

TITLE: One year mortality following surgical intervention for neck of femur fractures in the elderly in a developing country.

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DECLARATION

I, Barend Hermanus Pieterse, declare that this research report is my own original work. It is being submitted for the degree of Master of Medicine in orthopaedics at the University of the Witwatersrand, Johannesburg. It has been submitted before for a MMed degree. On 31 May 2017 it passed with a mark of 72% with minor corrections.

Signed:

This.....day of 2017

DEDICATION

Deepest thanks go to my dear wife, Ria for always being there for me, your love and support helped me in my research. And to my lovely son, Harry for providing extra motivation to complete it.

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This thesis would not have been successfully without the help, guidance and support of a number of individuals. I would like to express my profound thanks to them.

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ABSTRACT

BACKGROUND: Fractures of the neck of the femur are currently one of the most serious health care problems facing developed nations on account of their aging populations. The one-year mortality rate is in the region of 30%. Although less of burden in developing nations, the fractures still affect a significant proportion of the elderly population. Very little has been published on the subject in developing nations and outcomes in resource rich countries may not be applicable to the less developed world. We hypothesized that the one year mortality would be higher in our setting.

AIM OF THE STUDY: To determine the one year mortality following operative treatment of neck of femur fractures in the elderly at Charlotte-Maxeke Johannesburg academic hospital.

METHODS: We undertook a retrospective study of all patients admitted with a fractured neck of femur in a teaching hospital over a five year period. Males and females over the age of 65 who underwent surgical treatment for neck of femur fractures were included into the study. Excluded was open fractures of any nature, neck of femur fractures due to tumors or metastatic bone disease, hip fractures other than neck of femur fractures and hip fractures treated non-operatively. The patient's files were collected to identify their ID numbers. Home affairs records were used to determine if the ID numbers were registered as a death. The website <http://www.dha.gov.za/status> was used for this purpose. To determine the time of death of the deceased patients Home affairs was contacted using the Request for access to record of public body form.

RESULTS: The study comprised of 66.2% females and 33.8% males with a age range of 65-93 and a mean age of 80. We found that females had a higher age at the time of surgery than males. Our one year mortality was 43% ($p=0.00288781$) and significance level of 99.7%.

CONCLUSION: Our mortality rate was significant higher compared to international or local figures. This might be due to the higher age of patients that we are seeing or lack of proper treatment protocols for the elderly with neck of femur fractures. Further investigations are needed to determine the cause.

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ABBREVIATIONS

- | | |
|-----------|---|
| 1. NOF | Neck of Femur fractures |
| 2. DHS | Dynamic Hip Screw |
| 3. THA | Total Hip Arthroplasty |
| 4. USA | United States of America |
| 5. NHS | National Health Service |
| 6. POSSUM | Physiological and Operative Severity Score for the enumeration of Mortality |
| 7. KZN | Kwa-Zulu Natal |
| 8. CMJAH | Charlotte Maxeke Johannesburg Academic Hospital |
| 9. ID | Identification document |

1.0 INTRODUCTION

1.1 BACKGROUND AND LITERATURE REVIEW

1.1.1 ANATOMY

The neck of the femur (NOF) is a flattened pyramidal process of cancellous bone that connects the femoral head with the femoral shaft, as shown in Figure 1.

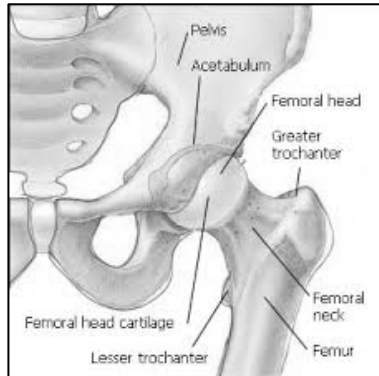


FIGURE 1

<http://www.rudyard.org/transverse-acetabular-ligaments>

The hip is a ball-and-socket joint that is surrounded by muscles, enabling a wide range of motion in several planes like Flexion, Extension, Abduction, Adduction and Circumduction while at the same time exhibiting remarkable stability¹. As the link between the lower extremities and the upper skeleton, the hips not only transmit forces from the ground up but also carry forces from the axial skeleton and upper extremities¹.

The hip joint is unique anatomically and physiologically thus pathological conditions is more difficult to diagnose than for most other joints¹ as shown is section 1.1.2

1.1.2 FEMORAL HEAD BLOOD SUPPLY

The vascular supply to the femoral head (Figure 2) has been well studied due to the risk of vascular necrosis of the head. When it is disrupted, particularly in fractures or dislocation of the hip¹ three areas are affected. (1)Small vessel found within the ligamentum teres. (2)Supply from the medullary canal. (3)And a network of vessels anastomosing around the femoral neck.

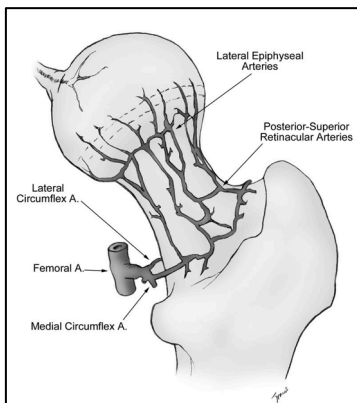


FIGURE 2

<http://msk-anatomy.blogspot.com/2012/09/normal-circulation-of-femoral-head.html>

This third mentioned is perhaps the most important of the three¹. These small vessels ascend toward the femoral head in the synovial membrane that is attached onto the femoral neck. These vessels originate from posterior, mainly from the medial circumflex femoral artery that is a branch off the deep femoral artery. The lateral circumflex artery makes less of a contribution¹.

1.1.3 FRACTURE CLASSIFICATIONS AND TREATMENT OPTIONS

British orthopaedic surgeon Robert Symon Garden described a classification system that is based on the completeness of the fracture line extending from the one cortex to the other. And the amount of displacement. This classification is referred to as the Garden classification and consisting of four grades (Figure 3).

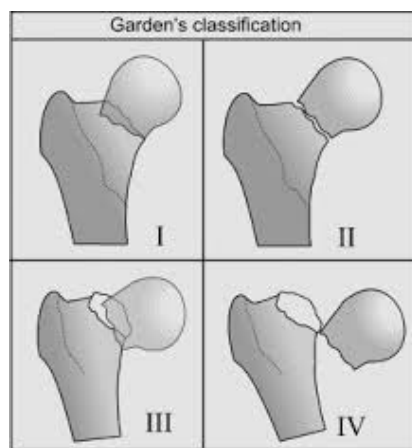


FIGURE 3

<http://www.gla.ac.uk/t4/~fbis/files/fab/tutorial/clinical/orhip.html>

Garden classification

- I – Incomplete fracture with valgus impaction
- II - Complete fracture with no displacement
- III – Complete fracture with less than 50% displacement
- IV – Complete fracture with more than 50% displacement

Femoral neck fractures can also be classified descriptively into nondisplaced and displaced fractures dictated by the alignment of the fractured segments in relation to the original anatomic position of the femur. This classification help with treatment options.

Nondisplaced (Garden 1,2) fractures of the femoral neck that are in near-normal alignment found on initial x-rays are called nondisplaced NOF by most orthopaedic surgeons. About 30% of femoral neck fractures are classified as nondisplaced^{2,3}. The treatment of nondisplaced femoral neck fractures is fairly uncontroversial and generally involves internal fixation⁴. Either DHS (Dynamic Hip Screw) (Figure 4), Cannulated screws (Figure 5) or Cepho-medullary reconstruction nails (Figure 6) can be used. With the NOF aligned and stabilized with one of these devices, these fractures commonly heal without complications.

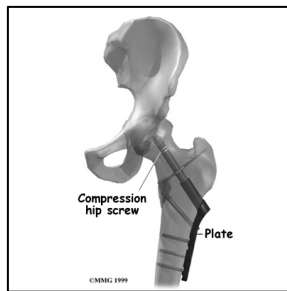


FIGURE 4

<http://www.orthogate.org/patient-education/hip/hip-screw-compression-fixation-for-a-fractured-hip.html>

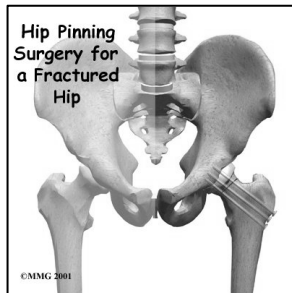


FIGURE 5

<http://www.eorthopod.com/hip-pinning-surgery-for-a-fractured-hip/topic/53>

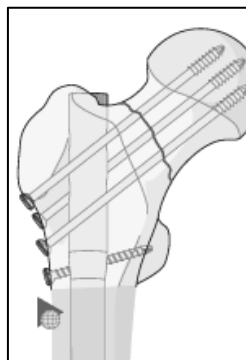


FIGURE 6

<https://www2.aofoundation.org>

Displaced (Garden 3,4) fractures of the femoral neck that are found on initial x-rays to be moderately to severely misaligned are called displaced femoral neck fractures. There are more controversy's surrounding the treatment of these type of fractures^{5,6}. Elderly patients with displaced femoral neck fractures may be treated with different types of arthroplasties, either hemiarthroplasty (Figure 7), or THA^{5,6} (Figure 8). Selecting which one depends on multiple factors, such as the patient's general health status, cognitive status, functional abilities, age, and surgeon preference⁷

FIGURE 7 <http://www.eorthopod.com/hip-fractures/topic/49>

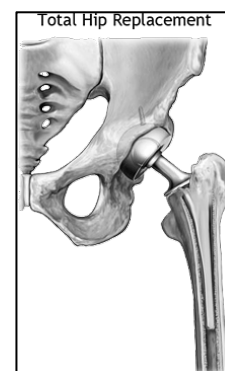
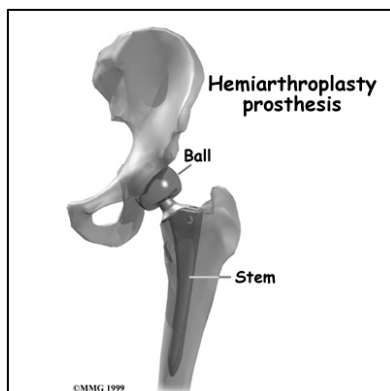


FIGURE 8

<http://www.bannercorecenter.com/banner-core-specialties/hip-replacement>

A 2008 review by Miyamoto et al⁸ noted that there is a limited role for non-surgical management and that cemented unipolar hemiarthroplasty remains a good option. They stated that in appropriately selected patients the outcome following total hip replacement appears to be favorable.

1.1.4 THE BURDEN OF NECK OF FEMUR FRACTURES

The fact that fractures of the femoral neck in the elderly occurs, has led to the notion that this is, a pathological fracture. This is not a new concept. Nearly 200 years ago Astley Cooper (1824) noted the relationship between old age and fragility of the bones, which “. . . become thin in their shell and spongy in their texture”⁹.

Millar¹⁰ proposed that NOF fractures may be viewed as a disease with a predictable rate and pattern of mortality. Not only is the acute injury accompanied by pain, and an inability to walk or stand on the fractured leg, but there is significant vascular damage to the femoral head as shown before. Ultimately leading to avascular necrosis that progresses to secondary osteoarthritis.

In terms of loss in disability-adjusted years for people 65 years and older NOF fractures rank in the top ten of all impairments worldwide¹¹.

NOF fractures in the elderly leads to a functional decline and a reduce quality of life. Furthermore, they are associated with an in-hospital mortality rate of 7–14%¹². Morbidities associated with NOF fractures may include, deep vein thrombosis (DVT), Muscle wasting, Postoperative infection, pain, and loss of mobility¹³. However, it is not clear how much of percentage of the mortality is due to the fracture and its sequelae or to the underlying frailty of the patient that may predispose them to a fracture¹⁴.

Revision surgery on NOF fractures are around 49% (42% Internal fixation, 7% Hemiarthroplasty), which is heavily influenced by fracture characteristics and surgical interventions¹⁵. Which places a enormous burden on the surgeon to treat these fractures appropriately.

There is an increase in the world's ageing population due to better medical care. And the incidence of femoral neck fractures is expected to triple in the next 50 years¹⁶. It is estimated that the number of NOF fractures will increase to 2.6 million in 2025 and to 6.3 million by the year 2050¹⁶.

Despite the advances that have been made in terms of the surgical and medical management, the one-year mortality rate of neck of femur fractures remains in the region of 30%¹⁶. The immediate mortality rate after a fracture of the hip in an elderly population is raised for a period^{18,10} before returning to that of the normal population.

Avascular necrosis can be expected in 12% of displaced fractures and non-union may occur in 28% of cases¹⁹. Overall, the risk for failure of fixation of displaced fractures is estimated at 43%¹⁹.

1.1.5 EVIDENCE-BASED THERAPIES

Given the interest in identifying strategies to improve outcomes in NOF fractures over the past five decades, we would predict significant improvements in the mortality rate, as has been the case with mortality after myocardial infarction and stroke. Carandand et al²⁰ showed that mortality rates from coronary artery disease in the USA decreased by over 40% within 20 years (1980 to 2000), which prevented 340,000 deaths in the year 2000. Nearly half of this reduction in mortality has been attributed to the introduction of “evidence-based medical therapies”²¹.

The National Health Service (NHS) in the United Kingdom in 2008 realized the burden and poor mortality of NOF fractures and introduced a national clinical guideline for the management of hip fractures in older people. It was implemented and aimed at improving the 30-day mortality rate.

In the National Hip Fracture Database report (2012) the features addressed to improve quality of their fracture service²² as stipulated by the NHS was as follow.

- ❖ Prompt admission to orthopaedic care (<6 hours from fracture)
- ❖ Rapid comprehensive assessment – medical, surgical and anaesthetic
- ❖ Minimal delay to surgery (<48 hours)
- ❖ Accurate and well-performed surgery
- ❖ Prompt mobilization (12-18 hours post-operative)
- ❖ Early multidisciplinary rehabilitation

With these guidelines the acute length of stay reduced three fold²² and the 30-day mortality rate went from 9.4% in 2008 to 8.0% in 2011²².

Similarly in the United States of America the following guidelines were implemented²³.

- ❖ Admission to medical ward for adequate analgesia and consultation with an orthopedic surgeon
- ❖ Prophylaxis against thromboembolism and infection
- ❖ Optimization of comorbidities
- ❖ Surgery within 48 hours
- ❖ Fast track rehabilitation

The 1 year mortality for women decreased from 24% in 1986 to 21.9% in 2009²³. For men the decrease was somewhat larger: from 40.6% in 1986 to 32.5% in 2009²³.

1.1.6 PREDICTING MORTALITY RATE

Fangke et al. postulated the mortality could be the result of comorbidities and the complications, and not the fracture itself. He highlights the need to identify those patients who are candidates for interventions in order to reduce their risk for mortality²⁴. Intense controversies are still ongoing about these preoperative risk factors for the high mortality²⁵. The presence of concomitant medical illness and poor health status as negative predictors were reported in numerous studies. Advanced age^{24,25}, male gender^{24,25}, poor pre-fracture functional abilities^{24,25}, low preoperative haemoglobin level^{24,25} and diabetes²⁵. Dementia was also suggested as a predictor of mortality²⁵. However, the most predominant of these predictors have not been identified, and whether other factors, such as fracture type²⁶, low serum albumin and pre-fracture living conditions²⁶ could be considered as predictors, are still unknown.

In 1993 Ingemar Sernbo suggested a scoring system to predict the 30-day mortality of NOF fractures²⁷. The Sernbo scoring system is shown in Figure 9. This score stratifies patients into a low- and a high-risk group. High-risk patients were defined as those scoring below 15 points²⁷. The mortality rate is less than 1% in the Low-risk group and 8% in high risk group²⁷.

FIGURE 9

Sernbo score predicts survival after intracapsular hip fracture in the elderly. Annals Royal College of Surgeons of England 2013 Jan;95:29-33.

Domain		Score
1. Age	<80 years	5
	≥80 years	2
2. Social situation	Independent (no carers)	5
	Package of care / residential care / nursing care	2
3. Mobility	Walks unaided / one stick	5
	Two sticks / frame / wheelchair / bedbound	2
4. Mental state	Normal	5
	History of dementia	2
Total:		/20

The Sernbo score was described originally as a method for deciding which patients should receive a hemiarthroplasty and which should receive a total hip arthroplasty after an NOF fracture²⁷. There is, however, a clear rationale behind using these four factors to predict mortality as each is simple to collect and each is an established marker of frailty.

Alternative risk stratification tools include the Physiological and Operative Severity Score for the enumeration of Mortality and morbidity (POSSUM)^{24,37}, the orthopaedic POSSUM, the Charlson co-morbidity index²⁷, the Estimation of Physiologic Ability and Surgical Stress^{24,27} and the Nottingham hip fracture score²⁴. Each of these uses a greater number of variables and a greater level of

complexity to predict mortality. This information may not be readily available in the short time before surgery. Such scores also require the precise definition of co-morbidities by junior staff in the emergency room. The greatest advantage of the Sernbo score over other existing scores is its simplicity and ease of use by junior and non-specialist staff.

1.1.7 SOUTH AFRICAN NECK OF FEMUR FRACTURE MORTALITY RATE

One year mortality rates of neck of femur fractures are well described in developed countries. In general there are differences in access and quality of medical care between developed and developing countries. Improvements in life expectancy have led to increased elderly populations in developing countries²⁸.

In 1988 Hammer et al. conducted a retrospective review of elderly white patients admitted to Addington hospital in KZN. The mortality rate was estimated to be around 20% at 1 year²⁹.

Ngobeni et al. (2010) looked at the mortality rate of the elderly with intertrochanteric fractures admitted to Kalafong hospital. In-hospital mortality was 14%³⁰, patient mortality rate within 1 year was 32%³⁰.

There were no current mortality statistics found for NOF fractures in the elderly admitted to the Johannesburg Hospitals which led to this study to compare our NOF mortality rate in the elderly to local and international statistics.

1.2 AIM OF THE STUDY

To determine the one year mortality following operative treatment of neck of femur fractures in the elderly at Charlotte-Maxeke Johannesburg academic hospital.

1.3 HYPOTHESIS

One year mortality of hip fractures is higher in Charlotte-Maxeke Johannesburg hospital compared with international statistic of 30%.

2.0 METHODOLOGY

2.1 STUDY POPULATION

Retrospective study of patients operated on for NOF fractures at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH) from January 2008 to December 2012.

2.2 INCLUSION CRITERIA

Both males and females above 65 years of age who sustained a NOF fracture that was treated surgically with either Arthroplasty, Cannulated screws, Dynamic Hip Screw (DHS) or Cepho-medullary reconstruction nails.

2.3 EXCLUSION CRITERIA

- ❖ Any open NOF fractures
- ❖ Patients who sustained a NOF fracture due to metastatic bone disease
- ❖ Hip fracture other than NOF fracture ex. Intertrochanteric fracture
- ❖ Patients who were not treated operatively for the hip fracture

2.4 SAMPLE SIZE

Patients was identified using the suppliers of arthroplasties and the theatre records from the trauma and arthroplasty units. A total of 139 patients were identified. 49 Patients records were untraceable due to lost files or non-South African ID numbers hence they were excluded from the study.

2.5 STUDY METHOD

The patients' files were collected from CMJAH records. Their information was collected on a data collection sheet (Appendix A). The following information was collected: patients ID, sex, age at surgery, surgery date, type of procedure performed, birth date. Home affairs records was used to find out if the ID number is registered as a death. The website <http://www.dha.gov.za/status> was used for this purpose. To determine the time of death of the deceased patients Home affairs was contacted using the Request for access to record of public body form as shown in Appendix B. The one year mortality rate was calculated and compared to the international rate of 30%.

2.6 STATISTICAL METHODS

IBM SPSS (Statistical Package for the Social Sciences) was used for data analysis. For this study a p-value less than 0.05 was considered statistical significant and a 95% confidence interval was considered. The Chi-squared test was used for independence on sex and death indicator and comparing procedures versus one year mortality rate.

2.7 ETHICS CLEARANCE

Ethics application was considered on 25/07/2014 by Human Ethics Committee (Medical). The clearance certificate M140743 as shown in Appendix C. The study group information was handled with confidentiality.

2.8 FUNDING

The study was funded by the Wits Health Consortium through Division of Orthopaedic Surgery.

3.0 RESULTS

This study comprised of 139 observations of which 90 had a confirmed life status (dead or alive). We only analyzed $90/139=64.7\%$ of the sample due to loss of records. Although we essentially ignore a large part of the sample (49 observations), we still have a large sample (90) that will provide statistically significant answers. The missing values are missing completely at random, implying that their removal from the analysis should not change the results. Hence, the reason why they were removed is not a driving factor of death/survival.

Using the 90 observations, we looked at the relationship male/female in the sample and this is summarized in Table 1.

Table 1: Sex ratio

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	60	66.7	66.7	66.7
	Male	30	33.3	33.3	100.0
	Total	90	100.0	100.0	

Graphically the male and female ratios can be represented by a bar chart in Figure 10.

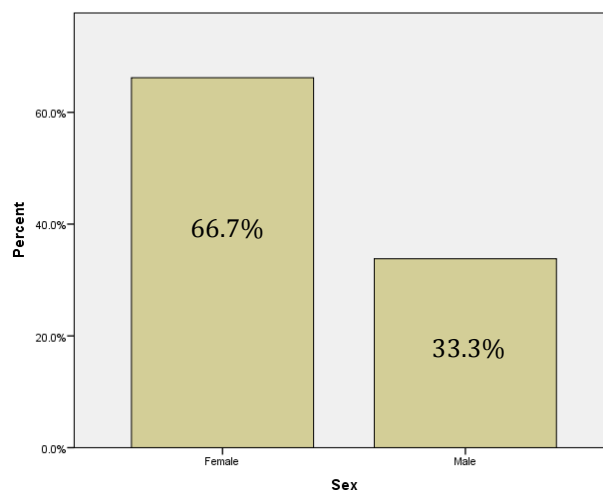


Figure 10: The percentage male to female

We also analyzed the age at surgery covariate and summarize the descriptive statistics in Table 2.

Table 2: Descriptive statistics for Age at surgery

		Statistic	Std. Error
Age of patient	Mean	78.9778	.83149
	95% Confidence Interval for Mean	Lower Bound	77.3256
		Upper Bound	80.6299
	5% Trimmed Mean	79.0000	
	Median	80.0000	
	Variance	62.224	
	Std. Deviation	7.88823	
	Minimum	65.00	
	Maximum	93.00	
	Range	28.00	
	Interquartile Range	12.00	
	Skewness	-.193	.254
	Kurtosis	-.973	.503

The study had a total of 60 females (66.7%) and 30 males (33.33%). The mean age was 80. Minimum age of 65 and maximum age of 93 (Figure 11). The mean age of surgery for NOF in females was also higher than that of males as shown in Figure 12.

The histogram for the covariate age at surgery (Figure 11) and age of a patient at surgery by sex (Figure 12).

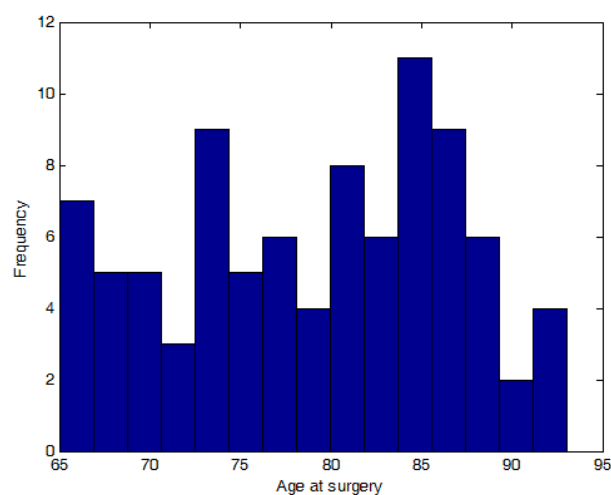


Figure 11: The histogram of the age of a patient at surgery.

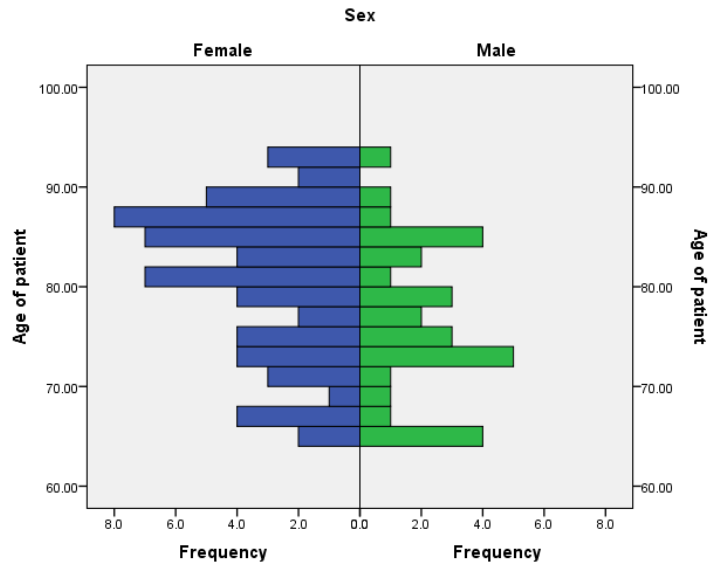


Figure 12: The histogram of the Age of a patient at surgery by sex

The contingency table of male/female versus death within one year is given in Table 3. We also summarize the mortality rate for male/female in the table. For example, 55% of females survived one year post surgery, whereas 60% of males survived.

Table 3: Sex by death within one year of surgery

			Death within 1 year of surgery		Total
			No death within one year	Death within one year	
Sex	Female	Count	33	27	60
		% within Sex	55.0%	45.0%	100.0%
	Male	Count	18	12	30
		% within Sex	60.0%	40.0%	100.0%
Total		Count	51	39	90
		% within Sex	56.7%	43.3%	100.0%

We calculated the mortality rate for females as 45% and males at 40% independently and the overall mortality rate for this study was 43.3%.

We wanted to see if the sex of the patient had an effect on the mortality rate (hypothesis = two covariates are dependent). So we performed a Chi-square to test for independence on the sex and death indicator. The test statistic and corresponding p-value was 0.203620 and 0.651815 respectively. Implying that we could not reject the null hypothesis (that the two covariates are independent). So, the sex of a patient does not have any statistical relationship with the occurrence of death.

We then analyzed the type of surgery that was performed and summarized the results in the pie chart in Figure 13.

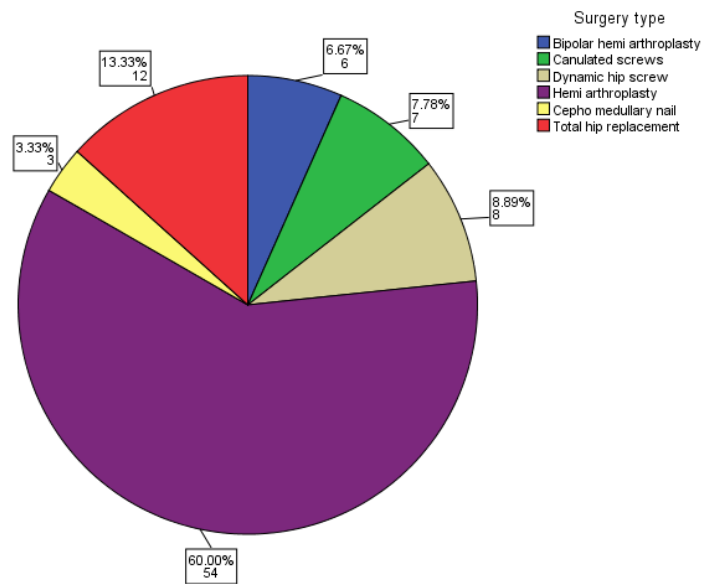


Figure 13: Percentage of surgeries.

The number of deaths and survival one year post surgery can graphically be presented by the bar chart in Figure 14.

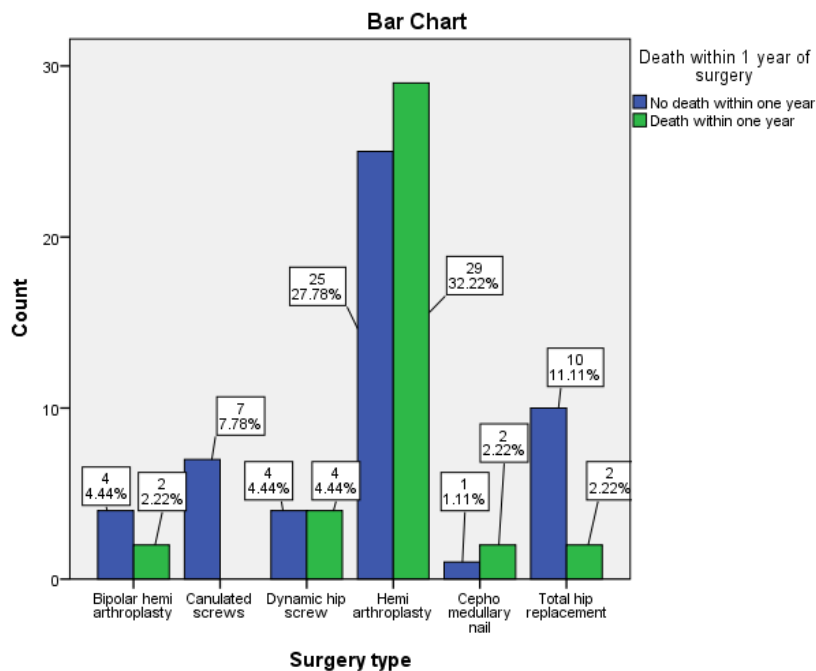


Figure 14: The bar chart depicting the number/percentages of deaths/survivals per surgery type.

We wanted to see whether there was a relationship between the type of procedure and mortality. After inspecting the data we found that there was not enough data in each of the different cells (Figure 14).

So, we used the following grouping:

1. Hemi arthroplasty and bipolar hemi arthroplasty, (Hemi).
2. Open Reduction Internal Fixation, (ORIF).
3. Total hip replacement.

The resulting contingency table is in Table 4. The one year mortality rate for Hemi, Total hip replacement and ORIF is 51.7%, 16.7% and 43.3% respectively.

We tested the independence of the Hemi, ORIF or total hip replacement against the death indicator. This test should give us an indication of whether the procedure performed is dependent on the death occurrence or not. In other words, does the procedure performed have a statistical significant effect on the one year mortality rate or not? Again we used the Chi-squared test for independence and found that the test statistic was 5.904977 with p-value of 0.05221. Hence, the null hypothesis (testing for independence) was not rejected at a significance level of 95%. So, we proved that statistically there is no relationship between the type of procedure and the occurrence of death (i.e. they are independent).

Note that if we were to test this hypothesis at a 90% significance level (or even 94% significance level), the converse result would have been proved. So, the null hypothesis is rejected, but only just. Note that the chi squared test is valid since the expected count in each cell is more than five (not to be confused with the observed count as shown in Table 4, where one cell has only two observations).

Table 4: Hemi, ORIF or total hip replacement by death within 1 year of surgery cross tabulation

		Death within 1 year of surgery		Total
		No death within one year	Death within one year	
Hemi, ORIF or total hip replacement	Hemi	Count 29	Count 31	Count 60
	% within Hemi, ORIF or total hip replacement	48.3%	51.7%	100.0%
	Total hip replacement	Count 10	Count 2	Count 12
	% within Hemi, ORIF or total hip replacement	83.3%	16.7%	100.0%
	ORIF	Count 12	Count 6	Count 18
	% within Hemi, ORIF or total hip replacement	66.7%	33.3%	100.0%
Total	Count	51	39	90
	% within Hemi, ORIF or total hip replacement	56.7%	43.3%	100.0%

Graphically we can depict Table 4 as bar charts in Figure 15

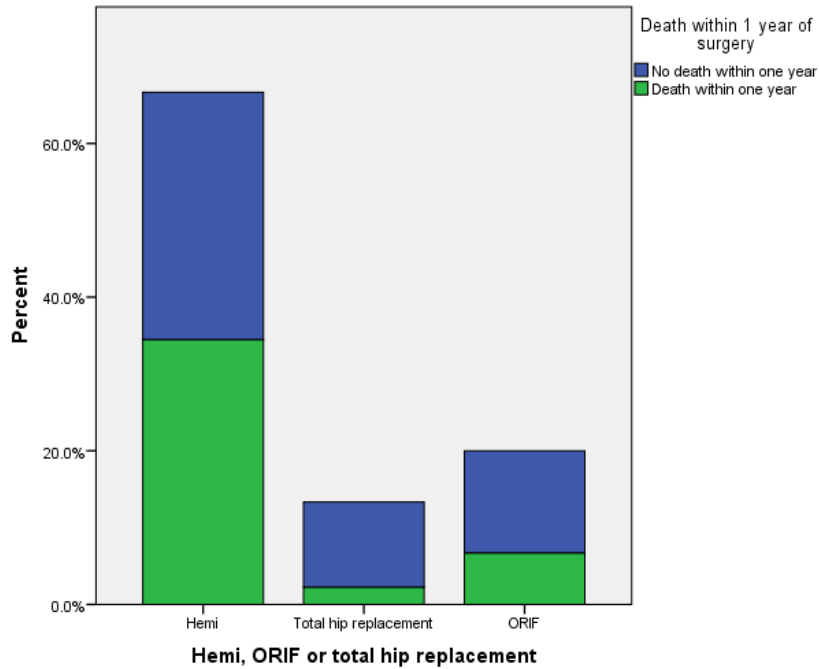


Figure 15: The bar chart depicting the type of surgery (Hemi, ORIF or total hip replacement) per occurrence of death within one year post surgery

This showed that half of the patients that received hemiarthroplasties has died where only 16% of the patients that received THR died.

Inferential statistics

This is to compare our mortality rate to international statistics. We wanted to test whether this is higher than the industry norm of 30%. To do this we performed the following hypothesis test. Let p denote the proportion of deaths over the study period, then the appropriate hypothesis to test would be:

$$\begin{aligned}
 &H_0: p = 30\% \\
 &\text{versus} \\
 &H_a: p > 30\%
 \end{aligned}$$

So, the alternative hypothesis (H_a) is that the proportion of deaths over the study period is greater than the heuristic $p = 30\%$. Hypothesis tests like this one is used often to test whether proportions are equal, less than or more than a predetermined number (in our case larger than the heuristic 30%). We tested this hypothesis and used the test statistic

$$Z = \frac{\hat{p} - 30\%}{\sqrt{30\%(1 - 30\%)/n}}$$

where n is the size of the sample (in this case $n = 90$) and $\hat{p}$ is the estimated sample proportion of deaths (here the observed proportion is $\hat{p}=43\%$). This resulted in $Z= 2.76$ and p-value of 0.00288781. Comparing this to the usual $\alpha=0.05$ it leads to the conclusion that we reject the null hypothesis (accept the alternative hypothesis) with significance of 95%. In fact, we can even conclude this statement at a 99.7% significance level. This leads us to conclude that the mortality rate is statistically significantly larger than the heuristic 30%.

The probability of death within one year

We want to determine whether the sex of a patient, age at surgery of the patient, surgery date, and/or the type of surgery performed (Hemi, ORIF or total hip replacement) influenced the mortality rate. We want to obtain a model for predicting the one year death probability of a patient. To do this we use the well-known logistic regression model (related to survival analysis and a special case of counting processes). In a certain sense we want to determine whether the effect of each variable is significant on the mortality rate within one year. So, the use of logistic regression can be seen as a combination of the individual chi squared tests (done in the previous sections) in one elegant test. This regression will show where there are interactions and which variables are the most predictive of mortality. We fitted a logistic regression model that predicts the death/alive event using the covariates age at surgery, sex, surgery date and type of surgery performed as independent covariates. The model that we tried to fit was heuristically in the form

$$\begin{aligned} \text{logit}(p) = & \beta_0 + \beta_1 \text{Sex} + \beta_2 \text{Age} + \beta_3 (\text{Surgery date}) + \beta_4 (\text{Surgery type}) + \beta_5 \text{Age}^2 \\ & + \beta_6 \text{Age} \times (\text{Surgery type}) \end{aligned}$$

where p is the probability of the patient dying within one year post surgery and Surgery type (Hemi, Total hip replacement, ORIF). We included quadratic terms as well as interaction terms. We specifically included the interaction term between age and surgery type (the product of the two covariates and the last term of the equation above) to see whether the interaction between these covariates are significantly different from zero in the regression model. We used the link function

$$\text{logit}(p) = \log\left(\frac{p}{1-p}\right)$$

We used both forward and backward stepwise selection (procedures used to determine the most statistically significant covariates if many covariates are present) to perform the regression analysis and found that only the covariate 'age at surgery squared' plays a significant role.

In other words: using all the four covariates (with an additional quadratic term (Age^2) and interaction term ($Age \times (Surgery\ type)$)), none other than the age at surgery squared could predict the outcome of the mortality significantly. The parameter estimates of the logistic model are summarized in Table 5

Table 5: Variables in the logistic regression equation

	β	S.E.	Wald	df	Sig.	Exp(β)
Age^2	$\beta_5 = .000465$	.000187	6.140900	1	0.013209	1.000465
Constant	$\beta_0 = -3.216878$	1.218740	6.967014	1	0.008303	0.040080

So, the resulting logistic model is

$$\text{logit}(p) = -3.216878 + 0.000465 \times Age^2,$$

or equivalently the probability of death within one year is given by the formula

$$p = [1 + \exp(-(-3.216878 + 0.000465 \times Age^2))]^{-1}.$$

4.0 DISCUSSION

This is a retrospective study where patients aged 65 or older with a NOF were identified in Johannesburg General Hospital. Hence, care should be taken when inferring the statistics of this sample to any other hospital within South Africa or any other age group. Statistically, the results we show here are only representative of Johannesburg General Hospital.

We gathered the following covariates: patient ID, sex, age at surgery, surgery date, and type of procedure performed, birth date and death date. For birth date and ID, not all fields were populated fully and some missing values occurred. Due to poor record keeping or non-South African ID numbers that could not be traced at Home Affairs. Hence, 49 cases were not included in this study and considered as incomplete data.

The study had a total of 60 females (66.7%) and 30 males (33.33%). The mean age was 80. Minimum age of 65 and maximum age of 93 (Figure 11). Since the female percentage in the study is much higher than the male percentage, this suggests that females are more prone to NOF fractures than males. The mean age of surgery for NOF in females was also higher than that of males as shown in Figure 12. This would mean that although females are more prone to NOF fractures, males get fragility NOF fractures much earlier.

Our one year mortality was calculated to be 43.3% with a p-value of 0.00288781 ($p < 0.05$) with a significant interval of 95%. This is significantly higher what was reported from the literature and thus proves our hypothesis of this study. We also analyzed the 30- and 90-day mortality rates. For our sample these were observed to be 15.56% and 23.33% respectively.

An interesting finding (as shown in Table 3) is that the sex does not have any statistical relationship with the occurrence of death. Females had a one year mortality rate of 45.0% and males 40.0%. The mortality rate for men was only 20% higher compared to the mortality rate in USA and for women it was twice as high. The significant difference between males and females might be due to the small numbers of males in the study.

We also showed that Hemi-arthroplasties is the most frequently performed surgery (60%) and Total Hip replacements were the second highest at 13.33%. Interestingly as shown in Table 4 is that more than half of the patients that received a Hemi-arthroplasty died (51.7%) compared to only a sixth of the patient in the THR group (16.7%). This supports Sernbo's scoring system that frail patients (Score < 15) has a higher 30 day mortality rate. What is worrying is that Sernbo suggested an 8% mortality rate in 30 day were ours where almost double that (15.56%). The reason for this was unclear in our study. It might be due to the higher age of patients that we are treating or lack of proper treatment protocols.

From our results we estimated that neither the sex of the patient nor the type of procedure performed, influenced our one year mortality rate.

Interpreting the estimated parameters in the logistic regression equation leads us to believe that there is a positive relationship between age at surgery and the probability of dying one year post surgery. In other words the higher your age, the more likely you are to die. For example if a patient of age 85 were to experience a NOF, the probability of death within one year can be estimated by

$$\begin{aligned}\hat{p} &= [1 + \exp(-(-3.216878 + 0.000465 \times 85^2))]^{-1} \\ &= 0.535626 \\ &= 53.5626\%\end{aligned}$$

This fitted logistic regression function can be drawn, as is illustrated in Figure 16. Here the age is on the horizontal axis and the probability of death within one year on the vertical axis. Reading the value Age=85 of the vertical axis, it is clear that the probability of death within one year is at about 53%. The exact answer we have just seen to be 53.5626%

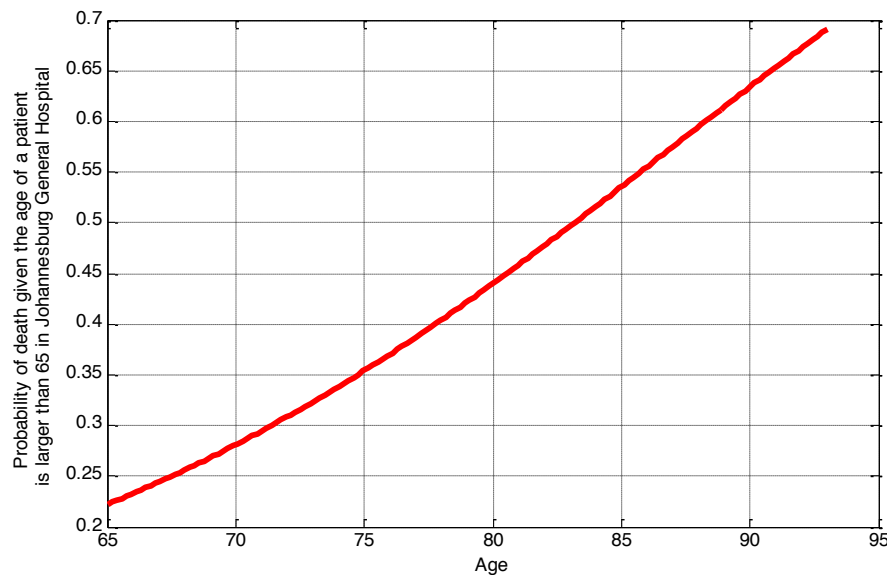


Figure 16: The probability of death modeled as a function of age at surgery.

Care should be taken when extrapolating the results of this graph for ages lower than 65 and higher than 93 (these are our minimum age and maximum age respectively). We support this finding by the side by side histogram in Figure 17. From this figure it is clear that the distribution of the 'deaths' has higher age than the distribution of the 'non-deaths'.

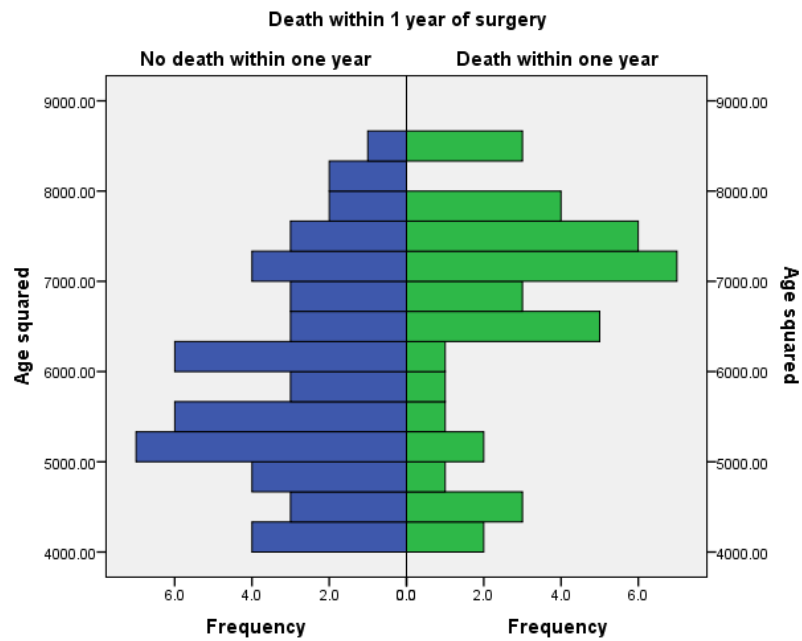


Figure 17: The side by side relative frequency histogram of age at surgery versus death within one year post surgery.

5.0 CONCLUSION

Neck of femur fractures and their sequelae have a significant impact on the mortality rates in the elderly patients seen at Charlotte-Maxeke Johannesburg hospital.

Our mortality rate was significantly higher compared to international figures. Even more worrying is the significantly higher 30 day mortality rate. This might be due to the higher age of patients that we are seeing or lack of proper treatment protocols. We were unable to establish if there were delays in referral of the patient or time to surgical procedure. Further investigations are needed to determine the cause of our high mortality rate.

Our hospital needs a structured treatment algorithm. We recommend following the National Health Service (NHS) guidelines from the United Kingdom with a follow-up mortality rate study.

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Data collection sheet

Demographics:

Study number: _____

GT/GP number: _____

Age: _____

Sex: M / F

Ethnics: African/Caucasian/Asian/Indian/Other

ID number: _____

Surgical information for Neck of Femur fractures:

Date of surgery: _____

Type of surgery:

Hemiarthroplasty

Cannulated screws

Dynamic Hip screw

Cepho-medullary nail

Complications: _____

Home Affairs records:

Status: Alive / Dead

Date of death: _____

Dead within one year of surgery:

YES

NO

8.0 APPENDIX B



REPUBLIC OF SOUTH AFRICA

FORM A
REQUEST FOR ACCESS TO RECORD OF PUBLIC BODY
(Section 18(1) of the Promotion of Access to Information Act, 2000 (Act No. 2 of 2000))
[Regulation 6]

FOR DEPARTMENTAL USE	
	Reference number:
Request received by .. (state rank, name and surname of information officer/deputy information officer) on . (date) at (place).	
Request fee (if any): R 	
Deposit (if any): R 	
Access fee: R 	
....	
SIGNATURE OF INFORMATION OFFICER/DEPUTY INFORMATION OFFICER	

A. Particulars of public body

The Information Officer/Deputy Information Officer:

FORM A: REQUEST FOR ACCESS TO RECORD OF PUBLIC BODY

B. Particulars of person requesting access to the record

- (a) The particulars of the person who requests access to the record must be given below.
(b) The address and/or fax number in the Republic to which the information is to be sent, must be given.
(c) Proof of the capacity in which the request is made, if applicable, must be attached.

Full names and surname:

Identity number:

Postal address:

Telephone number:

()

Fax number:

()

E-mail address:

Capacity in which request is made, when made on behalf of another person:

C. Particulars of person on whose behalf request is made

This section must be completed ONLY if a request for information is made on behalf of another person.

Full names and surname:

Identity number:

D. Particulars of record

- (a) Provide full particulars of the record to which access is requested, including the reference number if that is known to you, to enable the record to be located.
(b) If the provided space is inadequate, please continue on a separate folio and attach it to this form. The requester must sign all the additional folios.

1. Description of record or relevant part of the record:

FORM A: REQUEST FOR ACCESS TO RECORD OF PUBLIC BODY

2. Reference number, if available:

3. Any further particulars of record:

E. Fees

- (a) A request for access to a record, other than a record containing personal information about yourself, will be processed only after a request fee has been paid.
- (b) You will be notified of the amount required to be paid as the request fee.
- (c) The **fee payable for access** to a record depends on the form in which access is required and the reasonable time required to search for and prepare a record.
- (d) If you qualify for exemption of the payment of any fee, please state the reason for exemption.

Reason for exemption from payment of fees:

F. Form of access to record

If you are prevented by a disability to read, view or listen to the record in the form of access provided for in 1 to 4 below, state your disability and indicate in which form the record is required.

Disability: Mark the appropriate box with an X. NOTES: (a) Compliance with your request for access in the specified form may depend on the form in which the record is available. (b) Access in the form requested may be refused in certain circumstances. In such a case you will be informed if access will be granted in another form. (c) The fee payable for access to the record, if any, will be determined partly by the form in which access is requested.	Form in which record is required:
---	--

1. If the record is in written or printed form:			
☐	copy of record*	☐	inspection of record
2. If record consists of visual images - (this includes photographs, slides, video recordings, computer-generated images, sketches, etc.):			
☐	view the images	☐	copy of the images*
☐		☐	transcription of the

FORM A: REQUEST FOR ACCESS TO RECORD OF PUBLIC BODY

					images*	
3. If record consists of recorded words or information which can be reproduced in sound:						
	listen to the soundtrack (audio cassette)		transcription of soundtrack* (written or printed document)			
4. If record is held on computer or in an electronic or machine-readable form:						
	printed copy of record*		printed copy of information derived from the record*		copy in computer readable form* (stiffy or compact disc)	

*If you requested a copy or transcription of a record (above), do you wish the copy or transcription to be posted to you? Postage is payable.	YES ☐	NO ☐
Note that if the record is not available in the language you prefer, access may be granted in the language in which the record is available.		
In which language would you prefer the record?		

G. Notice of decision regarding request for access

You will be notified in writing whether your request has been approved / denied. If you wish to be informed in another manner, please specify the manner and provide the necessary particulars to enable compliance with your request.
--

How would you prefer to be informed of the decision regarding your request for access to the record?

Signed at .. this day . of . year .

SIGNATURE OF REQUESTER /
PERSON ON WHOSE BEHALF REQUEST IS MADE

9.0 APPENDIX C



R14/49 Dr BH Pieterse

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M140743

NAME: Dr BH Pieterse
(Principal Investigator)

DEPARTMENT: Department of Orthopaedics
CM Johannesburg Academic Hospital

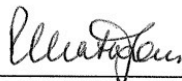
PROJECT TITLE: One Year Mortality following Surgical
Intervention for Neck Femur Fractures in the
Elderly in a Developing Country

DATE CONSIDERED: 25/07/2014

DECISION: Approved unconditionally

CONDITIONS:

SUPERVISOR: Dr Lipalo Mokete

APPROVED BY: 
Professor PE Cleaton-Jones, Chairperson, HREC (Medical)

DATE OF APPROVAL: 25/07/2014

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

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Secretary in Room 10004, 10th floor, Senate House, University.

I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report.**

Principal Investigator Signature

Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES