipulation under anaesthesia (6), removal of internal fixation (8), removal of foreign body (3), and skin graft (1), and tendon release (1).
- ☼ Cost of k wires = R33.92

Therefore cost of 2 k wires = R67.84

Laboratory tests

- ☼ Full blood count X 3 = R28.99 X 3 = R86.97
- ☼ Urea and electrolytes X 2 = R89.20 X 2 = R178.40
- ☼ Glucose (random) X 1 = R15.61

Total cost of lab tests = R280.98

Staff time (in ward and theatre)

- Consultant orthopaedic surgeon:
  154 minutes = 2.57 hours at cost of R227.96 per hour = R585.86
- Orthopaedic registrar
  197 minutes = 3.28 hours at cost of 172.34 per hour = R565.28
- Orthopaedic intern
  63 minutes = 1.05 hours at cost of 104.25 per hour = R109.46
- Professional nurse
  247 minutes = 4.12 hours at cost of 43.32 per hour = R178.33
- Staff nurse
  220 minutes = 3.67 hours at cost of 32.32 per hour = R118.51
- Student nurse
  70 minutes = 1.17 hours at cost of R27.77 per hour = R32.49
- Enrolled nursing assistant
  245 minutes = 4.08 hours at cost of R25.88 per hour = R105.59
- Porter
  50 minutes = 0.83 hours at cost of R23.79 per hour = R19.75

Additional staff time in theatre

- Anaesthetic consultant
  140 minutes = 2.33 hours at cost of R227.96 per hour = R531.91

Total costs of staff time in ward and theatre = R2305.59

Overhead costs

- Overhead costs for running orthopaedic ward for one day per patient = R200.98 (see calculations appendix 26)

Therefore overhead costs for hospital stay of 7 days = R1406.86

Cost for hospital treatment of one patient (unit cost for hospital treatment of injury to elbow)

Therefore total cost for hospital treatment of injury to elbow (including internal fixation) = R4553.48

And total cost for hospital treatment of injury to elbow (excluding internal fixation) = R4485.64

Cost for hospital treatment of elbows injured due to trauma in 2000:
(NB: all calculations for patients rounded off to the nearest whole number)

- There were 30 patients who required elbow surgery in 2000
- 80% of these were as a result of trauma (that is, 24 patients)
- Of these 24 patients, 70.00% required internal fixation (see above) that is, 17 patients required internal fixation and therefore cost R4553.48 each, or a total of R77409.16
- The remaining 13 patients did not require internal fixation and therefore cost R4485.64 each or a total of R58313.32

Therefore, all the patients who had elbow surgery as a result of trauma in the year 2000 cost R135722.48

APPENDIX 19. BOTTOM UP COSTING - FOOT

Calculated for foot on basis of 21 days in ward and 120 minutes in theatre

Drugs in ward

- Cefril 500mg 4x daily for 5 days as prophylaxis = R1.83 per tablet X 20 doses = R36.60
- Pethedine for 1.5 days = R0.10 X 3 doses per day X 4 days = R1.20
- Indocid suppositories for 2 days = R0.87 X 3 doses per day X 2 days = R5.22
- Indocid tablets for 9 days = R0.05 X 2 doses per day X 9 days = R0.90
- Paracod tablets for 9 days = R0.15 X 3 tablets per day X 9 days = R4.05

Total cost of drugs in ward = R47.97

Consumables in ward

- Cotton wool 100g = R13.61/5 = R2.72 (where one packet of 500g costs R13.61)
- Non-sterile latex gloves = R0.77 X 11 X 21 = R177.87 (where a box of 25 costs R19.35 and, on average, each of the medical staff would use one pair per day and each of the nursing staff 2 pairs per day when dealing with the patient – again, an estimate of the worst case scenario, but in this age of possible cross infection from patients, not a far-fetched one).
- 2 Venflons 18G = R5.59 X 2 = R11.18
- 2 Giving sets = R4.79 X 2 = R9.58
- 2l Ringers lactate over first 24 hours after theatre = R7.07 X 2 = R14.14

Total costs of consumables in ward = R215.49

X rays (AP and lateral view)
(X rays done before and after surgery)

- Chemicals per x ray = R2.61 X 2 x rays = R5.22 before surgery and R5.22 after surgery = R10.44
- Films per x ray = 240 X 300mm (2 films used) = R2.71 X 2 = R5.42 before surgery and R5.42 after surgery = R10.84
- Radiographer for 30 minutes each time = 1 hour at R41.38 per hour = R41.38
- Specialist radiologist to read x rays at 7 minutes per of x ray = 0.47 hours at R227.96 per hour = R107.14

Total x ray costs = R169.80

Drugs in theatre
(Spinal anaesthetic has been performed for all patients with lower limb surgery, since the early 1990's. Personal communication: Dr Neville Rutherford-Jones, consultant anaesthetist at Addington hospital)

- 1 ampoule heavy marcain (4ml) = R6.72
- ½ multidose vial of 1% lignocaine = R3.26

Total costs of drugs in theatre = R9.98

Consumables in theatre

- 2l Ringers lactate = R7.07 per lire = R14.14
- 1 venflon = R5.59
- 1 giving set = R4.79
- 1 5ml syringe = R0.34
- 1 2ml syringe = R0. 35
- 1 21G needle = R0.19 (box of 100 costs R18.81)
- 1 25G needle = R0.43 (box of 100 costs R42.97)
- 1 26G pencil point spinal needle = R36.09
- 10 pairs of sterile latex gloves (5 people double gloving to prevent infection) = R14.50 (one box of 25 pairs costs R36.25)

Total costs of consumables in theatre = R76.42

Internal fixation
(NB: percentage requiring internal fixation calculated on sample from Theatre Books, 1995-2000, where on average 98% of the data was available)

- 40% (10/25) of patients requiring foot surgery had some form of internal fixation inserted. The most common of these, when specified, were k wires. This was confirmed by Dr Wood of Addington hospital, who stated that although the number used depends on the type of injury, a minimum of two are always used. Therefore 2 k wires were costed for 40% of all cases requiring foot surgery. Other surgical treatments for the foot were: arthorodesis, debridement, removal of fixation, removal of foreign body, tendon repair et cetera
- Cost of k wires = R33.92

Therefore cost of 2 k wires for use in the foot = R68.84

Laboratory tests

- Full blood count X 3 = R28.99 X 3 = R86.97
- Urea and electrolytes X 2 = R89.20 X 2 = R178.40
- Glucose (random) X 1 = R15.61

Total cost of lab tests = R280.98

Staff time (in ward and theatre)

- Consultant orthopaedic surgeon:
  182 minutes = 3.03 hours at cost of R227.96 per hour = R691.48
- Orthopaedic registrar
  233 minutes = 3.88 hours at cost of R172.34 per hour = R669.25
- Orthopaedic intern
  89 minutes = 1.48 hours at cost of R104.25 per hour = R54.64
- Professional nurse
  348 minutes = 5.80 hours at cost of R43.32 per hour = R251.26
- Staff nurse
  341 minutes = 5.6 hours at cost of R32.32 per hour = R183.68
- Student nurse
  269 minutes = 4.42 hours at cost of R27.77 per hour = R122.65
- Enrolled nursing assistant
  1155 minutes = 19.25 hours at cost of R25.88 per hour = R498.19
- Porter
  50 minutes = 0.83 hours at cost of R23.79 per hour = R19.75
- Physiotherapist
  80 minutes = 1.33 hours at cost of R41.38 per hour = R55.04

Additional staff time in theatre:

- Anaesthetic consultant
  140 minutes = 2.33 hours at cost of R227.96 per hour = R531.91

Total costs of staff time in ward and theatre = R3077.85

Overhead costs

- Overhead costs for running orthopaedic ward for one day per patient = R200.98 (see calculations appendix 26)

Therefore overhead costs for hospital stay of 21 days = R4220.58

Cost of treatment for one patient

Therefore unit cost for hospital treatment of one patient with injured foot (including internal fixation) = R8167.91

And unit cost for hospital treatment of one patient with injured foot (excluding internal fixation) = R8099.07

Cost of treatment for all victims of trauma
(NB: all calculations for number of patients rounded off to the nearest whole number)

- There were 30 patients who required foot surgery in 2000
- 80% of these were as a result of trauma (that is, 24 patients)
- Of these 24 patients, 40.00% required internal fixation (see above) that is, 10 patients required internal fixation and therefore cost R8167.91 each, or a total of R81679.10
- The remaining 14 patients did not require internal fixation and therefore cost R8099.07 each or a total of R113386.98

Therefore, all the patients who had foot surgery as a result of trauma in the year 2000 cost R195066.08

APPENDIX 20. BOTTOM UP COSTING - HAND

Calculated for hand (including fingers and thumbs) on basis of 7 days in ward and 60 minutes in theatre

Drugs in ward

- Cefril 500mg 4x daily for 5 days as prophylaxis = R1.83 per tablet X 20 doses = R36.60
- Pethedine for 1.5 days = R0.10 X 3 doses per day X 4 days = R1.20
- Indocid tablets for 3 days = R0.05 X 2 doses per day X 3 days = R0.30
- Paracod tablets for 3 days = R0.15 X 3 tablets per day X 3 days = R1.35

Total cost of drugs in ward = R39.45

Consumables in ward

- Cotton wool 50g = R13.61/10 = R1.36 (where one packet of 500g costs R13.61)
- Non-sterile latex gloves = R0.77 X 11 X 7 = R59.29 (where a box of 25 costs R19.35 and each of the medical staff would use one pair per day and each of the nursing staff 2 pairs per day when dealing with the patient – again, an estimate of the worst case scenario, but in this age of possible cross infection from patients, not a far-fetched one).
- 2 Venflons 18G = R5.59 X 2 = R11.18
- 2 Giving sets = R4.79 X 2 = R9.58
- 2l Ringers lactate over first 24 hours after theatre = R7.07 X 2 = R14.14

Total costs of consumables in ward = R109.41

X rays (AP and lateral view):

(X rays done before and after surgery)

- Chemicals per x ray = R2.61 X 2 x rays = R5.22 before surgery and R5.22 after surgery = R10.44
- Films per x ray = 240 X 300mm (2 films used) = R2.71 X 2 = R5.42 before surgery and R5.42 after surgery = R10.84
- Radiographer for 30 minutes each time = 1 hour at R41.38 per hour = R41.38
- Specialist radiologist to read x rays at 7 minutes per of x ray = 0.47 hours at R227.96 per hour = R107.14

Total x ray costs = R169.80

Drugs in theatre
(General anaesthetic performed for all upper limb surgery. Personal communication: Dr Neville Rutherford-Jones, consultant anaesthetist at Addington hospital).

☼	Induction:	propofol 1 ampoule = R17.96
☼	Muscle relaxants:	rocuronium 1 ampoule = R39.70
		Morphine 1 ampoule = R0.95
		Fentanyl 1 ampoule = R8.41
☼	Reversal:	Neostigmine 1 ampoule = R1.09
		Glycopyrolate 2 ampoules = R4.21 X 2 = R8.42
☼	Prophylactic antibiotic:	Ranzol 2 ampoules = R3.41 X 2 = R6.82

Total cost of drugs in theatre = R83.35

Consumables in theatre:

- ☼ Laryngeal mask (re-usable for 50 patients) = R70 (one mask costs R3500.00)
- ☼ Venflon = R5.59
- ☼ Giving set = R4.79
- ☼ 2l Ringers lactate = R7.07 X 2 = R14.14

Total cost of consumables in theatre = R94.52

Internal fixation
(NB: percentage requiring internal fixation calculated on sample from Theatre Books, 1995-2000, where on average 98% of the data was available)

- ☼ 7 of the 70 patients (10.00%) admitted for hand surgery required internal fixation. Of the remainder, 12 required debridement, 18 incision and drainage, 22 tendon repair, 3 tendon release, 3 tendon transfer, whilst single others required manipulation under anaesthesia, removal of ganglion, examination under anaesthesia , removal of foreign body et cetera
- ☼ Therefore in only 10% of all hand injuries costed will prosthesis be included. The most common form of internal fixation used in the hand are k wires (Personal communication: Dr Wood, consultant orthopaedic surgeon, Addington hospital). A minimum of 2 are used, sometimes many more, depending on the type of injury (ibid). As an average, 5 are used in this costing.
- ☼ One k wire costs R33.92 (Source: Addington surgical stores department).

Therefore 5 cost R169.60

Laboratory tests

- Full blood count X 3 = R28.99 X 3 = R86.97
- Urea and electrolytes X 2 = R89.20 X 2 = R178.40
- Glucose (random) X 1 = R15.61

Total cost of lab tests = R280.98

Staff time (in ward and theatre)

- Consultant orthopaedic surgeon:
  94 minutes = 1.56 hours at cost of R227.96 per hour = R357.14
- Orthopaedic registrar
  147 minutes = 2.45 hours at cost of 172.34 per hour = R422.23
- Orthopaedic intern
  63 minutes = 1.05 hours at cost of 104.25 per hour = R109.46
- Professional nurse
  187 minutes = 3.12 hours at cost of 43.32 per hour = R135.01
- Staff nurse
  160 minutes = 2.67 hours at cost of 32.32 per hour = R86.19
- Student nurse
  70 minutes = 1.17 hours at cost of R27.77 per hour = R32.49
- Enrolled nursing assistant
  245 minutes = 4.08 hours at cost of R25.88 per hour = R105.59
- Porter
  50 minutes = 0.83 hours at cost of R23.79 per hour = RR19.75

Additional staff time in theatre

- Anaesthetic consultant
  80 minutes = 1.33 hours at cost of R227.96 per hour = R303.95

Total costs of staff time in ward and theatre = R1571.81

Overhead costs

- Overhead costs for running orthopaedic ward for one day per patient = R200.98 (see calculations appendix 26)

Therefore overhead costs for hospital stay of 7 days = R1406.86

Cost of treatment for one patient

Therefore unit cost for hospital treatment of one patient with injured hand (including internal fixation) = R3925.78

And unit cost for hospital treatment of one patient with injured hand (excluding internal fixation) = R3756.18

Cost of treatment for all victims of trauma
(NB: all calculations for number of patients rounded off to the nearest whole number)

- There were 36 patients who required hand surgery in 2000
- 67% of these were as a result of trauma (that is, 24 patients)
- Of these 24 patients, 10.00% required internal fixation (see above) that is, 2 patients required internal fixation and therefore cost R3925.78 each, or a total of R7851.56
- The remaining 22 patients did not require internal fixation and therefore cost R3756.18 each or a total of R82635.96

Therefore, all the patients who had hand surgery as a result of trauma in the year 2000 cost R90487.52

APPENDIX 21. BOTTOM UP COSTING – HUMERUS

Calculated for fractured humerus on basis of 21 days in ward and 180 minutes in theatre

Drugs in ward

- Cefril 500mg 4x daily for 5 days as prophylaxis = R1.83 per tablet X 20 doses = R36.60
- Pethedine for 1.5 days = R0.10 X 3 doses per day X 4 days = R1.20
- Indocid suppositories for 2 days = R0.87 X 3 doses per day X 2 days = R5.22
- Indocid tablets for 9 days = R0.05 X 2 doses per day X 9 days = R0.90
- Paracod tablets for 9 days = R0.15 X 3 tablets per day X 9 days = R4.05

Total cost of drugs in ward = R47.97

Consumables in ward

- Cotton wool 100g = R13.61/5 = R2.72 (where one packet of 500g costs R13.61)
- Non-sterile latex gloves = R0.77 X 11 X 21 = R177.87 (where a box of 25 costs R19.35 and, on average, each of the medical staff would use one pair per day and each of the nursing staff 2 pairs per day when dealing with the patient – again, an estimate of the worst case scenario, but in this age of possible cross infection from patients, not a far-fetched one).
- 2 Venflons 18G = R5.59 X 2 = R11.18
- 2 Giving sets = R4.79 X 2 = R9.58
- 2l Ringers lactate over first 24 hours after theatre = R7.07 X 2 = R14.14

Total costs of consumables in ward = R215.49

X rays (AP and lateral views):

(X rays done before and after surgery)
(In practice, when a bone is injured, x rays of the joints above and below the injuries are taken as well as x rays of the bone itself, to check for injuries. After surgery, only the bone itself is x rayed to check for correct alignment (Mr Senoge).

- Chemicals per x ray = R2.61 X 8 x rays = R20.88
- Films per x ray:
  For humerus = 178 X 432mm (2 films used) = R2.89X 2 = R5.78 before surgery and R5.78 after surgery = R11.65
  For elbow = 180 X 240mm (2 films used) = R1.63 X 2 = R3.26 before surgery
  For shoulder = 240 X 300mm (2 films used) = R2.71 before surgery

- ☼ Radiographer for 90 minutes for admission x rays and 30 minutes for alignment x rays = 2 hours at R41.38 per hour = R82.96
- ☼ Specialist radiologist to read x rays at 7 minutes per x ray = 0.93 hours at R227.96 per hour = R212.00

Total x ray costs = R333.46

Drugs in theatre

(General anaesthetic performed for all upper limb surgery. Personal communication: Dr Neville Rutherford-Jones, consultant anaesthetist at Addington hospital).

☼	Induction:	propofol 1 ampoule = R17.96
☼	Muscle relaxants:	rocuronium 1 ampoule = R39.70
		Morphine 1 ampoule = R0.95
		Fentanyl 1 ampoule = R8.41
☼	Reversal:	Neostigmine 1 ampoule = R1.09
		Glycopyrolate 2 ampoules = R4.21 X 2 = R8.42
☼	Prophylactic antibiotic:	Ranzol 2 ampoules = R3.41 X 2 = R6.82

Total cost of drugs in theatre = R83.35

Consumables in theatre

- ☼ Laryngeal mask (re-usable for 50 patients) = R70 (one mask costs R3500.00)
- ☼ Venflon = R5.59
- ☼ Giving set = R4.79
- ☼ 2l Ringers lactate = R7.07 X 2 = R14.14

Total cost of consumables in theatre = R94.52

Internal fixation

(NB: percentage requiring internal fixation calculated on sample from Theatre Books, 1995-2000, where on average 98% of the data was available)

- ☼ Only 17.65% fractured humeri had internal fixation inserted, therefore cost of prosthesis was only applied to this percentage. Russell Taylor (RT) nail was chosen because it is the most expensive and it was considered best to cost the worst case scenario. Patient notes gave no indication of which prosthesis was used).

Cost of RT humeral nail = R3068.31

Laboratory tests

- Full blood count X 3 = R28.99 X 3 = R86.97
- Urea and electrolytes X 2 = R89.20 X 2 = R178.40
- Glucose (random) X 1 = R15.61

Total cost of lab tests = R280.98

Staff time (in ward and theatre)

- Consultant orthopaedic surgeon:
  242 minutes = 4.03 hours at cost of R227.96 per hour = R919.43
- Orthopaedic registrar
  295 minutes = 4.92 hours at cost of 172.34 per hour = R847.34
- Orthopaedic intern
  91 minutes = 1.52 hours at cost of 104.25 per hour = R158.11
- Professional nurse
  408 minutes = 6.80 hours at cost of 43.32 per hour = R294.58
- Staff nurse
  336 minutes = 5.6 hours at cost of 32.32 per hour = R180.99
- Student nurse
  126 minutes = 2.1 hours at cost of R27.77 per hour = R58.32
- Enrolled nursing assistant
  840 minutes = 14.00 hours at cost of R25.88 per hour = R362.32
- Porter
  50 minutes = 0.83 hours at cost of R23.79 per hour = RR19.75

Additional staff time in theatre:

- Anaesthetic consultant
  180 minutes = 2 hours at cost of R227.96 per hour = R683.88

Total costs of staff time in ward and theatre = R3524.72

Overhead costs

- Overhead costs for running orthopaedic ward for one day per patient = R200.98 (see calculations appendix 26)

Therefore overhead costs for hospital stay of 21 days = R4220.58

Cost for hospital treatment of one patient (unit cost for hospital treatment of injury to humerus)

Therefore unit cost for hospital treatment of one patient with a fractured humerus = R11869.38 (including prosthesis) and R8801.07 (excluding prosthesis)

Cost for hospital treatment of humeri injured due to trauma in 2000:
(NB: all calculations for patients rounded off to the nearest whole number)

- There were 54 patients who required humeral surgery in 2000
- 89% percent of these were as a result of trauma (that is, 48 patients)
- Of these 48 patients, 17.65% required internal fixation (see above) that is, 8 patients required internal fixation and therefore cost R11869.38 each, or a total of R94955.04
- The remaining 40 patients did not require internal fixation and therefore cost R8801.07 each or a total of R352042.80

Therefore, all the patients who had humeral surgery as a result of trauma in the year 2000 cost R446997.84

APPENDIX 22. BOTTOM UP COSTING - RADIUS/ULNA

Calculated for injured radius and ulna or radius alone on basis of 7 days in ward and 120 minutes in theatre

Drugs in ward

- Cefril 500mg 4x daily for 5 days as prophylaxis = R1.83 per tablet X 20 doses = R36.60
- Pethedine for 1.5 days = R0.10 X 3 doses per day X 4 days = R1.20
- Indocid tablets for 3 days = R0.05 X 2 doses per day X 3 days = R0.30
- Paracod tablets for 3 days = R0.15 X 3 tablets per day X 3 days = R1.35

Total cost of drugs in ward = R39.45

Consumables in ward

- Cotton wool 50g = R13.61/10 = R1.36 (where one packet of 500g costs R13.61)
- Non-sterile latex gloves = R0.77 X 11 X 7 = R59.29 (where a box of 25 costs R19.35 and each of the medical staff would use one pair per day and each of the nursing staff 2 pairs per day when dealing with the patient – again, an estimate of the worst case scenario, but in this age of possible cross infection from patients, not a far-fetched one).
- 2 Venflons 18G = R5.59 X 2 = R11.18
- 2 Giving sets = R4.79 X 2 = R9.58
- 2l Ringers lactate over first 24 hours after theatre = R7.07 X 2 = R14.14

Total costs of consumables in ward = R109.41

X rays (AP and lateral views)

(X rays done before and after surgery)

In practice, when a bone is injured, x ray of the joints above and below the injuries are taken as well as x rays of the bone itself, to check for injuries. After surgery, only the bone itself is x rayed to check for correct alignment (personal communication: Mr Senoge, consultant orthopaedic surgeon, Addington hospital).

- Chemicals per x ray = R2.61 X 8 x rays = R20.88
- Films per x ray:
  For radius/ulna = 240 X 300mm (2 films used) = R2.71 X 2 = R5.42 before surgery and R5.42 after surgery = R10.84
  For elbow = 180 X 240mm (2 films used) = R1.63 X 2 = R3.26 before surgery
  For wrist = 180 X 240mm (2 films used) = R1.63 X 2 = R3.26 before surgery
- Radiographer for 90 minutes for admission x rays and 30 minutes for alignment x rays = 2 hours at R41.38 per hour = R82.96

- Specialist radiologist to read x rays at 7 minutes per x ray = 0.93 hours at R227.96 per hour = R212.00

Total x ray costs = R312.32

Drugs in theatre

(General anaesthetic performed for all upper limb surgery. Personal communication: Dr Neville Rutherford-Jones, consultant anaesthetist at Addington hospital).

☼	Induction:	propofol 1 ampoule = R17.96
☼	Muscle relaxants:	rocuronium 1 ampoule = R39.70
		Morphine 1 ampoule = R0.95
		Fentanyl 1 ampoule = R8.41
☼	Reversal:	Neostigmine 1 ampoule = R1.09
		Glycopyrolate 2 ampoules = R4.21 X 2 = R8.42
☼	Prophylactic antibiotic:	Ranzol 2 ampoules = R3.41 X 2 = R6.82

Total cost of drugs in theatre = R83.35

Consumables in theatre

- Laryngeal mask (re-usable for 50 patients) = R70 (one mask costs R3500.00)
- Venflon = R5.59
- Giving set = R4.79
- 2l Ringers lactate = R7.07 X 2 = R14.14

Total cost of consumables in theatre = R94.52

Internal fixation

(NB: percentage requiring internal fixation calculated on sample from Theatre Books, 1995-2000, where on average 98% of the data was available)

- 55 of a total of 87 patients in the sample undergoing radial/ulna surgery required internal fixation (i.e 63.22%). Remainder of the operations included debridement, Examination Under Anaesthesis, external fixation, fitting of Plaster Of Paris, removal of internal fixation, tendon repair et cetera) Therefore the cost of internal fixations should only be added for 63.22% of cases.
- Internal fixation most commonly used for radial fractures is radial plate and screws. No fixation is used for the ulna. (Personal communication: Dr Wood, consultant orthopaedic surgeon, Addington). Most commonly used plates have between 6 and 8 holes, therefore costed 8 holes for worst case scenario).
- Cost of recon plate with 8 holes = R671.23
- Cost of screws = R191.72 X 8 = R1533.76

Total cost = R2204.99

Laboratory tests

- Full blood count X 3 = R28.99 X 3 = R86.97
- Urea and electrolytes X 2 = R89.20 X 2 = R178.40
- Glucose (random) X 1 = R15.61

Total cost of lab tests = R280.98

Staff time (in ward and theatre)

- Consultant orthopaedic surgeon:
  154 minutes = 2.57 hours at cost of R227.96 per hour = R585.86
- Orthopaedic registrar
  197 minutes = 3.28 hours at cost of 172.34 per hour = R565.28
- Orthopaedic intern
  63 minutes = 1.05 hours at cost of 104.25 per hour = R109.46
- Professional nurse
  247 minutes = 4.12 hours at cost of 43.32 per hour = R178.33
- Staff nurse
  220 minutes = 3.67 hours at cost of 32.32 per hour = R118.51
- Student nurse
  70 minutes = 1.17 hours at cost of R27.77 per hour = R32.49
- Enrolled nursing assistant
  245 minutes = 4.08 hours at cost of R25.88 per hour = R105.59
- Porter
  50 minutes = 0.83 hours at cost of R23.79 per hour = R19.75

Additional staff time in theatre

- Anaesthetic consultant
  140 minutes = 2.33 hours at cost of R227.96 per hour = R531.91

Total costs of staff time in ward and theatre = R2247.18

Overhead costs

- Overhead costs for running orthopaedic ward for one day per patient = R200.98 (see calculations appendix 26)

Therefore overhead costs for hospital stay of 7 days = R1406.86

Cost for hospital treatment of one patient (unit cost for hospital treatment of injury to radius/ulna)

Therefore unit cost for hospital treatment of fractured radius/ulna = R6799.06 (including prosthesis) and R4574.07 (excluding prosthesis)

Cost for hospital treatment of radius/ulna injuries due to trauma in 2000
(NB: all calculations for number of patients rounded off to the nearest whole number)

- There were 96 patients who required radial/ulna surgery in 2000
- 81% of these were as a result of trauma (that is, 78 patients)
- Of these 78 patients, 63.22% required internal fixation (see above) that is, 49 patients required internal fixation and therefore cost R6799.06 each, or a total of R333153.94.
- The remaining 29 patients did not require internal fixation and therefore cost R4574.07 each or a total of R132648.03

Therefore, all the patients who had radial/ulna surgery as a result of trauma in the year 2000 cost R465801.97

APPENDIX 23. BOTTOM UP COSTING – TIBIA/FIBULA

Calculated for tibia and fibula injuries, or injuries to the tibia alone, on basis of 21 days in ward and 120 minutes in theatre

Drugs in ward

- Cefril 500mg 4x daily for 5 days as prophylaxis = R1.83 per tablet X 20 doses = R36.60
- Pethedine for 1.5 days = R0.10 X 3 doses per day X 4 days = R1.20
- Indocid suppositories for 2 days = R0.87 X 3 doses per day X 2 days = R5.22
- Indocid tablets for 9 days = R0.05 X 2 doses per day X 9 days = R0.90
- Paracod tablets for 9 days = R0.15 X 3 tablets per day X 9 days = R4.05

Total cost of drugs in ward = R47.97

Consumables in ward

- Cotton wool 100g = R13.61/5 = R2.72 (where one packet of 500g costs R13.61)
- Non-sterile latex gloves = R0.77 X 11 X 21 = R177.87 (where a box of 25 costs R19.35 and, on average, each of the medical staff would use one pair per day and each of the nursing staff 2 pairs per day when dealing with the patient – again, an estimate of the worst case scenario, but in this age of possible cross infection from patients, not a far-fetched one).
- 2 Venflons 18G = R5.59 X 2 = R11.18
- 2 Giving sets = R4.79 X 2 = R9.58
- 2l Ringers lactate over first 24 hours after theatre = R7.07 X 2 = R14.14

Total costs of consumables in ward = R215.49

X rays (AP and lateral views):

(X rays done before and after surgery)
(In practice, when a bone is injured, x ray of the joints above and below the injuries are taken as well as x rays of the bone itself, to check for injuries. After surgery, only the bone itself is x rayed to check for correct alignment (personal communication: Mr Senoge, consultant orthopaedic surgeon, Addington hospital).

- Chemicals per x ray = R2.61 X 8 x rays = R20.88
- Films per x ray:
  For tib/fib = 178 X 432mm (2 films used) = R2.89X 2 = R5.78 before surgery and R5.78 after surgery = R11.65
  For knee = 300 X 400mm (AP) + 180 X 240mm (lateral) = R4.51 + R1.63 = R6.14 before surgery
- For ankle = 180 X 240mm (2 films used) = R1.63 X 2 = R3.26 before surgery

- Radiographer for 90 minutes for admission x rays and 30 minutes for alignment x rays = 2 hours at R41.38 per hour = R82.96
- Specialist radiologist to read x rays at 7 minutes per x ray = 0.93 hours at R227.96 per hour = R212.00

Total x ray costs = R316.00

Drugs in theatre

(Spinal anaesthetic has been performed for all patients with lower limb surgery, since the early 1990's. Personal communication: Dr Neville Rutherford-Jones, consultant anaesthetist at Addington hospital).

- 1 ampoule heavy marcain (4ml) = R6.72
- ½ multidose vial of 1% lignocaine = R3.26

Total costs of drugs in theatre = R9.98

Consumables in theatre

- 2l Ringers lactate = R7.07 per lire = R14.14
- 1 venflon = R5.59
- 1 giving set = R4.79
- 1 5ml syringe = R0.34
- 1 2ml syringe = R0. 35
- 1 21G needle = R0.19 (box of 100 costs R18.81)
- 1 25G needle = R0.43 (box of 100 costs R42.97)
- 1 26G pencil point spinal needle = R36.09
- 10 pairs of sterile latex gloves (5 people double gloving to prevent infection) = R14.50 (one box of 25 pairs costs R36.25)

Total costs of consumables in theatre = R76.42

Internal fixation

(NB: percentage requiring internal fixation calculated on sample from Theatre Books, 1995-2000, where on average 98% of the data was available)

- 51 (42.50%) of the 120 patients requiring surgery for tibial or tibia/fibula injuries required internal fixation. Although the type of internal fixation was unspecified for 90% of these operations, discussions with Mr Senoge and Mr Wood (consultant and head of the orthopaedic department at Addington, and consultant in the same department respectively) revealed that most of these are Russell Taylor nails.

The cost of a Russell Taylor tibial nail is R2086.77.

Laboratory tests

- Full blood count X 3 = R28.99 X 3 = R86.97
- Urea and electrolytes X 2 = R89.20 X 2 = R178.40
- Glucose (random) X 1 = R15.61

Total cost of lab tests = R280.98

Staff time (in ward and theatre)

- Consultant orthopaedic surgeon:
  182 minutes = 3.03 hours at cost of R227.96 per hour = R691.48
- Orthopaedic registrar
  235 minutes = 3.92 hours at cost of 172.34 per hour = R675.00
- Orthopaedic intern
  91 minutes = 1.52 hours at cost of 104.25 per hour = R158.11
- Professional nurse
  348 minutes = 5.8 hours at cost of 43.32 per hour = R251.26
- Staff nurse
  826 minutes = 13.77 hours at cost of 32.32 per hour = R444.94
- Student nurse
  340 minutes = 5.67 hours at cost of R27.77 per hour = R157.36
- Enrolled nursing assistant
  1575 minutes = 26.25 hours at cost of R25.88 per hour = R1335.60

15 Porter
50 minutes = 0.83 hours at cost of R23.79 per hour = R19.75

- Physiotherapist
  80 minutes = 1.33 hours at cost of R41.38 per hour = R55.04

Additional staff time in theatre:

- Anaesthetic consultant
  140 minutes = 2.33 hours at cost of R227.96 per hour = R531.91

Total costs of staff time in ward and theatre = R4413.51

Overhead costs

- Overhead costs for running orthopaedic ward for one day per patient = R200.98 (see calculations in appendix 26)

Therefore overhead costs for hospital stay of 21 days = R4220.58

Cost for hospital treatment of one patient (unit cost for hospital treatment of injury to tibia/fibula)

Therefore unit cost for hospital treatment of fractured tibia/fibula = R11667.70 (including prosthesis) and R9580.93 (excluding prosthesis)

Cost for hospital treatment of tib/fib injuries due to trauma in 2000
(NB: all calculations for patients rounded off to the nearest whole number)

- There were 42 patients who required tib/fib surgery in 2000
- 86% of these were as a result of trauma (that is, 36 patients)
- Of these 36 patients, 42.50% required internal fixation (see above) that is, 15 patients required internal fixation and therefore cost R11667.70 each, or a total of R175015.50
- The remaining 11 patients did not require internal fixation and therefore cost R9580.93 each or a total of R105390.23

Therefore, all the patients who had tib/fib surgery as a result of trauma in the year 2000 cost R280405.73

APPENDIX 24. X RAY COSTS

Films:
(Source: Surgical stores Department, Addington hospital)

CPBU films used, supplied by AGFA
Cost of films (in mm^2) per box of 100

- 354 X 432mm = R577.47
- 432 X 178mm = R288.55
- 350 X 350mm = R475.50
- 240 X 300mm = R270.86
- 180 X 240mm = R162.52
- 300 X 400mm = R451.44

Therefore one of each film costs:

- 354 X 432mm = R5.77
- 432 X 178mm = R2.89
- 350 X 350mm = R4.76
- 240 X 300mm = R2.71
- 180 X 240mm = R1.63
- 300 X 400mm = R4.51

Size of film used for each bone/joint:
(Source: Mrs Schwarting, Chief Radiographer, X ray Department, Addington hospital)

- Knee: 300 X 400mm (AP) + 180 X 240mm (lateral)
- Ankle: 180 X 240mm (both AP and lateral)
- Wrist: 180 X 240mm (both AP and lateral)
- Elbow: 180 X 240mm (both AP and lateral)
- Femur: 178 X 432mm (both AP and lateral)
- Tibia/fibula: 178 X 432mm (both AP and lateral)
- Radius/ulna: 240 X 300mm (both AP and lateral)
- Humerus: 178 X 432mm (both AP and lateral)
- Shoulder: 240 X 300mm (both AP and lateral)
- Hand: 240 X 300mm (both AP and lateral)
- Foot: 240 X 300mm (both AP and lateral)
- Hip: AP Pelvis: 354 X 432mm + oblique 240 X 300mm

Chemicals:
(Source: Surgical stores Department, Addington hospital)

- Developer: one container of 20l costs R372.47
- Fixer: one container of 20l = R208.21

Use about 30 of each per month, therefore monthly cost of developer = R11174.10

And monthly cost of fixer = R6246.30
Therefore total monthly cost of chemicals = R17420.40

Do about 80 000 x rays per year = 6 667 x rays per month (rounded off to nearest whole number).
Therefore cost of chemicals for each x ray = R2.61

Staff time:
(Source: Mrs Schwarting, Chief Radiographer, X ray Department, Addington hospital)

- 1 radiographer can do x rays for any skeletal injury
  For all skeletal x rays, an AP (antero-posterior) and lateral view is done
  For some (about 20%) fractures, 2 additional oblique views are necessary.
- 1 radiographer will take, one average, 30 minutes to do AP and lateral views for a skeletal x ray.
  Oblique views, done in 20% of cases, will take an additional 30 minutes, that is, 60 minutes in total
- 1 consultant radiologist will take 5-10 minutes to read a skeletal x ray. An average of 7 minutes will be costed.

The above are averages and some staff x rays will be done and read faster and some slower than the average. However, these will hopefully cancel one another out.

APPENDIX 25. OVERHEAD COSTS FOR THE ORTHOPAEDIC WARD AT ADDINGTON HOSPITAL

(Source: Financial Department Addington hospital, Meena Roopnaryn)

Persal

Not included as staff time (for health care professionals) has already been costed (NB: This will mean that the costs of time accounted for by some categories of staff, such as administration, management, technical, kitchen staff etc will not be included, resulting in an underestimation of costs. However, this was felt to be preferable to mistakenly including the costs of any staff categories twice).

Administration

- R2 343 799

Equipment

- R1 682 064

Professional (contract services, including lights, water, telephone et cetera):

- R20 966 874

Maintenance

- R4 792 879

Total = R29785616

- Percentage of total patient days borne by orthopaedic ward = 13017 divided by 151161 = 8.62%
- Where 13017 = total patient days provided by orthopaedic ward and 151161 = total patient days provided by Addington hospital in 2000
  (Source: Informatics Department, Addington hospital).

Therefore orthopaedic ward is responsible for 8.62% of total expenditure of Addington in a year that is, 8.62% of R29785616= R2567520.10

Therefore overhead costs for the orthopaedic ward for one day = R7034.30

If there are an average of 35 patients in the ward on any day in the year (13017/365), then the overhead costs for one patient per day in the orthopaedic ward are R200.98

APPENDIX 26. COSTS OF STAFF TIME IN ZAR, DERIVED FROM ANNUAL STAFF SALARIES

Staff	Salary per annum	Vacation leave per annum	Sick leave per annum	Medical aid = 2/3 of maximum contribution of R1014 per month across the board = 676.03 Med aid per year = 676.03 X 12 = R 8112.36	Housing subsidy = maximum of R625 per month across the board = R 7500 per year	Total yearly income	Payment per hour (see calculations below)
Specialist (third notch)*	191 781 (basic) + 89 511 (overtime) = 257 805	22 days	12 days	8112.36	7500	273417.36	227.96
Registrar (second leg)#	156 681 (basic) + 61 471 (overtime) = 177 046	22 days	12 days	8112.36	7500	192658.36	172.34
Intern	77 937 (basic) + 41 453 (overtime) = 119 390	22 days	12 days	8112.36	7500	135002.36	104.25
Professional nurse	62 568	34 days	12 days	8112.36	7500	78180.36	43.32
Staff nurse	42 723	34 days	12 days	8112.36	7500	58335.36	32.32
Enrolled nursing assistant (ENA)	31 695	30 days	12 days	8112.36	7500	47307.36	25.88
Student nurse♣	36 405	22 days	12 days	8112.36	7500	52017.36	27.77
Porter	28 296	30 days	12 days	8112.36	7500	43908.36	23.79
Physiotherapist	62 568	22 days	12 days	8112.36	7500	78270.36	41.38
Radiographer	62658	22 days	12 days	8112.36	7500	78270.36	41.38

(Source: Human Resources Department at Addington hospital, 2002)

* A consultant on the third notch was chosen as this is the highest that can be achieved in the public service, and the "worst case scenario" was costed where possible

\# A registrar on the second leg was chosen as there are currently no registrars senior to this at Addington.

♣ Student nurses do receive medical aid and housing subsidies, but, like all other categories of staff, only after one year of service. They are still considered to be employees of the Health Department. (Personal communication: Matron Chinnia, Addington hospital).

Note 1: Maximum for each category has been costed, for example maximum sick leave taken by all staff each year, maximum housing and medical aid subsidies taken by all staff each year.

Note 2: All classes of nurses work a minimum of 3 months night duty per year. This entails 77 hours per week. For the remainder of the year they work 40 hours per week day duty.

Note 3: All categories of medical staff work 40 hours per week at basic rate of pay, and 16 hours per week of commuted overtime at a higher rate of pay.

Calculations for costs of staff time:

Medical staff

- All categories of medical staff work 40 hours per week at their basic rate of pay and 16 hours per week at a commuted overtime rate of pay (see above).
- All categories of medical staff work 331 days per year (365 days per year – 22 days vacation leave – 12 days sick leave). In other words, all categories of medical staff work 47.29 weeks per year. That is, they work 1891.43 hours per year for their basic salary, and 756.57 hours for their overtime salary.

- For a **consultant**, the rate of payment per for 40 hours per week worked = 191 781 (basic salary) + 8112.36 (medical aid) + 7500 (housing subsidy) divided by 1891.43 hours = R109.65 per hour
- For a **consultant**, the rate of payment per for 16 hours overtime per week worked = 89 511 divided by 756.57 hours = R118.31 per hour.

Therefore the hourly rate of a medical **consultant** is R109.65 + R118.31 = R227.96

- For a **registrar**, the rate of payment per for 40 hours per week worked = 156 681 (basic salary) + 8112.36 (medical aid) + 7500 (housing subsidy) divided by 1891.43 hours = R91.09 per hour
- For a **registrar**, the rate of payment per hour for 16 hours overtime per week worked = 61 471 divided by 756.57 hours = R81.25 per hour.

Therefore the hourly rate of a **registrar** is R109.65 + R340.75 = R172.34

- For an **intern**, the rate of payment per for 40 hours per week worked = 77 937 (basic salary) + 8112.36 (medical aid) + 7500 (housing subsidy) divided by 1891.43 hours = R49.46 per hour
- For an **intern**, the rate of payment per hour for 16 hours overtime per week worked = 41 453 divided by 756.57 hours = R54.79 per hour.

Therefore the hourly rate of an **intern** is R49.46 + R54.79 = R104.25

Nursing staff

- All categories of nursing staff work 40 hours per week when on day duty. When on night duty (for three months of the year), they work 77 hours per week every second week.

- A **professional nurse** works 319 days in a year (365 days – 34 days vacation leave – 12 days sick leave). That is, a professional nurse works 45.57 weeks in a year.
  For 12 of these weeks when she works night duty, she works a total of 462 hours (77 hours every second week).
  For the remaining 33.57 weeks on day duty, she works a total of 1342.86 hours
  Therefore in a year, she works 1804.86 hours.
  Her total earnings in a year = 62 568 (Basic salary) + 8112.36 (medical aid) + 7500 (housing subsidy) = R78 180.30

Therefore the hourly rate of a **professional nurse** = R78 180.36 divided by 1804.86 = R43.32
NB: There is no overtime for nurses on day duty and a negligable allowance for night duty, therefore this was not costed (Personal communication: Matron Chinnia, Addington hospital).

- A **staff nurse** works the same number of hours in a year as a professional nurse, that is, 1804.86 hours.
  The basic salary of a staff nurse is R42 723 per annum. With medical aid and housing subsidy (as for a professional nurse), her total yearly earnings are R58 335.36

Therefore the hourly rate of a **staff nurse** is R32.32

☼ An **enrolled nursing assistant** (ENA) gets 30 days vacation leave per year. Therefore, including sick leave (see above), she works a total of 323 days, or 46.14 weeks in a year. For 12 of these weeks on night duty, she works a total of 462 hours (see above). For the remaining 34.14 weeks, she works a total of 1365.71 hours. Therefore in a year, an ENA works 1827.71 hours.
The basic salary of an ENA is R31 695 per annum. With medical aid and housing subsidy, her total yearly earnings are R47 307.36.

Therefore the hourly rate of an **enrolled nursing assistant** is R25.88
NB: The feminine pronoun used for nurses as, in the experience of the principal investigator, most of the nurses at Addington are female.

☼ A **student nurse** gets 22 days vacation leave in a year. Therefore including sick leave, she works a total of 331 days or 47.28 weeks per year. For 12 of these weeks she is on night duty and works a total of 462 hours (see calculations above). For the remaining 35.29 weeks of the year, she works a total of 1411.43 hours. Therefore in a year, a student nurse works 1873.42 hours.
The total yearly income of a nurse, including a basic salary of R36 405, medical aid subsidy of R8112,36 and housing subsidy of R7500, is R50 217.36

Therefore the hourly rate of a **student nurse** is R27.77

Other staff

☼ A **porter** gets 30 days vacation leave per year. Therefore, with 12 days sick leave, he works a total of 323 days or 46.14 weeks per year. Since he works 40 hours in a week, he works a total of 1845.71 hours in a year.
A porter's yearly income is R28 296 (basic salary) + R8112.36 (medical aid) + R7500 (housing subsidy) = R43 908.36

Therefore a **porter's** hourly rate is R23.79

☼ A **physiotherapist** works the same number of hours in a year as does a porter (see above). Her annual salary (including medical aid and housing subsidy) is R62 568 + R8112.36 + R7500 = R78 180.36

Therefore the hourly rate of a **physiotherapist** is R42.36.

☼ The calculations for a **radiographer's** salary are the same as for a physiotherapist.

Formula to calculate cost of staff time spent with patient

Total minutes spent with patient ÷60) X staff payment per hour

Appendix 27. Drug treatment

Antibiotic treatment

- Augmentin: 8 patients
- Cefril: 84 patients
- Cloxacillin: 15 patients
- Flucloxacillin: 12 patients
- Gentamycin: 5 patients

Total patients for whom antibiotic treatment is known = 124
Therefore percentage of patients receiving cefril = 67.7%

Analgesia

- Brufen: 7 patients
- Codis: 4 patients
- Doloxene: 16 patients
- Indocid: 43 patients
- Omnopon: 4 patients
- Paracetamol: 5 patients
- Paracod: 31 patients
- Pethedine: 10 patients

Total patients for whom analgeisa is known = 120

Appendix 28. Cause of injury in each age group in 2000

Age (years)	ssault	Fall	Gunshot	MVA unspecified	MVA driver	MVA pedestrian	MVA passenger	Other	Tumour	Total
0-9								1		1
10-19	1	2	3			6	5	2		19
20-35	8	13	13	6	5	14	7	3	1	70
36-60	8	14	6	1	1	5	4		1	40
61-100		18	1						1	20

APPENDIX 29. PERCENTAGE OF ADMISSIONS CAUSED BY TRAUMA PER YEAR

FEMUR

Year of admission	Assault	Fall	Gunshot	MVA	MVA driver	MVA pedestrian	MVA passenger	MVA total	Osteo-arthritis	Rheumatoid arthritis	Tumour	Other	Total cause known	Number caused by trauma	Percent caused by trauma
1998		8	8	3	2	9	3					1	35	25	71
1999	1	10	7	3	2	6	6					1	35	25	71
2000	2	10	17	2	2	10	9				2		54	42	78
Total	3	28	32	8	6	25	18				2	2	124	92	74

ANKLE

Year of admission	Assault	Fall	Gunshot	MVA	MVA driver	MVA pedestrian	MVA passenger	MVA total	Osteo-arthritis	Rheumatoid arthritis	Tumour	Other	Total cause known	Number caused by trauma	Percent caused by trauma
1998		4					1						5	1	20
1999		2				2	1						5	3	60
2000	2	5	1			1	1					1	11	5	45
Total	2	11	1			3	3					1	21	9	43

ELBOW

Year of admission	Assault	Fall	Gunshot	MVA	MVA driver	MVA pedestrian	MVA passenger	MVA total	Osteo-arthritis	Rheumatoid arthritis	Tumour	Other	Total cause known	Number caused by trauma	Percent caused by trauma
1998	1	1	1										3	2	66
1999		2	1										3	1	33
2000	3	1	1										5	4	80
Total	4	4	3										11	7	64

HAND (incorporated with fingers and thumbs)															
Year of admission	Assault	Fall	Gunshot	MVA	MVA driver	MVA pedestrian	MVA passenger	MVA total	Osteo-arthritis	Rheumatoid arthritis	Tumour	Other	Total cause known	Number caused by trauma	Percent caused by trauma
1998	1	1	1										3	2	66
1999		2	1										3	1	33
2000	3	1	1										5	4	80
Total	4	4	3										11	7	64

FOOT															
Year of admission	Assault	Fall	Gunshot	MVA	MVA driver	MVA pedestrian	MVA passenger	MVA total	Osteo-arthritis	Rheumatoid arthritis	Tumour	Other	Total cause known	Number caused by trauma	Percent caused by trauma
1998		1											1	0	
1999	1		1		2								4	4	100
2000		1		1		2						1	5	4	80
Total	1	2	1	1	2	2						1	10	8	80

HIP AND NECK OF FEMUR															
Year of admission	Assault	Fall	Gunshot	MVA	MVA driver	MVA pedestrian	MVA passenger	MVA total	Osteo-arthritis	Rheumatoid arthritis	Tumour	Other	Total cause known	Number caused by trauma	Percent caused by trauma
1998	3		1									2	6	1	17
1999	1		1			1							3	2	67
2000	9					1						1	11	2	18
Total	13		2			2						3	20	5	25

HUMERUS															
Year of admission	Assault	Fall	Gunshot	MVA	MVA driver	MVA pedestrian	MVA passenger	MVA total	Osteo-arthritis	Rheumatoid arthritis	Tumour	Other	Total cause known	Number caused by trauma	Percent caused by trauma
1998		1	1	1		1							4	3	75
1999	1	1			1	1							4	3	75
2000	1	1		1	1	5							9	8	89
Total	2	3	1	2	2	7							17	14	82

KNEE AND PATELLA															
Year of admission	Assault	Fall	Gunshot	MVA	MVA driver	MVA pedestrian	MVA passenger	MVA total	Osteo-arthritis	Rheumatoid arthritis	Tumour	Other	Total cause known	Number caused by trauma	Percent caused by trauma
1998		1	1			1					1		4	2	50
1999	1		1	1	1	2						1	7	6	86
2000		3	1			1							5	2	40
Total	1	4	3	1	1	4					1	1	16	10	63

RADIUS/ULNA AND RADIUS ALONE															
Year of admission	Assault	Fall	Gunshot	MVA	MVA driver	MVA pedestrian	MVA passenger	MVA total	Osteo-arthritis	Rheumatoid arthritis	Tumour	Other	Total cause known	Number caused by trauma	Percent caused by trauma
1998	1	2	2			1						2	8	4	50
1999	2		2	2	1	3	1					3	14	11	79
2000	5	3	1	1	1	4	1						16	13	81
Total	8	5	5	3	2	8	2					5	38	28	74

SHOULDER															
Year of admission	Assault	Fall	Gunshot	MVA	MVA driver	MVA pedestrian	MVA passenger	MVA total	Osteo-arthritis	Rheumatoid arthritis	Tumour	Other	Total cause known	Number caused by trauma	Percent caused by trauma
1998	1					1	1					2	5	3	60
1999	1	2									1	1	5	2	40
2000	1	1										1	3	1	33
Total	3	3				1	1				1	4	13	6	46

TIBIA/FIBULA AND TIBIA ALONE															
Year of admission	Assault	Fall	Gunshot	MVA	MVA driver	MVA pedestrian	MVA passenger	MVA total	Osteo-arthritis	Rheumatoid arthritis	Tumour	Other	Total cause known	Number caused by trauma	Percent caused by trauma
1998						5							5	5	100
1999						4	1					2	7	5	71
2000			1	1	1	3						1	7	6	86
Total			1	1	1	12	1					3	19	16	84

Appendix 30. Trauma as a cause for admission

Table: Year of admission vs. cause of admission 1995-2000 (inclusive)

Year of admission	Cause of admission													
	Assault	Fall	Gunshot	MVA unspecified	MVA driver	MVA pedestrian	MVA passenger	Osteo-arthritis	Rheumatoid arthritis	Tumour	Other	Total admissions cause known	Total admissions	Percentage admissions cause known
1995			1				2					3	144	2.08
1996		1	4	5	1	1	1	3	1	1	1	19	236	8.05
1997	2	5	5	3		1	4	1	2	3	2	28	330	8.48
1998	4	30	18	5	3	26	7			3	9	103	298	34.56
1999	15	29	15	7	5	26	12		1	2	12	124	362	34.25
2000	19	47	22	7	6	25	16			3	6	151	337	44.81
Total	40	112	65	27	15	79	42	4	4	12	30	430	1707	25.19

Table: Frequency and percentage of cause of admission for year 2000

	Assault	Fall	Gunshot	MVA Un-specified	MVA driver	MVA pedestrian	MVA passenger	MVA total	Osteo-arthritis	Rheumatoid arthritis	Tumour	Other	Total Adm-issions cause known	Total admissions	% adm-issions cause known	Total caused by trauma
Number	19	47	22	7	6	25	16	54			3	6	151	337	44.81	95
Percentage of all admissions, cause known	12.59	31.13	14.56	4.64	3.97	16.56	11.00	35.76			2.00	3.97				62.91

Table: Proportion of total trauma cases caused by each type of trauma

	Assault	**Gunshot**	**MVA unspecified**	**MVA driver**	**MVA pedestrian**	**MVA passenger**	**MVA total**	**Total cases caused by trauma**
Number	19	22	7	6	25	16	54	95
Percent	20.00	23.16	7.37	6.32	26.32	16.84	56.84	100

Table: Proportion of total admissions caused by MVA, due to each type of MVA

	MVA unspecified	**MVA driver**	**MVA pedestrian**	**MVA passenger**	**MVA total**
Number	7	6	25	16	54
Percent	12.96	11.11	46.30	29.63	100

Appendix 31. Trends of cause of injury vs. gender

Assault

Year of admission	Female	Male	Total
1995			
1996			
1997		2	2
1998	1	3	4
1999	4	11	15
2000	4	13	17
Total	9	29	38

Fall

Year of admission	Female	Male	Total
1995			
1996	1		
1997	1	4	5
1998	18	12	30
1999	13	16	29
2000	25	21	46
Total	58	53	111

Gunshot

Year of admission	Female	Male	Total
1995			
1996		4	4
1997	3	2	5
1998		18	18
1999		15	15
2000	2	21	23
Total	5	50	65

MVA

Year of admission	Female	Male	Total
1995			
1996	2	2	4
1997	2	2	4
1998	2	3	5
1999		7	7
2000	2	5	7
Total	8	19	27

MVA driver

Year of admission	Female	Male	Total
1995			
1996		1	1
1997			
1998		3	3
1999		5	5
2000		6	6
Total		15	15

MVA pedestrian

Year of admission	Female	Male	Total
1995			
1996		1	1
1997		1	1
1998	6	20	26
1999	6	20	26
2000	7	17	24
Total	19	59	54

MVA passenger

Year of admission	Female	Male	Total
1995			
1996		1	1
1997	2	2	4
1998	4	3	7
1999	7	5	12
2000	5	11	16
Total	18	22	40

Osteo-arthritis

Year of admission	Female	Male	Total
1995			
1996	2	1	3
1997	1		1
1998			
1999			
2000			
Total	3	1	4

Rheumatoid arthritis

Year of admission	Female	Male	Total
1995			
1996	1		1
1997	1	1	2
1998			
1999	1		1
2000			
Total	3	1	4

Tumour

Year of admission	Female	Male	Total
1995			
1996		1	1
1997	3		3
1998	2	1	3
1999	2		2
2000	2	1	3
Total	9	3	12

Other

Year of admission	Female	Male	Total
1995			
1996	1		1
1997	1	1	2
1998	3	6	9
1999	4	8	12
2000	1	5	6
Total	10	20	30

Appendix 32. Trends of cause of injury vs. race

Assault

Year of admission	Race			
	Asian	Other	Black	Total
1995				
1996				
1997		1	1	2
1998			4	4
1999	1	2	13	16
2000	2	3	14	19
Total	3	6	32	41

Fall

Year of admission	Race			
	Asian	Other	Black	Total
1995				
1996		1		1
1997	1	3	1	5
1998	6	11	12	29
1999	4	11	14	18
2000	20	13	14	47
Total	31	39	41	100

Gunshot

Year of admission	Race			
	Asian	Other	Black	Total
1995			1	1
1996			4	4
1997		1	4	5
1998	1	1	16	18
1999	1		14	15
2000	2	3	18	23
Total	4	5	57	66

MVA

Year of admission	Race			
	Asian	Other	Black	Total
1995				
1996	1	2	2	5
1997	1	2		3
1998	2	2	1	5
1999	1	2	4	7
2000	2	3	2	7
Total	7	11	9	27

MVA driver

Year of admission	Race			
	Asian	Other	Black	Total
1995				
1996	1			1
1997				
1998	1		2	3
1999		1	4	5
2000	4	1	1	6
Total	6	2	7	15

MVA pedestrian

Year of admission	Race			
	Asian	Other	Black	Total
1995				
1996		1		1
1997			1	1
1998	5	3	18	26
1999	5	4	17	26
2000	5	1	19	25
Total	15	9	55	79

MVA passenger

Year of admission	Race			
	Asian	Other	Black	Total
1995	2			2
1996			1	1
1997	1		3	4
1998	4	2	1	7
1999	4		8	12
2000	6	2	8	16
Total	17	4	21	42

Osteo-arthritis

Year of admission	Race			
	Asian	Other	Black	Total
1995				
1996	1	1	1	3
1997		1		1
1998				
1999				
2000				
Total	1	2	1	4

Rheumatoid arthritis

Year of admission	Race			
	Asian	Other	Black	Total
1995				
1996		1		1
1997		1	1	2
1998				
1999		1		1
2000				
Total		3	1	4

Other

Year of admission	Race			
	Asian	Other	Black	Total
1995				
1996		1		1
1997			2	2
1998	3	1	5	9
1999	4	5	3	12
2000	1	1	4	6
Total	8	8	14	30

Tumour

Year of admission	Race			
	Asian	Other	Black	Total
1995				
1996			1	1
1997	2		1	3
1998	1		2	3
1999		1		1
2000		1	2	3
Total	3	2	6	11

Appendix 33. Tariff costs

(charged to patients with medical aid attending public hospitals)

Source: Uniform Patient Fee Schedule (UPFS) for Externally Funded Patients attending Public Hospitals, April 2002[3]

Fractured femur
Calculated on basis of 21 days in ward, 4 x rays and seven contacts with physiotherapist

Anaesthetic category A, procedure category C

- Anaesthetic (professional fee): R144
- Radiology: R60 (professional fee)
  R30 (facility fee)
  For 4 sets of x rays = total of R360
  (X ray femur, knee and hip on admission, x ray femur post surgery)
- Inpatient (general ward):
  R116 per day (professional fee) for 21 days in ward = R2436
  R643 per day (facility fee) for 21 days in ward = R13503
- Pharmacy (prescription on discharge): R17
- Theatre procedure fee: R898 (professional fee)
  R2231 (facility fee)
- Physiotherapy:
  Facility fee (Supplementary health treatment in secondary level hospital): R25 for each of seven contacts = R175
  Professional fee (allied health practitioner): R46 for each of seven contacts = R322

Total for 21 days in ward = R20 086.00

Tibia/fibula or tibia alone
Calculated on basis of 21 days in ward, 4 x rays and seven contacts with physiotherapist

[3] "Most tariffs are based on a flat fee for services, rather than the itemised approach adopted in the past. The fees have been calculated to include overheads cost such as electricity and provision of general equipment as well as the cost of consumables. Account has also been taken of the salaries of support staff. The intention is to reduce the amount of items that appear on bills but to still reflect the value of the service being provided" UPFS April 2002.

Anaesthetic category A, procedure category B

- Anaesthetic (professional fee): R144

- Radiology: R60 (professional fee)
  R30 (facility fee)
  For 4 sets of x rays total cost = R360
  (X ray tib/fib, knee and ankle on admission, and x ray tib/fib post surgery)

- Inpatient (general ward):
  R116 per day (professional fee) for 21 days in ward = R2436
  R643 per day (facility fee) for 21 days in ward = R13503

- Pharmacy (prescription on discharge): R17

- Theatre procedure fee: R426 (professional fee)
  R1296 (facility fee)

- Physiotherapy:
  Facility fee (Supplementary health treatment in secondary level hospital): R25 for each of seven contacts = R175
  Professional fee (allied health practitioner): R46 for each of seven contacts = R322

Total for 21 days in ward = R18 679.00

Ankle
Calculated on basis of 21 days in ward and no contacts with physiotherapist

Anaesthetic category A, procedure category B

- Anaesthetic (professional fee): R144

- Radiology: R60 (professional fee)
  R30 (facility fee)
  Total cost for 2 sets of x rays = R180
  (X ray ankle on admission and post surgery)

- Inpatient (general ward):
  R116 per day (professional fee) for 21 days in ward = R2436
  R643 per day (facility fee) for 21 days in ward = R13503

- Pharmacy (prescription on discharge): R17

- Theatre procedure fee: R426 (professional fee)
  R1296 (facility fee)

Total for 21 days in ward = R18 002.00

Humerus
Calculated on basis of 21 days in ward, 4 sets of x rays and no contacts with physiotherapist

Anaesthetic category A, procedure category B

- Anaesthetic (professional fee): R144

- Radiology: R60 (professional fee)
  R30 (facility fee)
  or 4 sets of x rays = R360
  (X ray humerus, shoulder and elbow on admission, x ray humerus post surgery).

- Inpatient (general ward):
  R116 per day (professional fee) for 21 days in ward = R2436
  R643 per day (facility fee) for 21 days in ward = R13503

- Pharmacy (prescription on discharge): R17

- Theatre procedure fee: R426 (professional fee)
  R1296 (facility fee)

Total for 21 days in ward = R18 182.00

Radius/ulna
Calculated on basis of seven days in the ward, 4 sets of x rays and no contacts with the physiotherapist

Anaesthetic category A, procedure category C

- Anaesthetic (professional fee): R144

- Radiology: R60 (professional fee)
  R30 (facility fee)
  For total of 4 sets of x rays = R360
  (X ray radius/ulna, elbow and wrist on admission, x ray radius/ulna on discharge).

- Inpatient (general ward):
  R116 per day (professional fee) for 7 days in ward = R812
  R643 per day (facility fee) for 7 days in ward = R4501

- Pharmacy (prescription on discharge): R17

- Theatre procedure fee: R898 (professional fee)
  R2231 (facility fee)

Total for 7 days in ward = R8 963.00