PREDICTORS OF PATIENT LENGTH OF STAY POST-STROKE IN A SUB-ACUTE REHABILITATION SETTING IN GAUTENG

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DECLARATION

I, Thea Bijl, declare that the work contained in this research report is my own work.

This research report is being submitted for the degree of Master of Science in Physiotherapy at the University of the Witwatersrand, Johannesburg, South Africa.

This work has not been submitted for any other degree or examination in this or any other university.

30/08/2018

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ABSTRACT

Background

Stroke is the main cause of disability in South Africa. Patients who have a stroke require effective rehabilitation to achieve optimal function. Patient progress can be monitored with standardised outcome measures such as the Functional Independence Measure (FIM). This data along with other demographic and clinical data may be useful in making predictions about patients' functional outcomes and length of hospital stay (LOS). As LOS is an important indicator of the cost of care for patients post-stroke, this information may be useful to all stakeholders involved in the care and rehabilitation process.

Method

A retrospective file review was done for 243 patients post-stroke who were admitted to a private, sub-acute rehabilitation facility in Gauteng between 1 January 2015- 31 January 2017. Patient functional ability was measured using the FIM. Demographic and clinical data of the patients were also recorded. Descriptive statistics were used to summarise the data. Median and range values were used to describe the sample, their functional outcomes and their LOS. To determine if there were differences in patient outcomes (FIM scores and LOS) one-way ANOVA were done. Multiple regression analysis was done to determine the predictive value of clinical, demographic and functional variables on LOS.

Results

The median admission and discharge FIM scores were 43 points and 75 points respectively, and the median LOS was 43 days. Only admission FIM score had an influence on both discharge FIM score and FIM change scores. With the stepwise multiple regression model, the following patient characteristics were found to be predictors of LOS: the presence of a premorbid psychiatric condition, impaired speech on admission, requiring additional oxygen support, the development of pneumonia and the admission FIM motor score. The overall variance predicted by the model was 26.3%. Admission FIM motor score was the strongest individual predictor of LOS in this study (41%).

Conclusions

Low admission FIM score has an influence on poor patient outcomes and is important in the prediction of LOS for patients post-stroke in a private, sub-acute rehabilitation facility in South Africa. Low functioning patients post-stroke stay longer in hospital and may require

more resources to get them to functional levels. Other clinical variables may also influence LOS. Patients with speech impairments and those who require oxygen support on admission may require longer LOS to allow for more complete recovery. Patients who have a premorbid psychiatric condition or develop pneumonia have shorter LOS as they may not be able to participate effectively in rehabilitation or make adequate rehabilitation gains, leading to early discharge, or transfer back to an acute facility.

Recommendations

Study results may assist the facility to tailor its services to meet the specific needs of South African stroke patients. Being able to predict LOS on admission allows facility administrators to manage bed occupancy, human and clinical resources. Facilities may need to ensure that they are able to allocate enough beds to patients that need a longer LOS, ensure adequate numbers of therapists to manage the case-load and ensure early screening to prevent the development of complications (pneumonia). Low admission FIM motor scores may be used to motivate for additional funding and longer LOS from medical aid schemes. The short-term increase in costs in the interest of long-term savings may provide motivation for improved coverage for stroke patients requiring rehabilitation in South Africa's private healthcare sector. High admission FIM motor scores may also be used as justification for shorter stays, earlier discharge and appropriate referral to out-patient therapy. All of which reduce the cost of care post-stroke.

The findings of the study by the researcher will be sent to the rehabilitation facility in which the study was done and to South African journals for publication of the study findings, to disseminate them to South African therapists.

Future studies should consider using regression analyses to determine predictors of functional outcome as well as LOS. Rehabilitation facilities should implement the use of more standardised outcome measures to improve the quality of clinical data collected at these facilities.

Keywords: LOS; functional outcome; rehabilitation; South Africa; Functional Independence Measure; FIM; admission function.

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LIST OF ABBREVIATIONS

ADLs	Activities of Daily Living
AF	Atrial Fibrillation
AM-PAC	Activity Measure for Post-Acute Care
ANOVA	Analysis of Variance
BI	Barthel Index
CAD	Coronary Artery Disease
CHF	Congestive Heart Failure
CI	Confidence Interval
CIMT	Constraint Induced Movement Therapy
CNS	Canadian Neurological Scale
COPD	Congestive Obstructive Pulmonary Disease
CRF	Chronic Renal Failure
DSM	Diagnostic Statistical Manual
DV	Dependent Variable
DVT	Deep Vein Thrombosis
FAI	Frenchay Activities Index
FIM	Functional Independence Measure
Fu-FIM	Follow-up FIM
GCS	Glasgow Coma Scale
GDS	Geriatric Depression Scale
HIV	Human Immunodeficiency Virus
IADLs	Instrumental Activities of Daily Living
ICC	Interclass Correlation Coefficient
IRFs	Inpatient Rehabilitation Facilities

IV	Independent Variable
LogLOS	Logarithm of LOS
LOS	Length of Stay
LOS-EFF	LOS Efficiency Measure
LTAC	Long Term Acute Care
mBI	Modified Barthel Index
MCID	Minimal Clinically Important Difference
MDC	Minimal Detectable Change
MI	Myocardial Infarction
MMSE	Mini Mental State Examination
MRS	Modified Rankin Scale
NIHSS	National Institute of Health and Stroke Sciences
OR	Odds Ratio
OT	Occupational Therapy
PPS	Prospective Payment System
PT	Physiotherapy
RAVLT	Rey Auditory Verbal Learning Tests
RCT	Randomised Controlled Trial
RR	Relative Risk
SD	Standard Deviation
SE	Standard Error
SPSS	Statistical Package for Social Sciences
SSS	Scandinavian Stroke Scale
TBI	Traumatic Brain Injury
TCT	Trunk Control Test
TIA	Transient Ischaemic Attack

USN	Unilateral Spatial Neglect
UTI	Urinary Tract Infection
VIF	Variance Inflation Factor
w-CI	Weighted Co-morbidity Index

CHAPTER 1

1 INTRODUCTION

1.1 Background and Need

The burden of stroke continues to rise due to the increasing number of patients experiencing first-time strokes and the trend of population ageing (Danaei, *et al.*, 2011; Pillay & Maharaj, 2013). Stroke is the main cause of disability in South Africa (Maredza & Chola, 2016) and survivors of stroke may present with impaired motor, cognitive and speech function (Bryer, *et al.*, 2010). Patients require early and effective rehabilitation interventions post-stroke, in order to minimise the negative effects of stroke and promote maximal recovery (Galski, Bruno, Zorowitz & Walker, 1993; Duncan, *et al.,* 2002).

Rehabilitation facilities cater for a wide variety of patients with neurological conditions that require acute and sub-acute management before discharge. Patients in these facilities are generally medically stable but require further therapy to ensure their functional independence (Musicco, Emberti, Nappi & Caltagirone, 2003). Effective rehabilitation should include goal driven interventions based on the best evidence and protocols available. It should ideally start in the acute phase and end with community discharge (Bryer, *et al.*, 2010; Oyeyemi & Sedenu, 2010; Knecht, Hesse & Oster, 2011).

In order to determine patient outcomes and monitor progress, rehabilitation facilities may document patients' demographic, clinical and functional characteristics (Hamilton & Granger, 1994; DeJong, *et al*., 2005). The best way to monitor improvement after stroke is with the use of standardised outcome measures such as the Barthel Index (BI) and Functional Independence Measure (FIM) (Van der Putten, Hobart, Freeman & Thompson, 1999).

There is much literature on the factors which influence patients' functional outcomes after a stroke. Characteristics that have been investigated include patient age, the presence of co-morbidities; complications; perceptual and cognitive dysfunction and the timing and intensity of rehabilitation interventions (Kugler, *et al.*, 2003; Nys, *et al.*, 2005; Indredavik, Rohweder, Naalsund & Lydersen, 2008; Mohamed, *et al.*, 2015). There is less literature on the factors which influence length of stay (LOS) of patients post-stroke, particularly in rehabilitation facilities.

Hospital LOS is very important as it is the strongest predictor of inpatient costs (Mohamed, *et al*., 2015). The ability to predict hospital LOS may be beneficial for rehabilitation facilities as they could develop more accurate and realistic budgets for resource consumption. It would aid clinicians in developing treatment and discharge programmes at an earlier stage and it would give the patient and family an opportunity to prepare for discharge. (Franchignoni, *et al.*, 1998).

There are both service/facility related factors and patient related factors which influence LOS. Sometimes the home environment is not an appropriate referral destination and patients thus remain in facilities longer than they should while an appropriate discharge setting is arranged (Alexander, 1994; Mayo, *et al.*, 2000; Black-Schaffer & Winston, 2004). Other service/ facility related factors include: funding constraints, the implementation of prospective payment systems (PPS), provision of additional therapy and early discharge to nursing facilities. Patient related factors include: patient age, the development of complications, the presence of co-morbidities, perceptual and cognitive impairments and functional status on admission (Teasell, McRae & Finestone, 2000; Gillen, *et al.*, 2001; Kugler, *et al.*, 2003; Black-Schaffer & Winston, 2004; Gillen, Tennen & McKee, 2007; Indredavik, Rohweder, Naalsund & Lydersen, 2008; Peiris, Taylor & Shields, 2011; Mohamed, *et al.*, 2015; Oros, *et al.*, 2016).

1.2 Problem Statement

The results of several studies that investigate hospital LOS are out-dated and poorly generalisable. There is a paucity of recent and reliable literature, and to the best knowledge of the author, there are no South African studies on this topic.

Comparison of studies that explore the determinants of hospital LOS is challenging as there is great variation in the samples studied, the facilities selected, the type of data and data collection methods, the timing and type of rehabilitation interventions implemented and the outcome measures used by authors. In order to determine if specific variables are common to all stroke patients, it is necessary to review the available literature.

As little is known about the predictors of LOS in the South African stroke population, there is a need for more comprehensive observational and descriptive studies on LOS in a South African rehabilitation context. There are several factors that make the South African rehabilitation service provision unique. Rehabilitation is covered by both the public and private sector (Mayosi & Benatar, 2014). A significantly higher proportion of the population makes use of the public sector services due to the high costs of private care (Dayal, 2010; Mayosi & Benatar, 2014). Service delivery in the public sector is however not meeting the needs of disabled South Africans due to the high burden placed on it and managerial incapacity (Dayal, 2010). Effective rehabilitation services are thus not reaching many people with disabilities due to the poor socio-economic status of many South Africans (Dayal, 2010). The disparities between South African rehabilitation service delivery and rehabilitation services abroad necessitates the need for further research as factors which affect LOS in a South African context may be different.

If the predictors the LOS (and thus the cost of care) could be determined for private South African rehabilitation facilities, they would be better able to structure their policies and allocate resources according to the specific needs of this population.

1.3 Research Question

What are the predictors of hospital LOS in patients post-stroke, in a private, sub-acute rehabilitation setting in Gauteng?

1.3.1 Aim of the study

The aim of this research report was to determine the factors that predict hospital LOS in patients admitted to a private, sub-acute rehabilitation setting in Gauteng, post-stroke.

1.3.2 Objectives of the study

Primary Objective

- To determine the factors that predict hospital LOS in patients admitted to a private, sub-acute rehabilitation setting in Gauteng post-stroke, between 1 January 2015 and 31 January 2017, based on the information provided by completing the secondary objectives.

Secondary Objectives

- To establish the demographic and clinical profile of patients admitted to a private, sub-acute rehabilitation setting in Gauteng, post-stroke, between 1 January 2015 and 31 January 2017.
- To determine the hospital LOS in patients admitted to a private, sub-acute rehabilitation setting in Gauteng post-stroke, between 1 January 2015 and 31 January 2017.
- To determine the functional outcomes (as measured with the Functional Independence Measure) of patients admitted to a private, sub-acute rehabilitation setting in Gauteng post-stroke, between 1 January 2015 and 31 January 2017.

1.4 Significance of the Study

Predicting LOS is not only important to patients, care-givers and therapists for planning, but may also be valuable to medical funders and rehabilitation facilities as a cost management strategy. In order to manage patients effectively, and maintain a certain level of care in a competitive healthcare market, facilities should be able to predict the resources required by patients post-stroke. If facilities could accurately estimate LOS as early as possible after a patient's admission, managing bed occupancy and developing realistic budgets for resource consumption would be easier.

If patient data collected on admission could be used to predict LOS, therapists would have adequate time to plan rehabilitation interventions, give accurate and insightful motivation for prolonged rehabilitation when necessary, and perform timely family/ care-giver training. It could prevent patients and family members from returning to their homes unprepared or with residual impairments. Another benefit of identifying the predictors of LOS is that it could assist in managing potentially preventable issues which have an effect on LOS. This would reduce the direct cost of stroke care.

CHAPTER 2

2 LITERATURE REVIEW

2.1 Introduction

A review of the literature relevant to this study will provide a better understanding of the factors influencing patients' functional outcomes and hospital LOS after a stroke. It provides insight into factors not previously considered, and is useful for comparative purposes. The review addresses the objectives of this study and will examine predictors of functional outcome and hospital LOS using patients' demographic, clinical and functional characteristics.

Scope

The literature review will briefly discuss the epidemiology and impact of stroke globally and in South Africa. It highlights the importance of rehabilitation in reducing disability after a stroke, and the way in which patient outcomes are measured. The review will examine in greater depth, studies on factors that influence patient outcomes and hospital LOS. Critical appraisal of studies is incorporated into the review. The relevance of predicting LOS and the gaps in the literature which necessitate the need for further research conclude the review.

The majority of the studies included in the review were accessed from databases such as EBSCOhost, PubMed, Science Direct and MedlinePlus via The University of the Witwatersrand library. Most studies were published between 2002 and 2016 and were sourced using keywords: stroke; ischaemic stroke; cerebrovascular accident; stroke rehabilitation; functional outcomes; functional outcome measures; predictors of function; Functional Impairment Measure; functional change; co-morbidities; complications; cost of care; rehabilitation costs; length of stay; length of hospital stay and inpatient rehabilitation facilities (IRFs).

2.2 Global Burden of Stroke

Stroke is the third leading cause of disability worldwide and second leading cause of mortality (Lozano, *et al*., 2013; Murray, *et al*., 2013). Between 1990 and 2010 there was a significant increase in the number of patients who had a first-time stroke, the number of stroke survivors and the number of stroke-related deaths (Feigen, *et al.*, 2014). The burden of stroke increased by 19% in this time-frame (Murray, *et al.*, 2013). Low and middle-income countries such as Southeast Asia, Africa, South America and the Middle East accounted for the greatest stroke burden, *i.e*. 68.6% of incident strokes, 52.2% of prevalent strokes and 70.9% of stroke-related deaths (Feigen, *et al.*, 2014). In high income countries (*i.e*. New Zealand, Australia, North America, and Central Europe) the stroke burden was markedly lower with 31.4% incident strokes, 47.8% prevalent strokes and 20.1% of stroke-related deaths (Feigen, *et al.*, 2014). This finding may be explained by the superior healthcare services available to patients in high-income countries, *i.e.* stroke prevention strategies and stroke care units available to these patients (Norrving & Kissela, 2013; Feigen, *et al.*, 2014; Marshall, *et al.*, 2015).

When looking at stroke incidence and prevalence according to age groups, the burden of stroke is greatest in patients younger than 75 years (62% of new strokes, 69.8% of prevalent strokes and 45.5% of stroke-related deaths) (Feigen, *et al.*, 2014). The increased prevalence of stroke risk factors (diabetes, obesity, high cholesterol levels, high systolic blood pressure and smoking) in younger adults is a likely explanation of the increased stroke incidence in younger patients (Wang, *et al.*, 2016). This is particularly prevalent in low and middle-income countries where the problem is compounded by the inaccessibility of health services (Bryer, *et al.*, 2010; Norrving & Kissela, 2013; Feigen, *et al.*, 2014; Marshall, *et al.*, 2015). If these factors are not addressed, the burden of stroke will continue to rise in lower-income countries.

2.3 Burden of Stroke and Epidemiology in South Africa

The global population of people over the age of 60 years is increasing exponentially (Pillay & Maharaj, 2013). South Africa shows a similar trend of population ageing, with nearly seven percent of the population (2.9 million people) over the age of 60 in 1997 (Kinsella & Ferreira, 1997; Bryer, *et al.*, 2010). The phenomenon of an aging population is linked to a decrease in mortality as a result of improved life expectancy/ medical advances) (Pillay & Maharaj, 2013).

In South Africa, stroke results in approximately 25 000 deaths per year (Bertram, *et al.*, 2013). The incidence rate of stroke in South Africa between 2007 and 2011 was 244 per 100 000 person-years and the mortality rate was 114 per 100 000 person-years (Maredza, Bertram & Tollman, 2015). In 2004, the crude prevalence of stroke was 300 per 100 000 (Connor, *et al*., 2004). The data were gathered by the authors from the Agincourt health and socio-demographic surveillance system. South Africa's rapid epidemiological transition with increased development of stroke risk factors will inevitably result in an increase in the burden of stroke (Pillay & Maharaj, 2013).

2.4 Disability as a Result of Stroke in South Africa

The impact of stroke is profound and may lead to significant disability in stroke survivors (Lloyd-Jones, *et al*., 2010). It was estimated that 98% of South African stroke survivors experienced some degree of disability post-stroke, measured with the Modified Rankin Scale (MRS). Of these patients, 23% experienced moderate long-term consequences and 15% experienced severe, long-term consequences (Maredza, Bertram & Tollman, 2015). Several factors contribute to the greater risk of disability that South African stroke survivors face.

Mayosi and Benatar (2014) found that 84% of South Africans are uninsured and are dependent on the public health sector. High patient numbers, staff shortages, decreased consultation times and shortages of medication and equipment in state facilities were found to be barriers to effective healthcare services in the public sector for patients with chronic conditions in South Africa (Steyn, Fourie & Temple, 2006; Gilson, Doherty, Loewenson & Francis, 2007). As a result, up to 25% of people pay privately for medical services that they are not insured for (Mayosi & Benatar, 2014). Inadequate public rehabilitation services, a lack of funds for private healthcare services and a lack of transport to and from medical facilities, as well as patients' fear of losing access to disability grants if fully rehabilitated, further exacerbate disability in South Africa's stroke population (Bryer, *et al.*, 2010; Ntamo, Buso, & Longo-Mbenza, 2013).

2.5 The Role of Rehabilitation in Reducing Disability

Rehabilitation aims to minimise disability by helping patients to regain optimal function post-stroke (Ntamo, Buso & Longo-Mbenza, 2013; Bernhardt, Indredavik & Langhorne, 2013). It facilitates participation in basic activities of daily living (ADLs) such as grooming, dressing, toileting and feeding, which allow patients to regain their independence (Cardol, *et al.*, 2002; Kwakkel & Kollen, 2013). Instrumental ADLs (IADLs) require more advanced skills than basic ADLs, *i.e.* shopping and managing finances, driving, caring for pets/ children and using a telephone (Oros, *et al.*, 2016). Both basic and instrumental ADLs are important for independent living and community interaction (Duncan, *et al.*, 2005).

The rehabilitation phase post-stroke may begin in an acute hospital setting even while the patient is still in intensive care (Bernhardt, Thuy, Collier & Legg, 2009) and is not restricted to management in a dedicated stroke unit (Duncan, *et al.*, 2005). The Board of Healthcare Funders (BHF) of Southern Africa defines a sub-acute or inpatient rehabilitation facility is a separate hospital or centre that provides multi-disciplinary rehabilitation services to patients with a variety of neurological, orthopaedic or medical conditions (Beckenstrater, 2013). Patients are generally medically stable and should be able to tolerate up to three hours of treatment daily (Musicco, Emberti, Nappi & Caltagirone, 2003; Duncan, *et al*., 2005).

At the beginning of the rehabilitation period, patients must be assessed comprehensively and appropriately referred to therapy departments such as physiotherapy (PT), occupational therapy (OT) and speech therapy (Kwakkel & Kollen, 2013). Initial rehabilitation may focus on early mobilisation and the initiation of self-care ADLs (Bernhardt, Thuy, Collier & Legg, 2009). Patient and family education and involvement are essential components (Duncan, *et al.*, 2005; Kwakkel & Kollen, 2013).

Several rehabilitation guidelines have been established to optimise patient care post-stroke. Ideally, interventions should be provided by a multidisciplinary team and be based on current evidence and patient-centred goals (Duncan, *et al.*, 2002; Duncan, *et al.*, 2005; Kwakkel & Kollen, 2013). It should aim to prevent patients from developing complications which increase their risk of morbidity and mortality, and raise the cost of their care (Heuschmann, *et al.*, 2004; Ingeman, *et al.*, 2011; Mohamed, *et al.*, 2015).

2.6 The Cost of Rehabilitation Post-stroke

While all patients who have had a stroke should have access to comprehensive, multidisciplinary care, this is not always the case. This level of care may be very costly (O'Brien, Xue, Ingersoll & Kelly, 2013). The costs incurred post-stroke include the hospital costs, diagnostic costs, and the cost of rehabilitation (Harvey, *et al.*, 1998).

Several studies use hospital LOS post-stroke as an indicator of resource utilisation (*i.e*. the cost of caring for patients post-stroke) (Jorgensen, Nakayama, Raaschou & Olsen, 1997; Harvey, *et al.*, 1998; Caro, Huybrechts & Duchesne, 2000; Saxena, *et al.*, 2006). Long hospital stays increase the financial pressure on hospitals, and patients paying out-of-pocket for rehabilitation services (Van Exel, Koopmanschap, Van Wijngaarden & Scholte op Reimer, 2003). Third-party payers such as medical aid schemes may also put pressure on rehabilitation facilities to reduce patients' LOS in order to reduce their costs (Gillen, Tennen & McKee, 2007). This is not ideal, and may result in patients being discharged with impairments and incomplete recovery (Langhammer, Lindmark & Stanghelle, 2007). Hospital LOS should be determined by the needs and circumstances of each individual and not driven by the payment systems that patients have access to (Gassaway, *et al*., 2005).

Rehabilitation and healthcare services need to be based on a balance between cost and effectiveness (Maredza & Chola, 2016). Optimisation of stroke rehabilitation is not only financially relevant, but clinically important too. As the demand for rehabilitation increases, the efficiency of rehabilitation services will need to improve to meet the needs of an ever-growing stroke population (Bagg, Pombo & Hopman, 2002). The way in which facilities and therapists can monitor the efficiency of the services they provide is with the use of standardised outcome measures. These tools allow therapists to quantify the effects of the rehabilitation interventions they implement.

2.7 Measuring Function after Stroke

The use of standardised outcome measures is the cornerstone of good clinical practice and allows medical professionals to communicate in a universal language (Hamilton & Granger, 1994; Jette, 2006). A few examples of standardised outcome measures used in stroke management include the National Institute of Health Stroke Scale (NIHSS), the Modified Rankin Scale (MRS), The Activity of Daily Living Scale or the Katz Index, the Barthel Index (BI) and the Functional Independence Measure (FIM).

To determine if an outcome measure is effective and clinically useful, the following properties may be tested: reliability (the test measurements can be reproduced and repeated by single and varying observers), validity (it measures what it proposes to measure), sensitivity (the measure gives few false negative results) and specificity (the measure gives few false positives) (Lazarus, 1999).

Some measures relate to impairment and disability, e.g. the NIHSS and MRS. The NIHSS assesses neurological clinical signs but has been criticised for its complexity and variability (Lee, Venketasubramanian, Wong & Chen, 2016) and the MRS scores patients from zero to six based on their level of disability, ranging from perfect health, to death (Banks & Marotta, 2007).

Other instruments are used to measure functional outcome, such as the Katz Index, the BI and the FIM. The Katz Index is a carer-rated instrument assessing six ADLs including bathing, continence, transfers, feeding, dressing and transferring (Oros, *et al.*, 2016). The BI is a 10-item measure of ADLs and is frequently used in clinical practice as an outcome measure after stroke because of its excellent inter-rater reliability (Duffy, *et al.*, 2013). The FIM evaluates a patient's ability to perform 18 motor and cognitive tasks which are rated on an ordinal scale. The totals range from 18 (lowest) to 126 (highest) (Dodds, Martin, Stolov & Deyo, 1993; Hamilton & Granger, 1994). Each item has a minimum score of one and a maximum score of seven, where seven represents complete independence and one represents complete dependence. The scores from two to six represent the need for varying degrees of assistance

(Ottenbacher, Hsu, Granger & Fiedler, 1996). See Appendix D for a breakdown of the items evaluated under the motor and cognitive subscales.

Kidd *et al*. (1995) identify several advantages of using the FIM over the BI. The FIM evaluates not only ADLs, but also communication and cognitive function, which may severely limit a patient's function and independence. It allows for a more comprehensive assessment of motor function than the BI as it evaluates 13 motor components. The FIM expands dressing activities, which is useful as most patients have greater difficulty dressing their lower limbs, a distinction not made by the BI (Kidd, *et al.*, 1995). Lastly, a distinction that the FIM makes which the BI does not, is the difference between simple and more complex transfers. It includes shower and bath transfers as well as toilet transfers (Kidd, *et al.*, 1995). The FIM discriminates between levels of disability severity and is useful in determining discharge destination and support required, *i.e*. independence or institutionalisation (Hamilton & Granger, 1994).

The FIM requires certification before it can be used by clinicians. It is appropriate for use on adults with neurological injury over the age of 18 years. It has high test-retest reliability [interclass correlation coefficient (ICC) = 0.9] and construct validity even in the very elderly (those over the age of 80 years) (Pollak, Rheault & Stoecker, 1996). The minimal detectable change (MDC) has not been established, but the minimal clinically important difference (MCID) for the total FIM is 22 points, for the motor sub-scale it is 17 points and for the cognitive subscale, three points (Beninato, *et al.*, 2006).

Ottenbacher, Hsu, Granger and Fiedler (1996) used a meta-analysis to investigate the reliability of the FIM. Eleven published studies were included and coded based on the types of reliability tested, analysis strategies and sample sizes used. The studies included 1 568 patients and produced 221 reliability coefficients. After statistical analysis, the results revealed a very high median inter-rater reliability for the total FIM of 0.95 and median test-retest values of 0.95 across a variety of settings, raters and patients. These results indicate that the FIM is a reliable instrument in the assessment of adults with neurological impairments. Cronbach's alpha scores were: 0.95 for the total FIM, 0.95 for the motor sub-scale and 0.89 for the cognitive sub-scale (Van der Putten, Hobart, Freeman & Thompson, 1999). In patients with stroke specifically, Hsueh, Lin, Jeng and Hsieh (2002) found excellent internal consistency with a Cronbach's alpha value of 0.88 on admission and 0.91 at discharge.

In 106 patients admitted for rehabilitation after an acute stroke, Brock, Goldie and Greenwood (2002) found a minimal ceiling effect for the FIM of 16%. Dromerick, Edwards and Diringer (2003) found no floor or ceiling effect in their sample of 95 moderately disabled, acute stroke patients. Hseuh, Lin, Jeng and Hsieh (2002) found a minimal floor effect of 5.8% at admission, and 3.5% at discharge from inpatient rehabilitation for patients with stroke and no ceiling effect at admission or discharge. This is an advantage as the low/ minimal floor and ceiling effects do not limit the range or variability of data that the FIM can report on. As there is a minimal ceiling effect, the FIM is able to discriminate between highly functioning patients and determine their functional capabilities and functional change. The low floor effect means that very low functioning patients can also be evaluated with the FIM and that the instrument can detect change even amongst these patients.

Standardised outcome measures are the best way to determine if rehabilitation interventions are successful as they quantify improvement (Van der Putten, Hobart, Freeman & Thompson, 1999). It was suggested by Hamilton and Granger (1994) that improvement after a stroke occurs as a result of the patient's capacity to regain function, the success of the therapeutic intervention and time. There is much literature on factors which influence or predict patients' functional outcomes after a stroke.

2.8 Factors Influencing Functional Outcome after Stroke

The difference between the functional score on admission and at discharge provides the functional change score. Both discharge functional scores and functional change scores are useful in describing patients' functional outcomes.

Figure 2.1 below was developed to show a simplistic representation of the relationship between some of the variables that have been associated with patient outcomes. There are several other interactions and variables that could have been included in the diagram, but the depicted variables have the greatest relevance to this study.

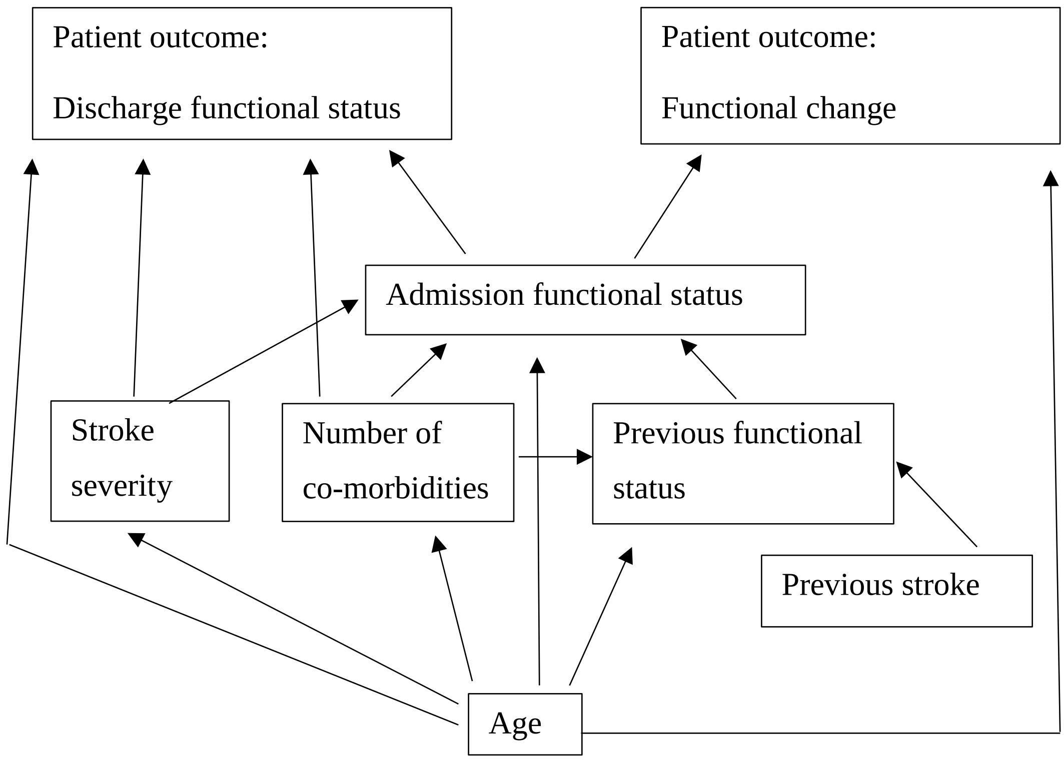

Figure 2.1 Schematic of variables which influence functional outcomes (discharge function and functional change)

Age lies at the bottom of the schematic and is linked to variables above it, such as the number of co-morbid conditions patients have, the severity of their stroke and their functional status prior to the stroke. Additional variables found to influence a patient's level of function prior to the stroke are previous strokes and co-morbid conditions. Stroke severity, co-morbid conditions and previous functional status form the second tier of the schematic, and are all shown to have an influence on the third tier (admission functional status). Admission functional status is influenced by all three of these variables, as well as age.

Admission functional status is shown to influence the fourth tier of the schematic (functional outcomes- both at discharge and functional change). Some of the second tier variables such as co-morbidities and stroke severity also influence functional outcomes, and even age is shown to have an independent influence on functional outcomes. The studies outlined below were used to create the schematic and show the relationships described.

2.8.1 Age, Pre-morbid Function, Stroke Severity and Admission Functional Status

The risk of stroke increases with age, and the elderly are often more clinically complex patients (Kolominsky-Rabas, *et al*., 1998; Kugler, Altenhöner, Lochner & Ferbert, 2003). They have different social and health conditions to younger patients, and are often more functionally compromised and more dependent in ADLs (Colantonio, Kasl, Osfeld & Berkman, 1996; Kolominsky-Rabas, *et al*., 1998). More severe strokes, the female gender, living alone and greater pre-existing disability were all associated with old age (Nakayama, Jorgensen, Raaschou & Olsen, 1994; Kelly-Hayes, *et al.*, 2003; Kammersgaard, *et al*., 2004).

Pre-stroke disability has an effect on the functional outcomes of elderly patients post-stroke (Colantonio, Kasl, Osfeld & Berkman, 1996). The functional outcomes of 63 patients over 65 years of age were measured with the Katz Scale at six months post-stroke. Fewer ADL limitations prior to the stroke were associated with fewer limitations at six months post-stroke ($p = 0.009$). The pre-stroke Katz Scale score was also the strongest independent predictor of a patient's post-stroke score ($p < 0.007$). A previous stroke may also render a patient more functionally compromised and dependent than those with a first-time stroke (Jongbloed, *et al*., 1986, Desmond, *et al*., 2000; Sachdev, *et al*., 2014).

In an outdated critical review by of studies looking at predictors of functional recovery after stroke, Jongbloed (1986) clearly demonstrates the importance of clearly defining the dependent variable which represents recovery. When considering functional gain as the dependent variable, age was found to have no relationship with functional recovery in three of four studies reviewed. However, when function at discharge was the outcome investigated, 12 of 14 studies found a negative relationship between age and recovery (Jongbloed, 1986). This demonstrates that the same variable may appear to have a very different effect on functional recovery depending on the way in which recovery is defined. Studies should include both discharge function and functional gain when determining patient outcomes/ recovery.

Nakayama, Jorgensen, Raaschou and Olsen (1994) investigated the effect of age on stroke severity and functional status at admission and discharge in 418 patients post-stroke. Stroke severity was measured with the Scandinavian Stroke Scale (SSS) and function with the BI. The authors' analysis showed that age had an independent and negative effect on initial BI score (-4 points per 10 year increase in age, $p< 0.01$), initial SSS score (-2 points per 10 years) and discharge BI score (-3 points per 10 years). The study does not investigate functional change. In this study, and others (Kelley-Hayes, *et al.*, 2003; Kammersgaard, *et al*., 2004), the elderly participants are significantly more often women (with a greater number of co-morbid conditions) that were widowed and institutionalised before the stroke. While this study shows the negative effect of age on admission function, discharge function and stroke severity, it is unclear whether the negative effects are due to age alone, or to other factors which influence functional outcomes, such as patients premorbid conditions and level of dependence.

In a very informative study by Kugler, Altenhöner, Lochner & Ferbert (2003) on the ability of older patients to recover functional ability after stroke, the data from 2 219 patients from seven hospitals were collected. Age had a minor negative effect on admission functional status, functional status at one week after admission and at discharge. The small, negative effect of age on functional gain was also identified with regression analyses. Patients under the age of 55 years reached a relative improvement in ADLs of 67% compared to the 50% improvement in patients over 55 years. However, age only explains 1.7% of the variance in functional outcome when ADL status on admission is taken into consideration. The strongest independent predictor of functional status after one week and at discharge was the admission BI score (Kugler, Altenhöner, Lochner & Ferbert, 2003). As the sample size was very large, even the smallest cohort included 163 participants, making meaningful analysis possible. The use of data from several centres reduced the influence of specific hospitals, meaning that the results have good generalisability to other rehabilitation facilities treating patients in the acute phase post-stroke. Bagg, Pombo and Hopman (2002) similarly found that after adjusting for admission FIM score in the regression analysis, the variance in discharge FIM score explained by age was only 1.3%.

Black-Schaffer and Winston (2004) examined the effect of age on FIM gain in 979 patients post-stroke. To control for the effects of admission FIM status on FIM gain, admission FIM status was divided into three cohorts (FIM <40; FIM 40-80 and FIM >80 points). Age was divided into five cohorts (<55 years, 55-64 years, 65-74 years, 75-84 years and >85 years). The authors found a strong relationship between older age and poorer outcome for patients with admission FIM scores < 40, a variable relationship in those scoring FIM 40-80 on admission and no relationship between age and FIM gain in patients scoring FIM > 80 on admission. The oldest and most severely functionally impaired patients at admission made poorer FIM gains than younger and more functional cohorts (Black-Schaffer & Winston, 2004). The authors conclude that admission function plays a greater role in determining patient outcomes, but the effect of age cannot be ignored, specifically in the most severely impaired patients where it has the greatest effect on outcomes.

Alexander (1994) used the same age and admission FIM cohorts to determine the effect of age and admission FIM score on discharge function, LOS and discharge destination for 520 patients admitted to a rehabilitation hospital post-stroke. They found that admission FIM score correlated significantly with discharge FIM score (r= 0.8) and with LOS (r= -0.5). In the ANOVA, only age and admission FIM were found to influence FIM change. The reason age influenced FIM change was due to the effect of younger patients (<55 years) showing significantly greater improvement than older patients (≥55 years). When it came to admission FIM scores, those scoring between 40-80 showed significantly greater FIM gains than any other group. These patients may have the most to gain from rehabilitation (Alexander, 1994).

Comparing studies on the effect of age on functional recovery after stroke is challenging as outcome measures, time-frames for measuring function, and age cohorts differ greatly. What is evident from the studies of age and functional outcome, is that both function at discharge and functional change should be considered, and that admission function cannot be disregarded when examining patient outcomes. Age, stroke severity and pre-stroke level of function have been discussed. Most studies do not consider these variables separately and use admission function as a proxy (Alexander, 1994; Black-Schaffer & Winston, 2004). The effect of co-morbid conditions on admission and discharge function will be described below.

2.8.2 Co-morbidities

There is a well-established link between older age and a greater number of co-morbidities present in patients that patients present with (Alexander, 1994; Guccione, *et al*., 1994; Kelly-Hayes, *et al*., 2003; Boyd, *et al*., 2005). While co-morbidities may influence function in the elderly, it is unclear which conditions have the greatest effect on ADL performance (Guccione, *et al*., 1994). Twenty conditions were studied for their association with the performance of seven functional tasks. Depression was found to be significantly associated with dependence in five different ADLs. Knee osteoarthritis, heart disease, congestive heart failure, and chronic obstructive pulmonary disease were associated with dependence in four ADLs each. ADLs included stair-climbing, walking a mile, heavy home chores, housekeeping, cooking, grocery shopping and carrying a 10-pound bundle (Guccione, *et al*., 1994). A limitation of this study and others is that a standardised co-morbidity index was not used. A standardised outcome measure for determining function was also not used. While it provides strength to the argument that co-morbidities influence function negatively, the validity and accuracy of the findings of this study are limited.

In a large study of 897 patients who suffered ischaemic strokes between 2005 and 2007, the most common co-morbidities were: hypertension (64.9%), smoking (47.4%), diabetes (38.2%), coronary artery disease (CAD) (22.3%), chronic renal failure (CRF) (17.4%), congestive heart failure (CHF) (12.7%), chronic obstructive pulmonary disease (COPD) (11%), atrial fibrillation (AF) (7.9%), urinary tract infection (UTI) (6.6%), fever (5.2%), cardiac arrhythmias (3.3%) and pneumonia (1.8%) (Mohamed, *et al.*, 2015). These findings are similar to those of Kugler, Altenhöner, Lochner and Ferbert (2003) in whose sample of 2 219 patients with stroke, 70.1% of the sample presented with hypertension, 27.7% with cardiovascular disease and 26.2% with diabetes mellitus. The findings also correspond with the findings of Chang, *et al*. (2015), who found the most common premorbid conditions to be hypertension (50.2%), diabetes (18.3%), cardiac disease (7.1%) and hyperlipidaemia (6.1%). Using multivariate regression analysis only two co-morbidities were found to be associated with greater disability (measured with the MRS). These were CRF and the presence of AF (Mohamed, *et al.*, 2015). Once again, the use of a standardised co-morbidity index may have improved the validity of findings.

A study by Karatepe, Gunaydin, Kaya and Turkmen (2008), however, used The Liu Index to measure co-morbidities, the FIM to measure functional outcome and gain, and the Canadian Stroke Scale to measure stroke severity in 94 patients post-stroke. The Liu Index is a valid and reliable instrument to use for measuring co-morbidities in patients post-stroke (Liu, Domen & Chino, 1997). Conditions are weighted (with a score of zero to five) according to the need for treatment and limitations on ADLs and the weighted score (weighted co-morbidity index- w-CI) can be calculated by adding the scores (Karatepe, Gunaydin, Kaya & Turkmen, 2008).

The authors found that the w-CI was negatively correlated with FIM gain and follow-up FIM (fu-FIM) score at four weeks (Karatepe, Gunaydin, Kaya & Turkmen, 2008). Multiple regression analysis revealed that 3.1% of the variation in the fu-FIM score could be explained by the w-CI score. The admission FIM score and stroke severity were much stronger predictors, explaining 45% and 5.8% of the variation in fu-FIM respectively. While these factors are much stronger predictors, the fact that the w-CI score remained an independent predictor when added to the regression analysis indicates the clinical importance of identifying and managing co-morbidities in patients post-stroke. The abovementioned study findings also support the links demonstrated in the schematic between stroke severity and functional outcome, as well as admission functional status and functional outcome.

The relationships identified in the schematic have been discussed. For simplicity, some additional factors were not depicted, but may also influence functional outcomes. These include the development of complications; perceptual and cognitive dysfunction and the timing and intensity of rehabilitation. Their effects on functional outcome will be discussed in the following paragraphs.

2.8.3 Complications

Stroke severity is the strongest predictor of developing complications post-stroke (Roth, *et al*., 2001; McLean, 2004; Indredavik, Rohweder, Naalsund & Lydersen, 2008; Kitisomprayoonkul, Sungkapo, Taveemanoon & Chaiwanichsiri, 2010). There is great variation in the proportion of patients with stroke reported to develop complications in the literature. This is likely due to the differences in study designs, the accuracy of recording complications, the timing for measuring complications and the different types of facilities studied.

Common complications include pneumonia, myocardial infarction (MI), UTI, shoulder pain, pressure sores, falls, pulmonary embolisms, deep vein thrombosis (DVT), fever and constipation (Indredavik, Rohweder, Naalsund & Lydersen, 2008; Ingeman, *et al.*, 2011; Mohamed, *et al.*, 2015). The emphasis of early care should be the prevention and recognition of common complications post-stroke (Ingeman, *et al.*, 2011).

In an unselected sample of 489 patients with stroke, in the acute phase, admitted to a specialised stroke unit, the most common complications (documented at one week) were pain (53.3%), UTIs (27.9%) and falls (25%) (Indredavik, Rohweder, Naalsund & Lydersen, 2008). Similar complications were identified by Mohamed *et al*. (2015) who found that only the development of UTIs was associated with greater disability (measured with the MRS) in patients in the acute phase post-stroke (odds ratio [OR]: 2.31, 95% Confidence interval [CI]: 1.2- 4.4) (Mohamed, *et al*., 2015).

2.8.4 Cognitive and Perceptual Impairments and Communication

Cognitive disorders may be a severely debilitating early consequence of stroke (Nys, *et al.*, 2005). As many as 61.7% of patients experience some form of cognitive decline after a stroke (Pohjasvaara, Erkinjuntti, Vataja & Kaste, 1997). The percentage is significantly greater in older cohorts (74.1% in age group 74- 85 years vs 45.7% in age group 55- 64 years; p= 0.0008).

The relative risk (RR) of disability (measured with the BI) after a stroke was doubled in patients with cognitive impairments compared to those without at three months post-stroke (RR: 2.4, 95% CI: 1.93- 3.01). Patients may experience deficits in episodic memory, executive functions, language deficits and visual attention deficits (Lincoln, *et al.*, 1998; Hanks, Rapport, Millis & Deshpande, 1999; Duncan, *et al.*, 2005). These may all impact the patient's ability to successfully participate in ADLs (Oros, *et al.*, 2016). Patients with attention and executive dysfunctions may struggle to understand, and therefore participate in rehabilitation, and may not make effective progress with rehabilitation therapies (Robertson, Ridgeway, Greenfield & Parr, 1997; Oyeyemi & Sedenu, 2010; Skidmore, *et al.* 2010). (Douiri, Rudd & Wolfe, 2013).

Admission cognitive function was found to have a significant influence on functional gain in 336 patients over the age of 60 years, admitted for rehabilitation (Heruti, *et al*., 2002). Cognitive function was measured with the Mini Mental State Examination (MMSE) and FIM cognitive subscale, and the outcome measured was the FIM motor gain. Patients with higher cognitive scores on admission had better motor gain scores than those with greater cognitive impairment. Admission FIM cognitive score correlated with FIM motor change ($r = 0.48$, $p < 0.001$) and admission MMSE score correlated with FIM motor change ($r = 0.46$, $p < 0.001$). Patients were divided into four cohorts depending on their admission MMSE scores. The most and least severe cohorts were compared to determine the effects of MMSE on functional gain. Patients were considered to have made satisfactory functional gains if their FIM motor gain scores were greater than 0.5 (*i.e.* 50% of their potential improvement). Logistic regression analysis results showed that admission MMSE was strongly associated with functional gain after controlling for confounders (sex, age, onset admission interval and neurological symptoms). A five point increase in admission MMSE score increased the chance for functional improvement two-fold (OR: 2.0; 95% CI: 1.5– 2.5) (Heruti, *et al.*, 2002).

The aim of a study by Nys *et al.* (2005) was to determine which domain-specific cognitive impairments were more related to outcome than others after stroke. Patients' cognitive function was evaluated with neuropsychological tests that covered the entire cognitive spectrum. The outcomes selected were long-term cognitive and functional impairment in terms of basic ADLs (measured with the modified Barthel Index [mBI]) and IADLs (measured with the Frenchay Activities Index [FAI]). The sample included 168 patients with acute stroke and 75 carefully matched control subjects. Demographic, medical and cognitive data were collected on admission. At six months, 31% of the patients had residual cognitive impairment (19% displayed residual impairments in basic ADL functions and 24% of patients were unable to manage IADLs, *i.e.* grocery shopping, reading, and household management

(Nys, *et al.*, 2005). With the regression model, visual memory, hemi-neglect and admission glucose level were independent predictors of incomplete basic ADL recovery (Nys, *et al.*, 2005). When IADL performance was used as the dependant variable in the regression model, impaired visual perception and construction, poor mBI score on admission and right hemisphere lesion were independent predictors of poor recovery (Nys, *et al.*, 2005). The low median NIHSS score (5) of this sample indicates a rather mildly impaired sample. These results may therefore not be generalisable to all populations of patients with first-time strokes.

Oros *et al.* (2016) found similar results in their study examining the impact of cognitive impairment on ADL performance in a smaller sample of 75 patients over the age of 65 years, who had a stroke. The most commonly impaired IADLs were cleaning, shopping and personal care (Oros, *et al.*, 2016). In their sample, 72% had cognitive impairments while 28% had intact cognitive function. Results showed an association between cognitive impairment on the Mini Mental State Examination (MMSE) and ADL performance (as measured with the Katz Index) (Spearman rho= -0.458, $p < 0.01$), as well as a significant negative correlation between Rey Auditory Verbal Learning Tests (RAVLT) and ADL function. Although different outcome measures were used, their findings were similar to those of Nys *et al*. (2005). A shortfall of this study is that it does not specify the time-frame at which outcomes were measured post-stroke.

Zinn *et al.* (2004) similarly found that cognitive impairment (as measured with the MMSE) was both associated with, and a predictor or IADL impairment (measured with the Lawton IADL score) at six months in 288 stroke patients hospitalised at 11 different Departments of Veterans Affairs hospitals ($b = –2.3$, $p = 0.01$) when baseline characteristics were controlled for (race, sex, marital status, education status, prior stroke, stroke severity). While it was also associated with ADL function at six months (measured with the FIM motor score), it was not a significant predictor thereof. Admission motor FIM and pre-stroke walking ability were the strongest predictors of ADL function. The differences in study results may be due to the different outcome measures used (FIM motor score rather than FIM gain) or differences in sampling criteria (in this study patients who could not follow a two-step command were excluded, thus patients may not have been as severely impaired as other studies) (Zinn, *et al*., 2004).

Unilateral spatial neglect (USN) is a common visual-perceptual spatial problem post-stroke. It is commonly associated with right parietal lesions because of the right hemisphere's role in modulating the left and right visual fields (Paolucci, Antonucci, Grasso & Pizzamiglio, 2001).

Paolucci, Antonucci, Grasso and Pizzamiglio (2001) studied 178 patients admitted to a rehabilitation hospital within three days of a first-time stroke. The authors found that patients with USN had longer LOS (116.8 days vs 81.3 days), decreased ADL performance (discharge BI score: 44.9 vs 71.7) and smaller BI change scores (30.9 vs 54.1). They showed greater disability despite the eight week rehabilitation intervention being standardised to bi-daily, 60-minute physiotherapy sessions, six days per week, and patients with USN receiving an additional five hours per week of specific exercises and interventions for USN. In the multiple regression analyses USN was positively associated with longer LOS ($b= 0.3$, $p< 0.001$) and negatively associated with BI change ($b= -0.2$, $p< 0.01$). While patients with and without USN were matched for age and onset admission interval, patients with USN were more severely neurologically and functionally impaired at baseline (Canadian Neurological Scale [CNS]: 5.5 vs 6.9, and BI: 22.5 vs 40.2). The negative effects may have been due to the presence of USN, but also due to the greater impairment at baseline.

It is difficult to determine the incidence of neglect as most studies are hospital-based rather than community-based. In a Swedish community-based study of 337 patients with first-time strokes, 282 patients were able to complete the assessment for neglect. Neglect was diagnosed in 23% of the sample. In the logistic regression, neglect was found to predict greater dependence in ADLs in the acute phase (as measured by the Katz Index) (OR: 2.5, 95% CI: 1.1- 6.0, $p= 0.037$). In a systematic review of studies determining the effect of neglect on functional outcomes after stroke, 26 studies based in general or rehabilitation hospitals met the inclusion criteria. Performance in ADLs was measured with the BI, the FIM, The FAI and the Katz Index. Eleven studies using multivariate regression analyses identified neglect as an independent predictor of poor functional outcomes. Six studies found that USN was a predictor of functional outcome when combined with one other variables (i.e. age, hemi-paresis or stroke severity), and eight studies found it to be a predictor when combined with two or more variables (Jehkonen, Laihosalo & Kettunen, 2006).

As many as 82.3% of patients may present with speech disorders after acute stroke. In 771 patients admitted to Tuzla University Clinical Centre post-stroke, dysarthria was the most common impairment (70%) followed by aphasia (30%). This is similar to the findings of Berthier (2005) who reported the incidence of aphasia to be 21-28% amongst acute stroke patients.

In an assessment of 156 patients with acute left hemisphere strokes, 67% presented with aphasia using the Aachen Aphasia Test [AAT]. Independent variables entered into the regression analysis to determine predictors of functional outcomes were age, gender, stroke type, lesion size, onset to admission interval, stroke severity (NIHSS), admission function (Fugl-Meyer Scale, Trunk Control Test, initial motor FIM) and AAT (spontaneous speech, token test, repetition, written language, confrontation naming, comprehension). Admission functional score (with Fugl-Meyer Scale, Trunk Control Test and motor FIM) as well as all items of the AAT were significantly correlated with total discharge FIM score. In the multivariate regression analysis, Initial Fugl-Meyer Scale score, initial FIM motor score and comprehension were the strongest predictors of discharge FIM score ($b= 0.35$, $b=0.35$, $b=0.36$ respectively; $p< 0.001$ for all) with the model accounting for 68% of the variance in discharge FIM total score (Gialinella, 2011). The results from these studies indicating the independent effect of USN, aphasia and cognitive impairment on ADL function are clinically important when determining predictors of functional outcome.

2.8.5 Rehabilitation Practices

Rehabilitation interventions are often tailored to the needs of individual patients, leading to great variability in rehabilitation practices amongst therapists and facilities, and a lack of standardisation (DeJong, Horn, Smout & Ryser, 2005). Ideally, in order to compare outcomes, RCTs should be performed for each intervention or variation in practice. This is however not practical or feasible (DeJong, Horn, Smout & Ryser, 2005).

Due to the neural plasticity of the brain, the intensity of therapy is important and activation of areas associated with function may lead to significant recovery if appropriate stimuli are applied at the correct time (Johansen-Berg, *et al.*, 2002). Comparison of studies on stroke rehabilitation interventions is difficult due to the differences between patient populations studied, different time periods at which interventions are implemented and different tools used to measure improvement. Few studies achieve level one evidence. There is little consistency in the results confirming the effectiveness of any one specific treatment over another. If suppliers of rehabilitation services cannot provide evidence for the effects of their interventions, it limits their ability to validate the need for funding of rehabilitation programmes from medical insurers or government services for managing patients with stroke (DeJong, Horn, Smout & Ryser, 2005).

Not only is the type of intervention important, but also the timing. Early rehabilitation is part of many stroke management guidelines (Duncan, *et al.*, 2005; European Stroke Organisation (ESO) Executive Committee & ESO Writing Committee, 2008), but there is little consensus on the optimal dose or time to initiate rehabilitation. There is poor agreement on what early rehabilitation constitutes and the term has been used in the literature to describe interventions implemented hours, days, weeks and even months after stroke onset (Bernhardt, Indredavik & Langhorne, 2013).

Early mobilisation training, starting within 24 hours of stroke onset is feasible, safe and speeds up the recovery of unassisted walking (Bernhardt, *et al.*, 2008; Cumming, *et al.*, 2011). Patients who are mobilised very early require less mechanical ventilation, experience less delirium, and regain functional independence faster than those confined to bed rest (Morris, *et al.*, 2008; Schweickert, *et al.*, 2009).

In a review of RCTs of early mobilisation of patients (within 48 hours of stroke), only one trial met the inclusion criteria as dose and therapy content are often poorly described (Bernhardt, *et al.*, 2008). The selected study included 71 patients with acute stroke. The experimental group received earlier and more frequent mobilisation than the control group (median 18.5 hours *vs* 30.8 hours, and mean 167 minutes of mobilisation *vs* 69 minutes). Of the experimental group, fewer patients died or were institutionalised at three months post-stroke, but this was not statistically significant and the confidence intervals were wide (OR: 0.67, 95% CI: 0.25- 1.79, p= 0.42) (Bernhardt, *et al.*, 2008). While there was no significant difference between groups, there were also no harmful effects identified. These included falls which result in head injury or fractures, a decline in function measured by a drop of two or more points on the SSS, excessive fatigue and three or more consecutive drops in systolic blood pressure that resulted in therapy being temporarily discontinued. There was thus insufficient evidence either to refute or support very early mobilisation.

2.8.6 Discharge to Nursing Facilities

Patients who are not able to return home or are not functioning independently when discharged from IRFs are often placed in nursing homes as an interim or permanent discharge destination (Kane, Chen, Blewett & Sangl, 1996; O'Brien, Xue, Ingersoll & Kelly, 2013). Chan *et al.* (2013) studied 222 Californian patients post-stroke and found that patients at nursing facilities made poorer functional gains compared to those treated in IRFs at six months post-stroke. Patients in nursing facilities scored eight points less on the Activity Measure for Post-Acute Care (AM-PAC). This is double the minimal detectable change (MDC) for this functional measure (Chan, *et al.*, 2013). Confounders were carefully controlled (age, discharge function, co-morbidities, previous stroke and hours of rehabilitation), and case-mix adjustments, outcome comparison stratification and risk adjustments were done to ensure that groups from nursing homes and IRFs were comparable. A limitation of the study is that therapy content and quality was not controlled for and that only one IRF was used, limiting the generalisability of the results.

The probable cause for the discrepancy is that the quality and quantity of therapy at nursing facilities is not equivalent to that of an IRF. Nursing facilities are not required to provide the three hours of therapy daily or physician-directed multidisciplinary team care provided in IRFs (Kane, Chen, Blewett & Sangl, 1996; Kramer, *et al*., 2000; Duncan, *et al.*, 2002; Chan, *et al.*, 2013). Early discharge to nursing homes may be detrimental to patients' functional recovery as their needs for increased health services in the long term (due to lasting impairments) outweigh the benefits of earlier cost-saving (Duncan, *et al.*, 2002).

Patients' age and admission functional status, stroke severity, previous functional capacity and co-morbidities have all been found to affect patients' functional outcomes. The development of complications, perceptual and cognitive impairments, discharge destination and rehabilitation practices also influence patients' functional outcomes after stroke. There is some overlap in the literature on factors which affect functional outcome and those which affect LOS. Several of the abovementioned variables will be discussed below regarding their relationship with LOS.

2.9 Factors influencing Hospital Length of Stay

Identifying the factors which influence stroke patients' hospital LOS is useful when trying to improve health resource efficiency and manage hospital costs (Chang, Yoon & Kwon, 2009; McClure, *et al.*, 2011; Kim, Hwang, Oh & Kang, 2013). LOS is a major determinant of treatment costs after stroke (Jorgensen, Nakayama, Raaschou & Olsen, 1997; Harvey, *et al.*, 1998; Caro, Huybrechts & Duchesne, 2000; Saxena, *et al.*, 2006). In an attempt to achieve the best outcomes at the lowest costs, several different strategies are used by rehabilitation facilities. These include: reducing patients' hospital LOS, discharging patients to less costly facilities, and providing additional therapy. These are examples of facility/ service related factors which influence LOS. Patient related factors that have been studied to determine their influence on LOS include patients' age, functional status at admission, co-morbidities and complications, cognitive capacity and speech impairments.

2.9.1 Facility/ Service Related Factors

a) Early discharge due to funding constraints

As a large proportion of South Africans are not covered by medical insurance, up to 25% pay out-of-pocket for private rehabilitation services (Mayosi & Benatar, 2014). When these patients run out of funds, they may need to terminate their LOS before the expected discharge date (Van Exel, Koopmanschap, Van Wijngaarden & Scholte op Reimer, 2003). For patients who are insured by medical aid schemes, the required LOS for sufficient recovery is not always guaranteed. A patient's LOS may be limited to the financial coverage that their medical scheme provides. This is based on the prescribed minimum benefits of each medical aid scheme. Prescribed minimum benefits (PMBs) are defined by law, and are the minimum level of medical care and treatment that a medical aid scheme has to cover (Smit, 2015). Many South Africans need to make co-payments or pay for part of their healthcare services out-of-pocket to supplement the payments made by medical aid schemes (Mills, *et al*., 2012). Third party payers also put pressure on rehabilitation facilities to discharge patients earlier in order to reduce their costs (Gillen, Tennen and McKee, 2007).

b) Prospective Payment Systems

In the United States, IRFs provide the bulk of post-acute stroke care (O'Brien, Xue, Ingersoll & Kelly, 2013). The Centre for Medcare and Medicaid Services (CMS) implemented a prospective payment system (PPS) in 1984 for the purpose of reimbursing healthcare facilities caring for patients after stroke. IRFs were included under the PPS system from 2002 after the Balanced Budget Act, 1997 was enforced (Dobrez, Sasso & Heinemann, 2004). With implementation of the PPS, hospital LOS at IRFs has become significantly shorter (Dobrez, Sasso & Heinemann, 2004; Gillen, Tennen & McKee, 2007; Granger, *et al*., 2009). Facilities covered by PPS receive a pre-determined amount of funding for patients admitted to the facility based on their predicted needs. If patients require longer LOS to achieve the outcomes needed for safe discharge, these costs are not covered (Dobrez, Sasso & Heinemann, 2004; Gillen, Tennen & McKee, 2007; Granger, *et al*., 2009). The considerable decline in LOS was beyond what could be attributed to the continuation of the trend towards shortening LOS which was occurring before PPS implementation (Gillen, Tennen & McKee, 2007). Since hospital LOS is a strong predictor of the cost of care after a stroke, shortening hospital LOS is the facility's preferred method of maintaining financial stability (Dobrez, Sasso & Heinemann, 2004; Saxena, *et al.*, 2006; Gillen, Tennen & McKee, 2007; Mohamed, *et al.*, 2015).

After the implementation of the PPS between 2002 and 2007 in a very large, national sample (n= 371 211) the mean hospital LOS decreased by 1.8 days, the admission FIM scores were 4.4 points lower and discharge FIM scores were 3.6 points lower. When the study year and covariates were controlled for, each day spent in an IRF was associated with an increase of 0.5 points in the FIM score [confidence interval (CI): 0.48- 0.52; P = 0.05]. Both the lower admission FIM scores and shorter LOS may have contributed to poorer patient outcomes (O'Brien, Xue, Ingersoll & Kelly, 2013).

Rollnik and Janosch (2010) explored the trends in LOS in a German rehabilitation clinic amongst 2 060 patients after stroke or traumatic brain injury (TBI) in the early phase. They noted a statistically significant decrease in LOS ($p < 0.001$) from 46.8 days to 37.5 days between 2005 and 2008. The authors propose that the reduced LOS is due to the selection effect of patients admitted to the facility. Patients are selected if they are resilient enough to cope with an average 300 minutes per day of rehabilitation therapies and thus very severely affected patients (ventilated or with very low BI scores) are not selected as appropriate candidates for admission to rehabilitation facilities. The trend of shorter LOS may be due to stricter adherence by therapists to the daily minimum of 300 minutes of therapy and earlier discharge from acute care facilities. As the sample included all patients admitted for rehabilitation, the results are not specifically applicable to patients post-stroke (Rollnik & Janosch, 2010).

If patient LOS can be reduced without compromising patient outcomes, then a shorted LOS indicates efficiency (Peiris, Taylor & Shields, 2011). If rehabilitation does not become more efficient however, shorter rehabilitation stays may limit patients' potential for functional gain because of the reduced therapeutic dose available compared to the past (O'Brien, Xue, Ingersoll & Kelly, 2013).

c) Additional Therapy

English *et al.* (2016) hypothesised that weekend therapy would reduce LOS and therefore the cost of post-stroke care. In a review of two randomised controlled trials (RCTs), weekend therapy was found to reduce mean hospital LOS but that the difference did not reach statistical significance (English, *et al.*, 2016). While inconclusive, the results are promising, and are similar to those found previously by Peiris, Taylor and Shields (2011).

Peiris, Taylor and Shields (2011) found that an additional 19 minutes of physiotherapy daily led to a statistically significant decrease in LOS of four days (95% CI: 0- 7) in adults admitted to a rehabilitation setting after an acute event (stroke, hip fracture or coronary artery bypass surgery) (standard mean difference 0.22, 95% CI: 0.39- 0.05). The authors included 16 RCTs with 1 699 patients and defined "extra physiotherapy" as longer or more frequent sessions than those normally provided by a facility. The strength of this systematic review is the inclusion of only RCTs as this design carries the smallest risk of bias. The results however cannot be generalised to stroke patients as other rehabilitation diagnoses were also studied.

d) Discharge destination

The effect of early discharge on patients' functional outcomes has been discussed previously. It may also influence LOS. These facilities and services are less expensive than IRFs and the early discharge of patients from IRFs to nursing facilities may thus be seen as a cost-saving strategy for patients making slow progress (Kane, Chen, Blewett & Sangl, 1996; Buntin, *et al.*, 2010).

The longer hospital stays are more likely due to the severity of the functional impairments and the challenges in placing patients in institutional care than to the patients' ages. In the most severely functionally impaired cohort of patients post-stroke, Black-Schaffer and Winston (2004) found that the youngest patients had significantly longer LOS in rehabilitation facilities than the oldest patients (66.7 days compared to 43.7 days). Alexander (1994) found the same in 520 post-stroke patients admitted to a rehabilitation hospital. In the youngest age group (<55years), the most severely affected patients had the longest LOS (Admission FIM correlated with LOS [r= -0.5]. Both studies attributed the negative relationship between age and LOS to the fact that the youngest and most severely impaired patients had very long LOS due to the difficulty of finding appropriate referral settings for these patients. Young patients who need skilled nursing care are less willingly accepted into nursing facilities, (Alexander, 1994; Black-Schaffer & Winston, 2004). In older patients the main reason for discharge to institutional care was the lack of a supportive care-giver at home (Kelly-Hayes, et al., 2003). Single marital status was found to be significantly associated with longer LOS in hospital post-stroke (OR: 1.37) by Monane, Kanter and Glynn (1996). Often the role of care-giver is fulfilled by the spouse (up to 44.4% of care-givers of patients after stroke) (Gao & Liu, 2015). Single or widowed patients may not have a care-giver to return to at discharge, potentially placing them at risk of longer LOS while awaiting institutionalisation (Jorgensen, Nakayama, Raaschou & Olsen 1997; Kelly-Hayes *et al*., 2003)

In a study by Teasell, McRae and Finestone (2000) looking at young strokes, only four of 83 patients were accepted to nursing facilities at the point of discharge from rehabilitation. In most cases patients returned home with the spouse or parent of the patient as the primary care-taker. In the case of the four patients who were accepted at nursing facilities, the common factors were the severity of the stroke and the lack of a support system at home. This gives support to the concept that young stroke survivors are difficult to place in nursing facilities, particularly if their impairments are severe.

Before studying the effects of medical factors on LOS, a schematic may once again be useful for depicting the relationship between variables. See Figure 2.2 below for a visual representation of the medical and non-medical factors that influence LOS.

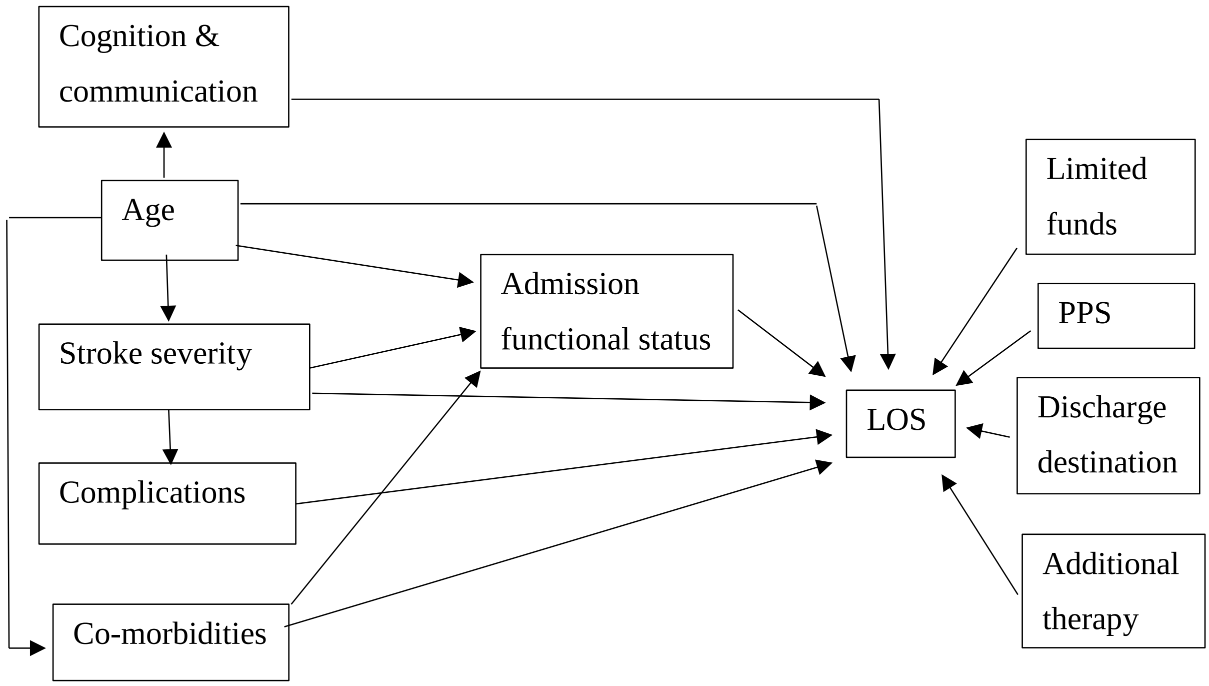

Figure 2.2 Schematic of the service/ facility related and patient related factors influencing LOS

The effect of age on stroke severity, admission functional status and co-morbid conditions has been discussed previously. The effect of age, stroke severity and co-morbidities on admission functional status has also been described. New relationships depicted in this schematic are those linked to LOS. The patient related factors are shown on the left while the service/

facility related factors are on the right. Once again, several other factors may have an influence on LOS, but those that had the greatest relevance to this study were prioritised.

2.9.2 Patient Related Factors

a) Admission functional status, age and stroke severity

A simple model incorporating FIM score on admission and age may be clinically useful for predicting hospital LOS for patients in IRFs post-stroke. Both parameters are readily available on admission. Franchignoni *et al.* (1998) used data of 129 patients, from three different IRFs, admitted within 60 days of a first-time stroke. Hospital LOS was transformed into its natural logarithm (logLOS) to correct for the positive skewness. The authors found a significant, negative correlation between the logLOS and FIM total score, FIM motor score, individual items of the FIM and age. Age, toilet transfers, social integration and expression were included in the regression model which explained 47.5% in the variance of LOS. Age alone explained a small but significant percentage (5.9%) of the variation in hospital LOS with toilet transfers alone explaining a much larger proportion (31.3%) (Franchignoni, *et al.*, 1998). Valach, Selz and Signer (2004) similarly found that patients with stroke, admitted to a rehabilitation facility, who were more mobile and independent in transfer items of the FIM on admission (bed/chair/wheelchair), had shorter hospital LOS ($b= -0.3$, $p< 0.001$). This item predicted 26% of the variance in LOS.

In a larger and more recent study, similar to that of Franchignoni *et al.* (1998), Chang *et al.* (2002) attempted to determine the major predictors of hospital LOS from 330 patients' admission data. The sample differed from that of Franchignoni *et al.* (1998) in that it included acute patients admitted within 48 hours of having a first-time stroke. The authors recorded a much greater variety of variables, providing depth to their study. Variables included patients' age, gender, stroke severity (NIHSS), functional status at admission (mBI), hours after stroke onset, co-morbidity (presence or absence of a variety of conditions), stroke subtypes, serum total cholesterol and triglyceride levels. The strongest predictors of hospital LOS were the initial stroke severity, mBI score on admission, small-vessel occlusion stroke, male gender, and smoking. The multiple regression analysis showed that a one point increase in NIHSS corresponded with an almost one day decrease in hospital LOS [regression coefficient=

0.02834, standard error (SE)= 0.013, p= 0.033]. A one point decrease in mBI score at admission, smoking and small-vessel occlusion type stroke were each associated with an approximately one day increase in LOS (p= 0.042; p= 0.001; p= 0.043 respectively) and male gender was associated with an approximately one day increase in LOS (p= 0.004). The variance in LOS explained by this model was 37%. Age had no effect on LOS in this study.

LOS may be used as a proxy for resource utilisation (Harvey, *et al.*, 1998). Harvey *et al.* (1998) were interested in the type of information that needed to be gathered on admission in order to identify predictors of resource utilisation (represented by LOS). The data from 866 patients were collected from a single rehabilitation hospital and divided into four categories: patient referral information, demographic and stroke characteristics, medical records (co-morbidities and laboratory results) and physical examination (neurological and functional impairment, measured with NIHSS and FIM). With stepwise regression analyses, only lower FIM motor scores and higher NIHSS scores remained significant predictors of LOS (b= -0.32, p< 0.001 and b= 0.36, p< 0.001 respectively). The model including these two variables explained 35.9% of the variance in LOS (adjusted r^2= 0.359, $F_{2,824}$= 231.9, p< 0.001). These results were very similar to those of Chang *et al.* (2002). As patients were only sampled from one acute hospital the results may have limited generalisability to other populations. The different time-frames for assessment in all the above-mentioned studies make comparison of results challenging.

Sebastia *et al.*, 2006 used a compound variable made up of the admission FIM score and the Trunk Control Test (TCT) to determine the variability in LOS for 245 patients with acute stroke admitted to a rehabilitation facility. The compound variable predicted 27% of the variability in LOS and 48% of the variability in discharge FIM score. The results were based on patients who developed no complications during their admission, had no cognitive impairments and no previous gait abnormalities according to the exclusion criteria of the study. This limits the generalisability of the results to other stroke patients in rehabilitation facilities as cognitive impairments and the development of complications are common.

A trend of shortening LOS prompted research in an acute German rehabilitation facility between 2005 and 2008 on the predictors of LOS. With LOS as the dependent variable in the univariate analysis of variance (ANOVA), age was found to have no correlation with LOS. This is in line with the findings of Black-Schaffer and Winston (2004) who found no relationship with age and LOS in their entire sample, and of Chang *et al*. (2002). Admission BI score was correlated with LOS, *i.e.* the lower the BI score, the longer the LOS ($F= 40.4$, $p< 0.001$) (Rollnik & Janosch, 2010).

McClure *et al.* (2011) also considered trends in LOS, but focused on a very different cohort to the studies mentioned above. The authors observed that highly functioning stroke patients were remaining in rehabilitation facilities for prolonged periods. The study included 134 patients with FIM scores >100 in Canada between 2005 and 2008 (mean admission FIM: 109 Standard deviation [SD] 6.6). Bivariate correlations and regression analyses were used to determine the predictors for LOS in this population. Eight significantly correlated variables were included in a multiple regression model. Admission FIM cognitive and motor sub-scores, admission MMSE score, orientation, financial independence and verbal, written and auditory communication together explained 60% of the variance in LOS ($p= 0.001$). These results are difficult to compare with other studies that include more functionally impaired patients (*i.e.* those with lower mean admission FIM/ BI scores). The findings that admission status is a predictor of LOS is however in line with that of many other studies, namely that of Franchignoni *et al.* (1998), Chang *et al.* (2002) and Rollnik and Janosch (2010).

Stroke severity was found to be a strong and reliable predictor of both acute and total LOS in a community based study of patients who had experienced ischaemic strokes (Appelros, 2007). Other factors that were found to be predictors of acute LOS were lacunar strokes, pre-stroke dementia and smoking. The only other predictor of total LOS in this study was pre-stroke dependence in ADLs. The authors found no relationship between age and LOS with correlations or regression analyses. The mean acute LOS was 12 days and the total LOS was 29 days. Stroke severity was measured with the NIHSS and a one point increase in NIHSS score on admission predicted a 0.8 day increase in acute LOS and a 3.4 day increase in total LOS. ADL dependence or independence prior to stroke was determined with a structured interview based on the BI. Previously dependent patients had a LOS that was 23 days shorter than those who were independent prior to the stroke and patients who suffered from pre-stroke dementia had a 6.5 day longer acute LOS. There was a trend of total LOS being shorter in patients with pre-stroke dementia, but this did not reach significance (Appelros, 2007).

The reason for the longer LOS in more severely affected patients may be the greater difficulty in rehabilitating these patients who may have more physical and cognitive impairments and be more fatigued. The longer acute LOS in patients with dementia could be due to the difficulty of mobilising these patients who may not remember or understand instructions. They may also be more difficult to place at discharge and may require institutional care. The trend of shorter total LOS in previously dependent patients may be related to their poor responsiveness to rehabilitation and quicker discharge home if care-givers are already in place (Appelros, 2007).

Despite the challenges in comparing model results, admission FIM score is clearly an important predictor of LOS in a variety of patient groups that have experienced stroke. Admission functional status may be a proxy for several variables (*i.e.* stroke severity, co-morbid conditions and pre-stroke level of function (Black-Schaffer and Winston, 2004), which results in its greater predictive power. Other variables that had an influence on LOS based on the above studies are patient age, stroke severity and cognitive capacity. The effects of co-morbidities, complications and communication will be discussed below.

b) Co-morbidities and Complications

The early management of co-morbidities that are associated with adverse patient outcomes would allow for a reduction in costs associated with medical management, and fast track patient recovery after stroke (Kelly-Hayes, *et al.*, 2003; Karatepe, Gunaydin, Kaya & Turkmen, 2008). Patients with a greater number of co-morbidities require longer LOS due to the additional time needed for motor training, functional skills and family training (Monane, *et al.*, 1996).

When exploring the relationship between co-morbidities and LOS using multivariate analysis, Mohamed *et al.* (2015) found that not all comorbidities influence LOS. After correcting for admission NIHSS score, medical insurance status, age and previous stroke, only three co-morbidities were found to significantly prolong LOS. These were CRF, CHF, and a history of arrhythmias. While findings from this study are clinically relevant, the use of a weighted co-morbidity index would have given greater validity to these results. As mentioned previously, the presence of pre-stroke dementia may prolong acute LOS (Appelros, 2007).

The development of complications hinders optimal rehabilitation (Saxena, *et al.*, 2006). Stroke severity is the most important risk factor for developing complications (Karatepe, 2008). This is likely due to the fact that patients who have suffered severe strokes have more limited mobility, which predisposes them to increased pain, the development of respiratory infections and pressure sores (Indredavik, Rohweder, Naalsund & Lydersen, 2008). Stroke severity may also affect a patient's ability to perform clinical functions such as swallowing safely and controlling their bladder/ bowel. Both these impairments may predispose patients to developing complications like aspiration pneumonia and UTIs. The management of these conditions (NG tube feeding and catheterisation) may also predispose patients to developing complications (Indredavik, Rohweder, Naalsund & Lydersen, 2008). It is thus necessary to determine which complications may influence LOS.

The development of resistant Staphylococcus aureus, enterococci and gram-negative bacilli in hospitalised patients may lead to increased mortality, a longer hospital LOS and higher costs of care. This may be due to delayed therapy and the increased frequency of surgical interventions required to manage infections (Cosgrove, 2006). While results are useful clinically, this study was not specific to patients with stroke.

Ingeman *et al.* (2011) investigated the impact of several complications on LOS, patient mortality and optimal rehabilitation. Of their sample of 3 453 patients with acute stroke admitted to a stroke unit, 25.2% experienced at least one complication during their hospital stay. The most common complications were UTI (15.4%), pneumonia (9%) constipation (6.8%) and falls (2.1%). Even after adjusting for confounders, the authors found all the above-mentioned complications to be associated with longer LOS. The adjusted LOS extensions were 2.29 days for UTIs (95% CI 1.88 - 2.80), 1.8 days for pneumonia (95% CI 1.54 - 2.11), 2.66 days for constipation (95% CI 2.23 - 3.16) and 3.06 days for falls (95% CI 2.67 - 3.52).

The predictors of pneumonia include mechanical ventilation, tube feeding, impaired swallow (dysphagia) and the use of a tracheostomy in patients with ischaemic strokes admitted 24 hours after stroke. Patients who developed pneumonia had lower Glasgow Coma Scale (GCS) and MRS scores on admission, indicating the more severe nature of their neurological and functional impairments. This may have pre-disposed them to the development of pneumonia. The development of pneumonia had a significant effect on patient morbidity (MRS) ($p = 0.003$), mortality ($p = 0.041$) and LOS ($p = 0.0001$). Patients with pneumonia had significantly longer LOS in acute care than those without (19.6 days vs 9.1 days) (Alsumrain, *et al*., 2013).

Results of observational data about complications should however be interpreted with care as it is difficult to determine whether longer hospital LOS results in an increased incidence of complications developing, or whether development of complications leads to longer hospital LOS. Since most complications develop early, it stands to reason that they are contributors to hospital LOS (Ingeman, *et al.*, 2011).

The presence of depression prior to stroke, or the development thereafter may be considered with the effects of co-morbidities and complications. Gillen *et al.* (2001) studied 243 patients admitted to an IRF post-stroke for the effect of depression on rehabilitation efficiency. Patients were screened for depressive symptoms and a history of depression. These were used as predictors of hospital LOS and rehabilitation service utilisation (measured with the LOS efficiency [LOS-EFF], *i.e.* FIM change divided by LOS). Depression was measured with the Geriatric Depression Scale (GDS). Higher scores indicate greater depression (Gillen, *et al*., 2001). Of the sample studied, 14% had a positive history of depression and 9% developed depression. Previous depression was related to higher GDS scores ($r = 0.23$, $p < 0.01$) and a longer hospital stay than a negative history of depression (27.8 days vs 23.2 days). These patients also used rehabilitation services less efficiently while in the hospital (lower LOS-EFF scores [$r = -0.17$, $p < 0.01$]). Patient who had depressive symptoms, but no previous history of depression also used services less efficiently, but did not have longer LOS.

Regardless of their initial level of functional impairment, more depressed patients showed slower improvement in mobility and regaining basic ADLs. This may be due to poor motivation and negative expectations (Gillen, *et al*., 2001). This study may have underestimated the prevalence of depression in patients with stroke by limiting the criteria for previous depression to depressive symptoms that were treated, as many cases of depression go untreated (Gillen, *et al*., 2001).

Infections such as staphylococcus aureus, UTIs and pneumonia, falls, constipation and depression all have an influence on LOS and thus the prevention of complications has been identified as an important strategy when trying to reduce the cost of care and shorten LOS for patients with stroke (Saxena, *et al.*, 2006; Ingeman, *et al.*, 2011).

c) Cognition, Perception and Communication

With a growing elderly population, the risk of stroke and cognitive impairment increases (Rabadi, Rabadi, Edelstein & Peterson, 2008). The question is whether or not cognitive impairment has an influence on hospital LOS. As previously discussed, USN was positively associated with longer LOS ($b= 0.3$, $p< 0.001$) (Paolucci, Antonucci, Grasso & Pizzamiglio, 2001).

In 175 patients with right hemisphere strokes, 29% experienced USN. Patients with and without USN were matched for admission functional status and despite this, patients with neglect still experienced longer rehabilitation LOS (30.5 days vs 25.2 days) than those without neglect. Using multivariate analysis the predictors of LOS were: admission FIM score, cognitive impairment (measured with the Cognisat), and the presence of USN (assessed with the letter cancellation test) ($b= 0.2$, $p= 0.05$). The results show that despite admission function being an important predictor of LOS, the effects cannot be explained by this variable alone (Gillen, Tennen & McKee, 2005).

The presence of severe perceptual dysfunction results in longer hospital LOS as these patients need more time to attain functional goals (Feigenson, *et al.*, 1977). Patients with severe mental disorders, however, rarely have extended hospital stays as their lack of potential to improve or make adequate progress does not warrant the prolonged stay and expenditure. The authors identified denial, apraxia and neglect as well as body schema disorders as specific contributors to prolonged hospital LOS in 284 patients post-stroke in a rehabilitation centre (Feigenson, *et al.*, 1977). The results were included in the literature review despite the study being very out-dated as there is a paucity of research on specific perceptual deficits and their impact on LOS after stroke.

In a more recent study, Rabadi, Rabadi, Edelstein and Peterson (2008) wanted to determine whether or not stroke patients who have cognitive impairments benefit from admission to an acute rehabilitation unit. Their sample of 668 patients was divided into four groups (similar in age, sex and ethnicity) based on their admission MMSE score (intact, mild, moderate or severe impairment). The outcomes investigated were a change in total FIM score, FIM cognitive sub-score at discharge, LOS, LOS-EFF and discharge destination. The change in total FIM score and LOS-EFF was similar amongst cognitively intact and impaired groups ($p= 0.58$). The impaired groups had significantly longer LOS ($p< 0.001$) and fewer home discharges, particularly the severely impaired group. A limitation to this study is that patients' baseline cognitive function (prior to stroke) was unknown.

As previously mentioned, the ability to communicate verbally was a significant contributor to LOS (McClure, *et al.*, 2011). In a large sample of 2 983 patients, having either dysphagia (difficulty swallowing) or dysphasia (speech impairment), or both conditions simultaneously, after stroke was associated with greater mortality and longer LOS ($p< 0.001$ for all) (Guyomard, *et al.*, 2009). After controlling for age, sex, premorbid functional status, previous stroke and stroke type, patients with dysphagia were almost four times as likely to have longer LOS. Those with dysphasia were one and a half times more likely to have longer LOS (OR 3.9, 95% CI 3.3 - 4.6 and OR 1.4, 95% CI 1.2 - 1.6 respectively). When patients had both conditions, the OR of having longer LOS was 3.7 (95% CI 3.1 - 4.6) and the presence of dysphagia appears to determine poor outcome (Guyomard, *et al.*, 2009).

The assessment and treatment of cognitive impairments after stroke is recommended to facilitate successful rehabilitation, shorter LOS and a decreased need for aftercare services (Galski, Bruno, Zorowitz & Walker, 1993). Cognitively impaired patients may make significant functional gains in rehabilitation and should be allowed to benefit from the same rehabilitation services as their cognitively intact counterparts (Rabadi, Rabadi, Edelstein &

Peterson, 2008) and finally, while the presence of dysphagia has a greater influence on LOS, the effect of dysphasia is noteworthy and cannot be disregarded when attempting to determine the predictors of LOS.

2.9.3 Gaps in the literature

There is a growing body of information on the factors which influence functional outcome and LOS in patients post-stroke because of the implications these factors have on the cost of caring for these patients. If factors which have a negative impact on functional outcome and length of stay can be identified for patients post-stroke at the beginning of the rehabilitation phase, they may be addressed through early and appropriate medical intervention or by providing more targeted therapeutic interventions. There are however several limitations and gaps in the available literature which necessitates the need for further studies.

While models of predictors of function and LOS are identified in the literature, few studies make recommendations for clinical practice or administrative management. There is a need for more studies that give practical recommendations that would reduce the cost of care without compromising patient outcomes.

While the use of RCTs would be the strongest methodological design for investigating the effects of specific variables on LOS and functional outcome, they are rarely practical or ethical to perform in rehabilitation research. Observational studies are thus more commonly performed, but depend on the accuracy and quality of the data collected. There is a need for further observational descriptive studies utilising more accurate and comprehensive data for predicting LOS, particularly in a South African rehabilitation context.

The types of facility selected for sampling across studies may limit their comparability. LOS is studied in acute neurological wards and stroke units, acute academic hospitals, inpatient rehabilitation facilities, long-term acute care (LTAC) hospitals and out-patient facilities. There are few community based studies from which to get an accurate estimation of the characteristics that patients present with prior to, or post-stroke. Studies also vary greatly in the samples of patients selected. Sometimes patients with a variety of neurological conditions are included in rehabilitation research which means that results are not necessarily generalisable to stroke patients. There is a need for research relating specifically to patients post-stroke in sub-acute rehabilitation facilities if recommendations for the care provided at such facilities and cost-saving interventions are to be made.

A gap in the literature that many studies do not consider is patients' functional status prior to the stroke which means that patients may not be comparable at baseline. Several studies use admission functional status as a proxy for several variables. It is necessary for further studies not only to investigate the effects of admission function, but also the effects of variables that influence it.

The use of a variety of outcome measures, some of which are not validated or standardised, compromises the reliability of study results. Some studies only measure discharge function or relative gain in function rather than measuring both outcomes. There is a need for studies that investigate both outcomes for a more comprehensive view of patient recovery.

Many predictors of function and LOS have been identified for stroke patients in developed countries, but few explore functional outcome and none explore LOS in a South African facility. As the South African stroke population may have unique characteristics that predispose them to greater disability, it is important to determine the characteristics which influence function and LOS in this population. Examples of such characteristics include: low socio-economic status of many South Africans, under-resourced state services, limited accessibility to private services available to those without funding and limited benefits or coverage from medical aid providers even for those with insurance.

2.10 Conclusion of the Literature Review

Stroke is a significant cause of disability worldwide, particularly in middle and low income countries. Rehabilitation aims to minimise the negative effects of the stroke and promote recovery, but is not always accessible and affordable. State facilities are largely under-resourced and mismanaged, and do not always provide adequate rehabilitation services. Due to the poor socio-economic status of many South Africans, they do not have medical insurance and access private health services out-of-pocket only when they have funds available. Even those with medical insurance may have limited benefits or coverage from medical aid providers and may make additional co-payments for the services required. Ideally rehabilitation policies and practices should be governed by the needs of patients and not the payment resources available to them.

The best way to quantify patients' progress after a stroke is with the use of standardised outcome measures. The FIM measures functional ability and is a reliable and valid tool for measuring the functional outcomes of patients post-stroke. LOS is often used as an indicator of resource utilisation, and thus prolonged hospital stays increases the financial pressure on facilities and those who pay for these services. In order for rehabilitation facilities to preserve financial stability, they may discharge patients at an earlier stage. Patients may also be referred to less expensive, but less effective nursing facilities in order to save costs in the short term. These are some of the non-medical factors which influence LOS. Other variables that have been investigated for their influence on functional outcome and LOS include co-morbidities, complications, cognitive, perceptual and language impairments, rehabilitation interventions, patient age, and admission levels of function.

Co-morbidities are more prevalent in the elderly and are correlated with greater disability and poor outcomes, but are rarely assessed with co-morbidity indices and thus study findings often lack reliability. Co-morbidities found to influence LOS include dementia, CRF, CHF, a history of arrhythmias, and depression. Complications are common post-stroke, especially in more severely neurologically impaired patients. Some of the most common complications are pneumonia, UTIs and falls, all of which prolong LOS. Cognitive and perceptual disorders may impact a patient's ability to successfully participate in rehabilitation and have been found to be predictors of poor ADL and IADL recovery. These patients may require longer stays to attain the same goals as less impaired patients. However, some patients may be so severely impaired that they do not make adequate progress with rehabilitation and are thus discharged to supportive care at an earlier stage.

There is little consensus in the literature regarding the best rehabilitation interventions and timing of rehabilitation to promote better functional outcomes and shorter LOS. Early mobilisation appears to be associated with better functional outcomes. Providing additional therapy may also result in a dose-related improvement in functional outcomes.

Some studies found old age to be associated with poor functional status at discharge, but not with poor functional change. In many studies admission functional status was a confounder, and the independent effect of age was minimal. There is no clear justification for denying older patients access to rehabilitation. In several studies, younger patients were found to have longer LOS than their older counterparts. This was explained by the difficulty in placing young and severely impaired patients in appropriate discharge destinations such as nursing facilities.

It has been found that a lower FIM score on admission is associated with a longer hospital LOS and a lower FIM score at discharge. Transfer items of the FIM on admission appear to have the greatest predictive power in determining LOS. Patients who are more functional on admission may require shorter stays to achieve the necessary milestones for safe community discharge.

The ability to predict hospital LOS is thus useful for clinicians, facilities, medical funders and family members who need to plan the course of patient care post-stroke. It is also useful to rehabilitation centres as they could develop more accurate and realistic budgets for resource consumption. It would aid clinicians in developing treatment and discharge programmes at an earlier stage and it would give the patient and family an opportunity to prepare for discharge.

CHAPTER 3

3 METHODOLOGY

3.1 Type of study

To answer the objectives of this study, a retrospective study utilising patient records was performed.

3.2 Subjects

3.2.1 Source of subjects

Patients for this study were sampled from a sub-acute facility based in Johannesburg, Gauteng. It is one of the largest private rehabilitation facilities in Gauteng with 102 adult beds and eight paediatric beds. The facility receives patient referrals from acute hospitals all over Gauteng from both the public and private sectors. Patients paying out-of-pocket and international patients are also accepted at the facility. The case managers at acute facilities identify patients that may be appropriate candidates for rehabilitation. Admission criteria dictate that patients need to be weaned from ventilators, be medically stable and be able to participate or show the potential to participate in an average three hours of therapy per day. Patients with the following diagnoses are accepted at this facility: neurological conditions such as spinal cord injuries, strokes, traumatic brain injuries and near drowning cases, other conditions treated at the centre include traumatic amputations, joint replacements, burns and general weakness after long hospitalisations. The patients sourced for this study were those admitted to the rehabilitation hospital between 1 January 2015 and 31 January 2017 who had experienced a stroke for the first time. On average, the facility admits 16 patients with stroke per month of which 12 are new admissions for first-time stroke.

Patients are ideally discharged from the facility when they are able to return safely to their home environment independently. A patient’s LOS may be limited to the financial coverage that they can afford if they are paying out-of-pocket, or by their medical scheme provides. This is based on the prescribed minimum benefits (PMB). PMB regulations do not clearly define what constitutes rehabilitation and the time-frame over which it should be provided.

Generally, when patients stop making functional gains (measured with standardised outcome measures) they are discharged. At this point patients have either regained full function and no longer need rehabilitation, or have plateaued with the recovery. A lack of gains constitutes discharge as a patient is seen to no longer be benefiting from the additional time in rehabilitation.

3.2.2 Sample size and selection

For this study, all patients with stroke who were admitted to the hospital between 1 January 2015 and 31 January 2017 were included in the study.

a) Inclusion Criteria

Participants were included in the study if they

- were male or female patients with first-time stroke.
- were over the age of 18 years.
- were admitted between 1 January 2015 and 31 January 2017.

b) Exclusion Criteria

Participants were excluded from the study if they

- died prior to discharge.
- had a previous stroke (due to the implications that a previous stroke/s may have on the patient's level of function prior to admission).
- suffered from dementia (due to Alzheimer's disease or other aetiology) (due to the implications that it may have on a patient's level of function prior to admission).
- had files with incomplete data as per requirements of the self-developed data extraction tool (*i.e.* if more than four fields of demographic information, and more than two fields of clinical information were incomplete, including FIM scores).

3.2.3 Instrumentation and Outcome measures

In order to gather information that answered the objectives for this study a self-developed data extraction tool capturing patient outcomes and data of interest was used. The self-developed data extraction tool contained demographic, clinical and functional information for each patient included in the study (see Appendix A). The functional information was documented with the use of the FIM. The self-developed data-extraction tool did not include the patients' names, only their assigned patient code. The name and code match-sheet was kept as a separate document to ensure patient anonymity.

The self-developed data-extraction tool included the following demographic information: patient code, age, gender, marital status, living situation and level of independence prior to stroke and vocation. Clinical information documented by the questionnaire included: date of admission, date of discharge, LOS, stroke type and location, the presence of co-morbidities and complications. The date of stroke onset was not documented in the majority of files and thus onset-admission interval could not be investigated in the study. Stroke severity was also not described in terms of any standardised outcome measure, and functional status at admission (as measured with the FIM) was thus the best indicator of stroke severity in this study.

The reason for discharge was not documented in patient reports or files and could thus not be included in the study despite its importance in determining LOS. A comprehensive list of co-morbidities to be investigated was put together from those conditions described in the literature (Kugler, Altenhöner, Lochner & Ferbert, 2003; Karatepe, Gunaydin, Kaya & Turkmen, 2008; Chang *et al*., 2015; Mohamed, *et al.*, 2015) as well as those that were documented routinely on patient admission forms. These included: cardiac conditions, Human Immunodeficiency Virus (HIV) status, neoplastic conditions, hypercholesterolaemia, hypertension, respiratory conditions, diabetes mellitus, renal diseases, psychiatric conditions, substance abuse related disorders (drug addiction/ alcoholism), epilepsy, orthopaedic conditions, auditory and visual impairments, thyroid and gastric conditions, prostate conditions, hysterectomies and depression.

Psychiatric conditions were based on the Diagnostic and Statistical Manual (DSM) of mental disorders as classified by the American Psychiatric Association. Conditions included dissociative disorders, schizophrenia and other psychotic disorders, bipolar disorder and mood disorders. Patients with dementia were excluded from the study as per the exclusion criteria listed above. Depression and substance related disorders were assessed separately. Complications that were documented included: respiratory infections, urinary tract infections, pressure sores, constipation, diarrhoea and sepsis. These were decided upon based on the literature (Indredavik, Rohweder, Naalsund & Lydersen, 2008; Ingeman, *et al.*, 2011; Mohamed, *et al.*, 2015) as well as the complications that were documented routinely in standard nursing progress notes (bladder and bowel function and skin condition). Sepsis, UTIs and respiratory tract infections were based on laboratory investigations which were done fairly routinely when patient presented with clinical symptoms (recorded in progress notes) and abnormal vital signs in daily nursing records.

It also included the following clinical functions and functional information: FIM scores on admission, including the total score, motor and cognitive sub-scores, FIM scores on discharge including motor and cognitive sub-scores, FIM gain for total and sub-scores of the FIM, language abilities, respiratory function, swallowing abilities and continence on admission.

As stated in the paragraphs above, some of the outcomes explored in the literature could not be investigated in this study due to the quality and consistency of documentation in patient files. The variables included in the data extraction tool were those that were recorded in the majority of patients on referral reports, standard nursing admission forms, therapists' admission reports, in patient progress notes (nursing and therapy) and laboratory results kept on file.

3.3 Procedure

Ethical clearance was granted by the University of the Witwatersrand Human Research Ethics Committee (Appendix C). Permission was also sought and obtained from the research committee of the rehabilitation hospital (Appendix B) and data collection was started.

The researcher had no connection with the facility and thus there was no potential for bias. Patient files were accessed after the study period, and all patients who were included in the study had already been discharged from the facility. All patient files from the study time period were obtained from the archives by the facility co-ordinator. All files were reviewed by the researcher to identify those which met the inclusion criteria of the study.

The study period was from 1 January 2015 until 31 January 2017. The study was retrospective in nature and thus could have included a much longer time period, but as the facility only started to implement the use of the FIM for assessment of patient outcomes consistently from January 2015, this was the earliest date that could be used. There were no major staffing changes or changes in the rehabilitation practices and programmes implemented over the study period that would have influenced admission numbers.

As part of the routine care of patients post-stroke at the rehabilitation hospital, all patients are evaluated and scored with the Functional Independence Measure (FIM) at admission and discharge. Therapists administering the FIM are trained and certified to do so. These scores are recorded electronically on the hospital's database by the treating therapists. Both electronic files created by allied health professionals and paper files used by all multidisciplinary staff were used. Electronic files contained patients' rehabilitation outcomes and progress notes and units of therapy. Paper files included patients' admission forms, demographic and clinical information, results of brain scans, laboratory test results, X-ray reports, nursing progress notes and medication charts. No electronic or paper files could be removed from the hospital premises and thus data collection was performed at the rehabilitation facility.

The data were captured by the researcher using a self-developed data extraction tool. The tool captured all outcomes and data of interest. Data were captured electronically and saved in a password-protected file. No hard copies of the demographic questionnaire were used. The data gathered from the questionnaires were stored on Microsoft Excel spread sheets. The raw data were cleaned and coded before being exported to IBM Statistical Package for Social Sciences (SPSS) Statistics for Windows, Version 24 (IBM Corp., Armonk, N.Y., USA.) for statistical analysis.

3.4 Ethical Considerations

- Ethical clearance was obtained from the Human Research Ethics Committee of the University of the Witwatersrand (M160936) on 06/02/2017 (Appendix C).
- Permission was sought and granted from the rehabilitation facility's managing authorities (Appendix B).
- As this study utilised patient records and was retrospective in nature, there was no risk for the patients whose data were used and individual participants did not need to give consent.
- No patients who were still admitted at the facility were included in the study once data collection commenced.
- For the purpose of confidentiality, patient data were recorded under codes on the demographic questionnaires and excel spread sheets to ensure patient anonymity.

3.5 Data Analysis Strategy

Data were analysed with the IBM SPSS Statistics for Windows, Version 24 (IBM Corp., Armonk, N.Y., USA). Patient data recorded at the time of their admission and during their rehabilitation were collected retrospectively. Data included each patient's demographic and clinical profile, and functional abilities. Functional ability was measured with the FIM and data collected included FIM scores on admission, FIM gains and FIM scores at discharge. FIM total scores and sub-scores (cognition and motor scores) were recorded. Lastly, the development of complications was recorded. These were the independent variables. Age was considered a continuous variable. All others were considered to be categorical variables and were dichotomised accordingly. The dependent variable was hospital LOS, a continuous variable measured from date of admission to the rehabilitation facility to date of discharge from the facility.

In order to meet the secondary objectives of the study, descriptive statistics were used. Median and range values were used to describe the sample, their functional outcomes and their LOS. Means and standard deviations were not used as the data were not normally distributed. The sample was divided into cohorts based on patients' ages, their admission FIM scores and premorbid conditions. Some preliminary investigations were done regarding factors which influence patient outcomes. To determine if there were differences in patient outcomes (FIM scores and LOS) between cohorts, median values of sample groups were compared in SigmaPlot, Version 11 (Systat Software, San Jose, CA) using Kruskal-Wallace One Way ANOVA on rank and Dunn's Method and Mann-Whitney Rank Sum tests. It was beyond the scope of this study to perform a regression analysis on predictors of functional outcome.

As the primary objective of the study was to determine the predictors of patient LOS, multiple regression analysis was done to determine the predictive value of clinical, demographic and functional variables on LOS. In order to build a model for predicting LOS, the follow sequential steps were taken.

1. Demographic, clinical and functional variables that may have had a theoretical link to LOS were identified from the literature review and clinical judgement.
2. All categorical variables were dichotomised in order for correlation coefficients to be calculated.
3. Bivariate correlations were done with all the independent variables (IVs) to the dependent variables (DV) (LOS) in order to determine if there was a significant relationship between any of the variables (r-values and p-values were examined).
4. To aid the process of identifying the most significant IVs, the significance level was set at $p < 0.1$ rather than the traditional $p < 0.05$ used in normal bivariate analysis. This is similar to the selection strategy discussed by Bursac *et al*. (2008) and Bagg, Pombo and Hopman (2002).

To check for multicollinearity, correlations of IVs to IVs were done, as well as variance inflation factor (VIF) and tolerance statistics. If two IVs were highly correlated, the redundant variable was removed. A stepwise multiple regression model with different combinations of independent variables was used to determine if the variables were predictors of hospital LOS.

Once the individual regressions for each IV was done, coefficient values, t-statistics and p-values were obtained, and then an ANOVA was done to get f-values and p-values. R-squared, r-squared adjusted, r-squared predicted and VIF values were used to choose the best model. A residual analysis was done to identify atypical data points and remove outliers.

3.6 Conclusion of the Methodology

The study design, aims, sample size, inclusion and exclusion criteria were discussed. The procedure, methodology, data collection and analysis were outlined. The results of the statistical analysis will be presented in the next chapter.

CHAPTER 4

4 RESULTS

4.1 Introduction

Following the procedure outlined in the analysis strategy, the results are presented and described in this chapter. The results will answer the primary and secondary objectives of this study. Descriptive statistics were used to create the demographic and clinical profile of the sample, to describe the length of hospital stay after a stroke and to determine the functional outcomes of patients included in this study.

Correlations, analysis of variance (ANOVA) and a stepwise multiple regression analysis are presented to demonstrate the selection of the best model for the prediction of LOS. The contribution of each independent variable in the model will also be discussed. Finally, results from residual analyses will be used in order to assess the fit of such a statistical model.

4.2 Description of the Study Sample

4.2.1 Demographic Characteristics

In order to meet the objective of describing the study sample, patients' data are presented below. See Table 4.1 for the demographic characteristics of the sample.

Table 4.1 Demographic characteristics of the study sample (n= 243)

Demographic variables	Sub-category	Number of patients (n)	Percentage of sample (%)
Gender	Male	107	44.0
	Female	136	56.0
Medical insurance	Insured	238	97.9
	Uninsured	5	2.1
Marital status	Single	41	16.9
	Married	151	62.1
	Widowed	51	21.0
Level of Independence Prior to Stroke	Independent	234	96.3
	Dependent	9	3.7
Vocation	Employed	130	53.5
	Unemployed	7	2.9
	Retired	103	42.4
	Student	3	1.2

Table 4.2 Age of the study sample (n= 243)

Demographic variables	Mean (SD)	Median (range)
Age	60.7 (14.4)	61.0 (20- 87)

The patient sample group consisted of almost equal numbers of men and women (44% and 56% respectively) and almost all of them (97.9%) were medically insured by various medical aid schemes. The patients ranged in age from 20 years to 87 years, but the mean age of patients was 60.7 years (SD 14.4) and the majority of these patients were functionally independent prior to the stroke (96.3%). Of the sample group, 62% were married, and 53.5% were employed prior to the stroke.

4.2.2 Clinical Characteristics

The patients' clinical characteristics are captured below in Table 4.3.

Table 4.3 Clinical characteristics of the study sample (n= 243)

Clinical variables	Sub-categories	N	Percentage of sample (%)
Stroke side	Left sided stroke	111	45.7
	Right sided stroke	125	51.4
	Bilateral stroke	7	2.9
Stroke type	Ischaemic	179	73.7
	Haemorrhagic	64	26.3

Of the sample 51.4% of patients had right-sided strokes, 45.7% had left-sided strokes and 2.9% experienced bilateral strokes. The majority of strokes were ischaemic (73.3%). Premorbid conditions were common as the mean number of co-morbidities was 3.9 (SD 2.4). See Table 4.4 below for a description of the sample co-morbidities.

Table 4.4 Co-morbid conditions amongst the study sample (n= 243)

Co-morbid condition	N	Percentage (%)
Hypertension	161	66.3
Hypercholesterolaemia	86	35.4
Cardiac condition	81	33.3
Diabetes	66	27.2
Arthritis	49	20.2
Auditory impairment	47	19.3
Respiratory condition	44	18.1
Visual impairment	37	15.2
Orthopaedic condition	30	12.3
Epilepsy	25	10.3
HIV	23	9.5
Renal condition	23	9.5
Hysterectomy	23	9.5
Gastric condition	17	7.0
Psychiatric condition	15	6.2
Thyroid condition	15	6.2
Prostate condition	12	4.9
Neoplastic condition	6	2.5
Substance abuse related conditions	5	2.1

The most common co-morbidities were hypertension (66.3%), hypercholesterolaemia (35.4%), cardiac conditions (33.3%) and diabetes mellitus (27.2%).

See Table 4.5 below for a description of additional clinical characteristics of the study sample that were documented consistently in most patient files and thus included in the analysis.

Table 4.5 Additional clinical characteristics of the study sample recorded at admission (n= 243)

Clinical function	Sub-categories	n	Percentage of sample (%)
Respiratory support required	None	225	92.6
	Require oxygen	17	7.0
	Tracheostomy	1	0.4
Respiratory function	Normal	198	81.5
	Compromised cough	19	7.8
	Audible secretions	26	10.7
Swallowing function	Normal	187	77.0
	Unsafe	56	23.0
Diet	Normal	143	58.8
	Soft	69	28.4
	NG tube	7	2.9
	PEG tube	24	9.9
Speech ability	Normal	103	42.4
	Affected	140	57.6
Type of speech disorder	Apraxia	49	35
	Aphasia	46	32.9
	Dysarthria	63	45
Presence of unilateral spatial neglect		44	18.1
Continence	Continent	119	49.0
	Incontinent	124	51.0

The majority of patients required no additional respiratory support, but 23.0% had an unsafe swallow and 7.8% had a compromised ability to cough. In this study sample, 2.9% of patients required a nasogastric tube (NG) and 9.9% required a percutaneous endoscopic gastrostomy (PEG) tube for feeding.

More than half (57.6%) of the sample presented with impaired speech on admission, where the most common impairments were dysarthria (45%) followed by apraxia (35%) and unspecified aphasia (32.9%). Some patients had a combination of speech impairments. Hemi-neglect occurred in 18.1% of patients. Incontinence of the bladder and bowel was recorded in 51% of the patients in the sample. Complications were documented in the hospital files of only 173 of the patients. See Table 4.6 below for patient complications, ranked from most to least common.

Table 4.6 Complications recorded during hospital LOS (n= 173)

Complication	n	Percentage (%)
Pneumonia	36	20.8
Depression	34	19.7
Pressure sore	32	18.5
Constipation	29	16.8
Urinary tract infection	26	15.0
Diarrhoea	17	9.8
Vomiting	2	1.2
Sepsis	2	1.2

The most common complications were the development of pneumonia (20.8%), depression (19.7%) and pressure sores (18.5%).

4.3 Functional outcomes of the study sample (FIM data)

A secondary objective of the study was to determine patients' functional outcomes. See Table 4.7 below for the sample's functional outcomes as measured with the FIM. Medians and range values are given for each sub-category of the FIM.

Table 4.7 FIM score information of the study sample (n= 243)

FIM scores	Sub-categories	Median	Range
Total FIM score	Admission FIM	43.0	16 – 119
	Discharge FIM	75.0	16 – 120
	FIM change	21.0	-23 – 82
Motor FIM score	Admission FIM	26.0	2 – 89
	Discharge FIM	52.0	11 – 90
	FIM change	21.0	-23 – 82
Cognitive FIM score	Admission FIM	15.0	5 – 35
	Discharge FIM	22.0	5 – 54
	FIM change	4.0	-13 – 33

Not all patients may have made meaningful improvements, as there were large range values associated with the FIM score medians. FIM total score for all stroke patients admitted to the facility on admission was 43 (range: 16- 119) while at discharge it was 75 (range: 16- 120). Therefore the analysis of functional outcome in several smaller cohorts was done to determine if more meaningful information could be found for sub-groups of patients within the sample.

4.3.1 Cohort Level Assessment of Functional Outcomes

The sample was divided into cohorts based on age and admission FIM score. See Table 4.8 below for the levels.

Table 4.8 Cohort levels of the study sample (n= 243)

Variable	Cohort	Sample size (n)
Age	< 40 years	21
	40-59 years	91
	60-79 years	111
	≥ 80 years	20
FIM total score on admission	< 40 (severe functional impairment)	101
	40-80 (moderate functional impairment)	115
	> 80 (mild functional impairment)	27

4.3.2 The Effect of Age on Functional Outcome

The sample was divided into four age cohorts and for each of the age cohorts, the medians and ranges were calculated for each of the following three variables: admission FIM score, discharge FIM score and FIM change score. See Table 4.9 below.

Table 4.9 Median admission FIM, discharge FIM and FIM change scores of the age cohorts of the study sample (n= 243)

Age (years)	Median admission FIM	Range	Median discharge FIM	Range	Median FIM change	Range
<40	60.0	30.0 – 113.0	87.0	63.0 – 120.0	30.0	0.0 – 58
40-59	40.0	16.0 – 80.0	70.0	16.0 – 102.0	22.0	0.0 – 72.0
60-79	43.0	16.0 – 103.0	75.0	16.0 – 103.0	17.0	-23.0 – 64.0
≥80	37.5	16.0 – 67.0	68.5	16.0 – 83.0	15.5	0.0 – 52.0

The youngest age cohort (below 40 years) had the highest median FIM admission and FIM discharge scores (60 points and 87 points respectively), and also the biggest median FIM change score (30 points). All other age cohorts were similar to one another, and similarly different to the youngest age cohort, in that they had lower FIM admission and discharge scores, and smaller FIM change scores. Median FIM change scores decreased with increasing age, but the associated ranges in score were variable and, in all cases, very large.

The distributions of the FIM scores were assessed for each age cohort, to determine the appropriate statistical tests to compare cohorts. This comprised a normality test and equal variance test, displayed in Table 4.10 below. Where the normality tests failed, non-parametric statistics were used to compare the FIM scores between age cohorts.

Table 4.10 Normality test and equal variance test results for FIM scores across age cohorts of the study sample (n= 243)

Scores compared	Normality test	Equal variance test
Admission FIM	Failed ($p < 0.05$)	Failed outright
Discharge FIM	Failed ($p < 0.05$)	Failed outright
FIM change	Failed ($p < 0.05$)	Failed outright

The distribution of all three FIM scores (admission, discharge, and FIM change) in the four age cohorts were not normally distributed, so non-parametric statistical tests could be done using median values. In order to test for statistically significant differences in median admission FIM scores, discharge FIM scores and FIM change scores across age cohorts, A Kruskal-Wallace One Way ANOVA on ranks were used. See Table 4.11 below.

Table 4.11 Kruskal-Wallace One Way ANOVA on ranks comparing median FIM scores across age cohorts ($p < 0.05$)

Variable	H-score	Degrees of freedom	Significance (p)
Median admission FIM scores	10.6	3	0.014
Median discharge FIM scores	11.9	3	0.008
Median FIM change score	6.3	3	0.099

When comparing the median admission FIM scores across the four age cohorts, the Kruskal-Wallace tests indicated that there were statistically significant differences between the scores ($p = 0.014$), but did not identify where the significant differences lay. The same was true for median discharge FIM scores ($p = 0.008$). The median FIM change scores were however not statistically, significantly different ($p = 0.099$). To isolate the specific cohorts that differed from one another regarding the median admission FIM scores and median discharge FIM scores, the Dunn's Method (Pairwise Multiple Comparison Procedure) was used. See Table 4.12 below for the results.

Table 4.12 Dunn's Method results for age cohorts of the study sample (n= 243)

Median FIM scores	Age cohorts compared	Difference in rank	Q	Significance ($p < 0.05$)
Admission scores	<40 years vs 40- 59 years	54.0	3.2	Yes
	<40 years vs ≥80 years	53.5	2.4	Yes
	<40 years vs 60-79 years	41.7	2.5	Yes
	60-70 years vs 40- 59 years	12.3	1.2	No
	60-70 years vs ≥80 years	11.7	0.7	Do not test
	≥80 years vs 40- 59 years	0.6	0.0	Do not test
Discharge scores	<40 years vs ≥80 years	63.3	2.9	Yes
	<40 years vs 60-79 years	55.1	3.3	Yes
	<40 years vs 40- 59 years	50.7	3.0	Yes
	40-59 years vs ≥80 years	12.7	0.7	No
	40-59 years vs ≥ 60-79 years	4.3	0.4	Do Not Test
	60-79 years vs ≥80 years	8.3	0.5	Do Not Test

In SigmaPlot, Version 11 (Systat Software, San Jose, CA), pairwise comparisons were done between each age cohort, for both admission FIM scores and discharge FIM scores. There are statistically significant differences ($p< 0.05$) between the admission FIM scores of: 1) the <40 years and the 40- 59 years, 2) the <40 years and the 60- 79 years and 3) the <40 years and the ≥80 years age cohorts. This shows that the differences noted in Table 4.8 (where the youngest age cohort had the highest median admission FIM and discharge FIM scores and also the biggest median FIM change score of all the age cohorts) were statistically, significantly different. In addition, there are statistically significant differences in the discharge FIM scores between: 1) <40 years and 40- 59 years, 2) <40 years and 60- 79 years and 3) <40 years and ≥80 years.

Dividing the sample into age cohorts identified significant differences between the youngest age group and the rest, with regard to FIM scores on admission and at discharge, but not with regard to FIM change across the different age groups. The significant differences found between the youngest age cohort and all the other age cohorts collectively, suggest that younger patients have higher functional outcomes on admission and at discharge than older patients, and this indicates that age may be a predictor of functional outcomes. However, at the cohort level tested in this study the results were not conclusive, and further analysis was beyond the scope of this study. The next cohort level investigated was admission FIM score.

4.3.3 The Effect of Admission FIM score on Functional Outcome

The sample was divided into three cohorts based on patients' admission FIM scores. For each of the FIM admission cohorts, the medians and ranges were calculated for each of the following two variables: discharge FIM score and FIM change score. See Table 4.13 below.

Table 4.13 Median discharge FIM scores and FIM change scores of the admission FIM cohorts of the study sample (n= 243)

Admission FIM cohort	Median Discharge FIM score	Range	Median FIM change	Range
<40 (severe impairment)	46.0	16.0 – 100.0	20.0	-14.0 – 82.0
40-80 (moderate impairment)	83.0	27.0 – 120.0	25.0	-23.0 – 64.0
>80 (mild impairment)	100.0	92.0 – 119.0	11.0	0.0 – 29.0

Patients in the low FIM admission score cohort (<40) have low median discharge FIM scores (46), and patients in the high FIM admission score cohort (>80) have high median discharge FIM scores (100), however, the ranges in score are large for all the cohorts. Interestingly, FIM change appears to be greatest in the patients with moderate impairments (25 points), while mildly impaired and severely impaired patients have smaller FIM change median scores (11 and 20 points respectively). To determine if there were statistically significant differences in functional outcome based on admission FIM scores, normality tests and equal variance tests were done to determine the appropriate statistical test required to compare cohorts. See Table 4.14 below.

Table 4.14 Normality test and equal variance test results for FIM scores across admission FIM cohorts of the study sample (n= 243)

Scores compared	Normality test	Equal variance test
Discharge FIM	Passed ($p > 0.05$)	Failed ($p < 0.05$)
FIM change	Failed ($p < 0.05$)	Failed outright

Even though the normality test passed for discharge FIM scores, the equal variance test failed, and parametric tests could not be used for cohort comparisons, so non-parametric statistical tests were done. To test for statistically significant differences between admission FIM cohorts, Kruskal-Wallace one way ANOVA on ranks were done. See Table 4.15 below.

Table 4.15 Kruskal-Wallace One Way ANOVA on ranks comparing median FIM scores across admission FIM cohorts (p< 0.05)

Variable	H-value	Degrees of freedom	Significance (p)
Median discharge FIM scores	121.8	2	P<0.01
Median FIM change score	17.7	2	P<0.001

Both the median discharge FIM scores and median FIM change scores were significantly different, thus, to isolate the specific cohorts that differed from one another regarding the median discharge FIM scores and median FIM change scores, the Dunn's Method (Pairwise Multiple Comparison Procedure) was used. See Table 4.16 for results.

Table 4.16 Dunn's Method results for admission FIM cohorts of the study sample (n= 243)

Median FIM scores	Admission FIM cohorts compared	Difference in rank	Q	Significance (p < 0.05)
Discharge scores	<40 vs 40-80	77.0	8.0	Yes
	<40 vs >80	149.6	9.8	Yes
	40-80 vs >80	72.6	4.8	Yes
FIM change scores	<40 vs 40-80	18.5	1.9	No
	<40 vs >80	43.2	2.9	Yes
	40-80 vs >80	61.7	4.1	Yes

For every FIM admission cohort group, pairwise comparisons showed that the FIM discharge scores were statistically significantly different (p< 0.05), and the same was true for all pairwise comparisons of FIM change scores, except in the <40 and 40-80 cohort (p> 0.05). This suggests that the FIM admission cohort of a patient may be useful in predicting their functional outcomes. However, at the cohort level tested in this study the results were not conclusive, as the ranges in score were very large in each cohort, and further analysis was beyond the scope of this study.

4.4 Description of LOS

The final secondary objective of this study was to determine the LOS in stroke patients in this rehabilitation setting. See Table 4.17 below.

Table 4.17 Description of LOS of the study sample (n= 243)

	Mean	SD	Median	Range
LOS (days)	42.9	17.0	43.0	3.0- 112.0

The LOS of patients ranged between three and 112 days, and the median LOS was 43 days. Length of stay could also be looked at in terms of the age, FIM admission and co-morbidity cohorts used before. See median and range values for LOS according to cohorts in Table 4.18 below.

Table 4.18 Median LOS across age cohorts and admission FIM cohorts of the study sample (n= 243)

Cohort	Cohort level	Median LOS (days)	Range
Age	< 40 years	39.0	7.0 – 78.0
	40 – 59 years	44.0	13.0 – 112.0
	60 – 79 years	42.0	3.0 – 89.0
	≥ 80 years	47.5	11.0 – 62.0
Admission FIM	< 40 points	51.0	10.0 – 112.0
	40-80 points	42.0	7.0 – 82.0
	> 80 points	27.0	3.0 – 45.0

The median LOS was shortest in patients < 40 years old (39 days) and longest in patients of ≥ 80 years (47.5 days), but the ranges in LOS were large for all age cohorts. Patients that had higher admission FIM scores had shorter LOS.

Normality and equal variance tests were used to determine which statistical tests to use for the comparison of LOS across age and admission FIM cohorts. See Table 4.19 below for test results.

Table 4.19 Normality test and equal variance test results for LOS across age cohorts and admission FIM cohorts of the study sample (n= 243)

Cohort	Values compared	Normality test	Equal variance test
Age	Median LOS	Failed ($p< 0.05$)	Failed outright
Admission FIM	Median LOS	Failed ($p< 0.05$)	Failed outright

As normality failed, non-parametric tests were run. In order to determine if any of these differences between the cohorts were statistically significantly different, Kruskal-Wallace One Way ANOVA on ranks was used to compare the median LOS for the age and admission FIM score cohorts. See Table 4.20 below.

Table 4.20 Kruskal-Wallace One Way ANOVA on ranks comparing median LOS across age and admission FIM cohorts ($p< 0.05$)

Cohort	Variable	H-value	Degrees of freedom	Significance (p)
Age	LOS	2.109	3	0.550
Admission FIM	LOS	43.918	2	0.001

There was no significant difference in LOS across age cohorts ($p= 0.550$) despite the median LOS being shortest in patients <40 years old and longest in patients of ≥ 80 years old. Due to the lack of significant differences in these cohorts, no further statistical analysis was done.

There were significant differences in median LOS scores across the three admission FIM score cohorts ($p= 0.001$), thus, to determine which pairs were significantly different, Dunn's Method was used. See Table 4.21 below for test results.

Table 4.21 Dunn's Method results comparing LOS across admission FIM cohorts for the study sample (n= 243)

Variable compared	Admission FIM cohorts compared	Difference in rank	Q	Significance ($p < 0.05$)
LOS	<40 *vs* >80	99.4	6.5	Yes
	40-80 *vs* >80	31.3	3.3	Yes
	<40 *vs* 40-80	68.1	4.5	Yes

LOS appears only to be influenced significantly by admission FIM scores, based on the significant differences in LOS noted across the admission FIM cohorts.

4.5 Predicting LOS

The primary objective of this study was to determine the factors which predict hospital LOS in patients admitted to a sub-acute rehabilitation facility in Gauteng between 1 January 2015 and 31 January 2017, post-stroke. Bivariate analyses were followed by multivariate analyses, and residual analyses.

4.5.1 Bivariate Analysis

Bivariate correlations were done with each of the demographic, clinical and functional variables from the data extraction tool with LOS. Pearson's Correlations were used as LOS was fairly well distributed around the mean for the whole sample. A summary of all the variables that were significantly correlated with LOS ($p < 0.1$) can be seen below in Table 4.22.

Table 4.22 Bivariate analysis of IVs that were significantly correlated with LOS

Independent Variable (IV)	n	r-value	Shared variance (r2) (%)	p-value (p< 0.1)
Presence of cardiac condition	81	-0.16	2.6	0.010
Valve replacement	16	0.11	1.2	0.083
Cardiac murmur	1	0.16	2.6	0.015
Presence of orthopaedic condition	30	-0.14	2.0	0.032
Spinal surgery	9	-0.11	1.2	0.094
Presence of a psychiatric condition	15	-0.14	2.0	0.030
Requiring oxygen support	17	0.12	1.4	0.061
Affected speech at admission	140	0.19	3.6	0.003
Apraxia at admission	49	0.12	1.4	0.062
Incontinence at admission	124	0.12	1.4	0.059
Development of pneumonia	36	-0.22	4.8	0.000
Admission FIM motor score	243	-0.43	18.5	0.000
Admission FIM cognitive score	243	-0.29	8.4	0.000
Admission FIM total score	243	-0.42	17.6	0.000

From the Pearson Product-Moment Correlations coefficient (r) we can determine the strength and direction of the relationship between variables, where positive r-values indicate positive correlations, and negative values indicate negative correlations. The shared variance values (r^2) indicate the percentage of variance in LOS explained by each of the independent variables. For two of the IVs (cardiac murmur and spinal surgery) the number of patients with that variable was very low (1 and 9 respectively) and thus these variables were not included in the regression as they would not contribute to explaining the change in the DV.

The four variables that had the strongest correlation with LOS, and incidentally, all negative correlations, were the development of pneumonia (r= -0.22), admission FIM cognitive score (r= -0.29) the admission FIM motor score (r= -0.43), and the admission FIM total score (r= -0.42). These were however not strong correlations. Motor and total admission FIM scores were considered moderate strength correlations (r= 0.4 - 0.59), while pneumonia and FIM cognitive score were considered weak correlations. Based on these r-values, Admission FIM scores and the development of pneumonia were expected to make it into the final regression model of predictors of LOS.

4.5.2 Multivariate Analysis

Variables from Table 4.22 above were put into the multiple regression model using a stepwise procedure. It was necessary to adhere to the recommended requirements of sampling and regression analyses, thus the following guideline was used: n >50+8m (*i.e.* a minimum sample of 50 patients, plus eight multiplied by m, where m is the number of IVs that can be included in the model) (Tabachnick, Fidell & Osterlind, as cited by Pallant, 2013). This allowed for the inclusion of up to 20 IVs in the model; however, the theory of parsimoniousness was applied in order to develop the best model with the smallest number of IVs.

An ANOVA was used to compare the fit of different models. The selected model had the smallest significant F-value (18.3), indicating that the probability of the null hypothesis (that all coefficients are 0) being true was 18.3%. As the significance was 0.000 (p< 0.1), we can conclude that this model provides a better fit than the intercept-only model. The selected model shows the best combination of IVs for predicting LOS in this sample. See Table 4.23 below for the model summary.

Table 4.23 Multivariate analysis model summary for predicting LOS for the sample (n= 243)

Predictors	R	r^2	Adjusted r^2	Standard error of the estimate	Durbin-Watson
Admission FIM motor score Development of pneumonia Requiring oxygen support Impaired speech on admission Premorbid psychiatric condition	0.528	0.279	0.263	14.600	1.9

The variables used to develop the best and most predictive model were: admission FIM motor score, the development of pneumonia, requiring oxygen support, impaired speech on admission, and the presence of a premorbid psychiatric condition. The r-squared value indicates the variance in the LOS explained by the model. For this model it was 27.9%. The adjusted r-squared value (26.3%) gives us a less exaggerated and truer reflection of the population value. There is a very small difference between the R-squared and adjusted R-squared value, likely due to the large sample size. In order to compare the contribution of each individual IV to prediction of LOS, coefficients are examined. See Table 4.24 below for multivariate analysis model coefficients.

Table 4.24 Multivariate analysis coefficients for the selected model

Factor	Coefficient			t	Significance (p)	95% Confidence Interval for B	
	Unstandardised Coefficients		Standardised Coefficients			Lower Bound	Upper Bound
	B	Std. Error	Beta (b)				
(Constant)	53.17	2.28		23.36	0.000	48.7	57.7
Admission FIM motor score	-0.38	0.05	-0.41	-7.31	0.000	-0.48	-0.28
Pneumonia	-9.14	2.68	-0.19	-3.42	0.001	-14.41	-3.87
Oxygen support	9.64	3.71	0.15	2.60	0.010	2.32	16.95
Impaired speech on admission	5.14	1.90	0.15	2.70	0.007	1.40	8.90
Psychiatric conditions	-8.33	3.92	-0.12	-2.13	0.035	-16.10	-0.61

The standardised beta values (b) indicate the individual contribution that each IV makes towards predicting LOS. The IV that was the largest individual contributor to predicting LOS was admission FIM motor score when all other values are controlled for (41%). This was followed by the development of pneumonia (19%), the requirement of oxygen support (15%), having a speech impairment at admission (15%) and the presence of a premorbid psychiatric condition (12%). All the IVs'contributions were statistically significant ($p< 0.05$). The significance (p) for the t-value of each IV is smaller than 0.05, and therefore we have strong evidence to reject the null hypotheses which state that each IV does not make a contribution towards predicting LOS.

When looking at unstandardised beta values (B), we gather the following:

- A one point increase in admission FIM motor score reduces LOS by almost a third of a day (B= -0.38)
- The development of pneumonia as a medical complication reduces LOS by just over nine days (B= -9.14)
- Requiring additional oxygen support (nasal cannula or facemask) increases LOS by almost 10 days (B= 9.64)
- Having impaired speech on admission (apraxia, dysarthria, aphasia or a combination) increases LOS by approximately five days (B= 5.14)
- Having a premorbid psychiatric condition reduces LOS by just more than eight days (B= -8.33).

To check for multicollinearity, tolerance and VIF statistics were examined. See Table 4.25 below.

Table 4.25 Multicollinearity statistics for the selected model (tolerance and variance inflation factor)

Predictors	Tolerance	VIF
Admission FIM motor score	0.99	1.015
Pneumonia	0.97	1.030
Oxygen support	0.98	1.023
Impaired speech on admission	0.99	1.008
Psychiatric conditions	0.99	1.014

The tolerance is greater than 0.1 indicating that there were no collinear relationships between the variables in this model. The VIF values are all well below 10, further confirming that there was no multicollinearity between IVs in this model.

4.5.3 Residual analysis

A residual analysis was done. Residuals are the difference between the obtained and predicted dependent variable scores. The statistics here are the serial correlation (Durbin-Watson), the distribution, and the homoscedasticity. The Durbin-Watson statistic (1.9) (Table 4.23 above) indicates minimal autocorrelation in this sample. The residuals should be normally distributed around the predicted LOS and the model should not violate the assumptions of homoscedasticity. See Figures 4.1 and 4.2 below.

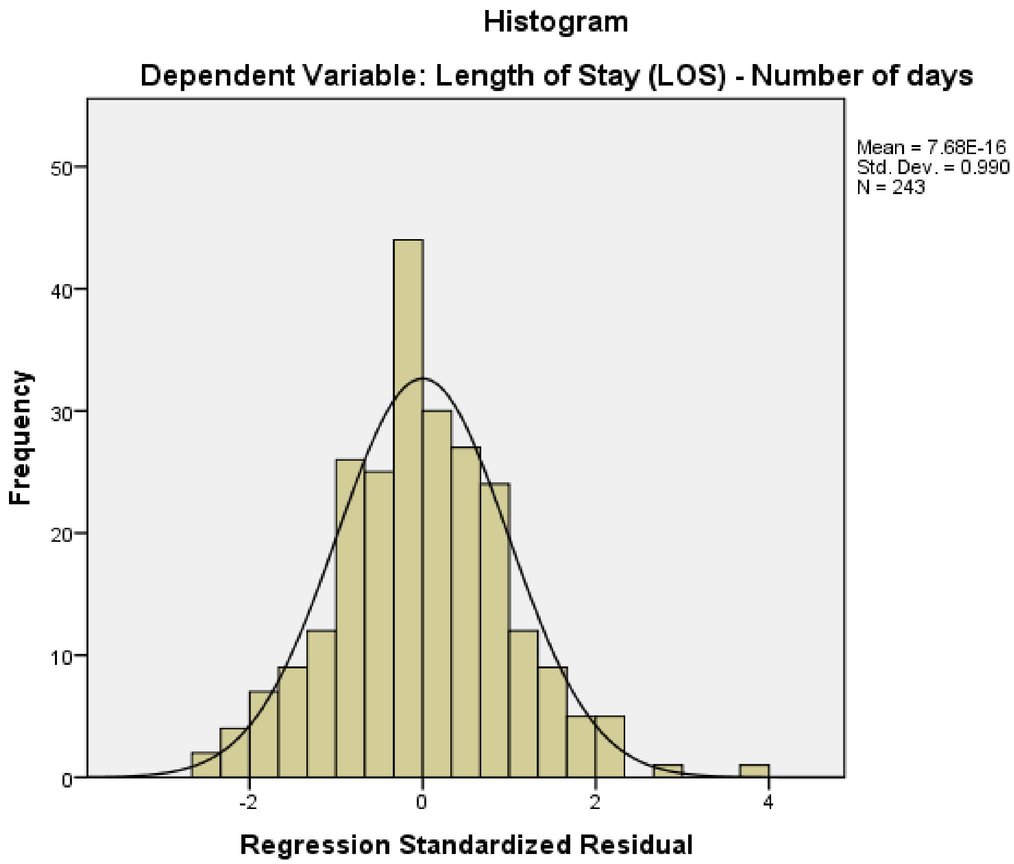

Figure 4.1 Distribution of residuals for the model predicting LOS

The histogram shows that the residuals are normally distributed. The scatterplot plots the standardised predicted value and the standardised residuals to check the assumption of homoscedasticity.

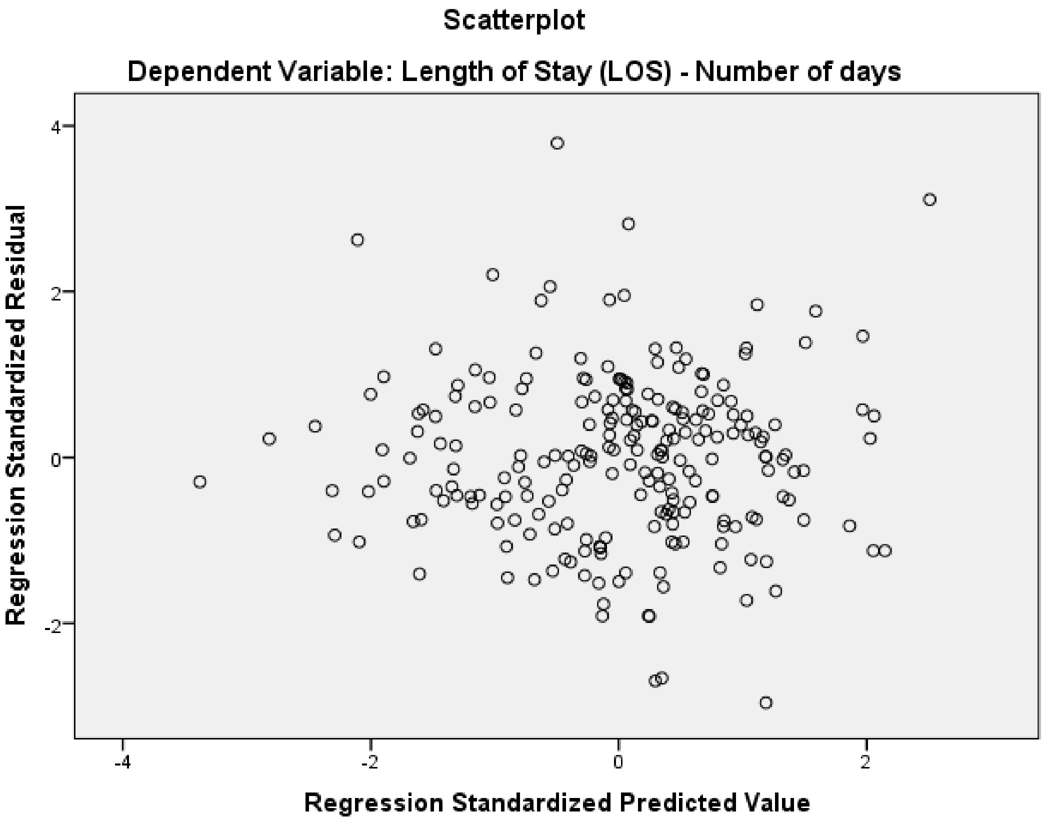

Figure 4.2 Standardised residuals and predicted values

The scatterplot shows that the residuals are not distributed in any pattern with the predicted values, *i.e.* the variance around zero is randomly scattered. As there is no pattern to the residuals, the model is well fitted and does not violate the assumption of homoscedasticity. As missing data were relatively randomly distributed, the sample was large, and one of the exclusion criteria was a lack of recorded data, the missing values made no significant contribution to the results of this study.

4.6 Summary of Results

The patient sample was divided into cohorts based on age and admission FIM score and some trends could be identified between the various cohorts. The most interesting being the following:

- Patients in the age group below 40 years had the highest median admission FIM and discharge FIM scores, and also the biggest median FIM change scores.
- Patients in the low admission FIM score cohort had low median discharge FIM scores and patients in the high admission FIM score cohort had high median discharge FIM scores which suggests that the FIM admission cohort of a patient may be useful in predicting their functional outcomes.
- FIM change appears to be greatest in the patients with moderate impairments (FIM admission scores between 40 and 80).
- Of the independent variables studied (age and admission FIM score) LOS appears only to be influenced significantly by admission FIM scores, based on the significant differences in LOS noted across the admission FIM cohorts.
- Admission FIM was anticipated to be one of the predictor variables of LOS. This, and other variables from the data extraction tool were considered in answering the primary objective of the study.

For the primary objectives of this study, bivariate and multivariate analyses were done. In the bivariate analysis, the four variables that had the strongest correlation with LOS were the development of pneumonia, admission FIM cognitive score, the admission FIM motor score and the admission FIM total score. These and other variables found to be correlated with LOS were put into the multiple regression model using a stepwise procedure. The variables used to develop the best and most predictive model were: admission FIM motor score, the development of pneumonia, requiring oxygen support, impaired speech on admission, and the presence of a premorbid psychiatric condition. The variance in LOS explained by the model was 26.3%.

A one point increase in admission FIM motor score reduces LOS by almost a third of a day (B= -0.38), the development of pneumonia as a medical complication reduces LOS by just over nine days (B= -9.14) and requiring additional oxygen support increases LOS by almost 10 days (B= 9.64). Having impaired speech on admission increases LOS by approximately five days (B= 5.14) and having a premorbid psychiatric condition reduces LOS by just more than eight days (B= -8.33).

5 DISCUSSION

5.1 Introduction

The aim of this study was to determine the predictors of LOS in patients post-stroke in a rehabilitation setting in Gauteng. The secondary objectives were to describe the study sample, their functional outcomes (with the use of the FIM) and their LOS. The primary objective was to describe to predictors of LOS for this study sample. The secondary objectives help to describe the sample which then aids in answering the primary objective.

Results will discussed under five headings, demographic characteristics, clinical characteristics, functional characteristics, description of LOS and prediction of LOS. Under each heading sample characteristics will be described, followed by the effect that each characteristic has on functional outcome and LOS based on descriptive statistics, and on a multiple regression analysis where relevant. Finally the predictors of LOS will be discussed and the overall variance in LOS predicted by the model will be compared to other studies.

5.2 Demographic Characteristics

The setting selected for this study was a sub-acute rehabilitation hospital in Gauteng. The sample was relatively large, including 243 patients who experienced first-time strokes and were admitted for rehabilitation between 1 January 2015 and 31 January 2017.

5.2.1 Insurance status

In the study by the researcher, 97% of patients used the same method of payment for rehabilitation services (private insurance by a variety of medical aid schemes). This does not reflect the insurance status of all South Africans who are largely uninsured and paying privately for medical care (Mayosi & Benatar, 2014). As a private rehabilitation facility was selected for sampling, this is not unexpected.

In the United States the majority of patients are covered by Medicare with a much smaller proportion of patients using private insurance or paying out of pocket. In a study by

Mohammed *et al*. (2015), a lack of insurance was correlated with a shorter LOS (r= 0.16, p= 0.0001), but this did not remain significant in the regression analysis. No cohort level analysis was done to determine whether payment method was correlated with LOS in the study by the researcher because of the similar payment method used by most patients.

5.2.2 Marital Status

A large proportion of patients in the study by the researcher were single or widowed (37.9%). Based on the findings in the literature that single marital status was significantly associated with longer LOS (Monane, Kanter & Glynn, 1996), and the relatively high number of single and widowed patients, the researcher expected to find a correlation in this study. The study by the researcher however found no significant relationship between marital status and LOS and it was thus not considered in the regression analysis.

5.2.3 Prior level of independence

A patients' level of independence in ADLs prior to the stroke is an important contributor to their overall admission FIM score (Black-Schaffer & Winston, 2004). The majority of patients in the study by the researcher were reported to be independent prior to their admission to the facility. This is not surprising as the patients in this sample were relatively young (60.7 years), and patients with previous strokes and dementia were excluded as these conditions may have affected their admission functional status. Level of prior independence was not included in cohort level analysis due to the small proportion of patients (nine) in this study that were dependent prior to admission. There was no correlation between LOS and dependence in the bivariate analysis and it was not entered into the regression analysis.

5.2.4 Age

The median age of patients in this study (60.7 years) was slightly younger than the ages reported for patients admitted to rehabilitation centres in Italy, the United States and Canada (68-73 years) (Alexander, 1994; Franchignoni, *et al*., 1998; Bagg, Pombo & Hopman, 2002; Black-Schaffer & Winston, 2004). Wang *et al.* (2016) reported an increased risk of stroke in younger adults in middle and low income countries. This could explain why this study's patients were slightly younger than those recorded by studies in developed countries. In an acute, state-run tertiary hospital in South Africa, the mean age of patients studied post-stroke was 59.8 years (Parekh & Rhoda, 2013), and in a specialised state-run rehabilitation facility the mean age of stroke patients was 53 years (Joseph & Rhoda, 2013). The similarity in other South African facilities supports the theory that the high number of stroke risk factors may be responsible for the younger age at which patients have strokes in developing countries (Bryer, *et al.*, 2010; Norrving & Kissela, 2013; Pillay & Maharaj, 2013; Feigen, *et al.*, 2014; Marshall, *et al.*, 2015).

According to the cohort level of analysis in the study by the researcher, age had an effect on functional outcome, but no apparent effect on LOS. Age appears to have an effect on admission FIM scores, as well as discharge FIM scores. The youngest patients (<40 years) had significantly higher median FIM scores at admission and discharge when compared to the older age groups (40- 59, 60-79 and over 80 years). The significant differences found between the youngest age cohort and all the other age cohorts collectively, suggest that younger patients have higher functional outcomes at discharge than older patients, and this indicates that age may be a predictor of functional outcomes. These results are substantiated by the findings of Alexander (1994); Nakayama, Jorgensen, Raaschou and Olsen (1994); Kugler, Altenhöner, Lochner and Ferbert (2003) and Bagg, Pombo and Hopman (2004).

However, other variables such as admission FIM score may be correlated positively with discharge FIM score (Alexander, 1994; Kugler, Altenhöner, Lochner & Ferbert, 2003; Bagg, Pombo & Hopman, 2004; Black-Schaffer & Winston, 2004; Karatepe, Gunaydin, Kaya & Turkmen, 2008), and therefore we cannot accept that age alone is a predictor of functional outcomes without further testing, which was beyond the scope of this research report.

When considering the median FIM change scores in the study by the researcher, it is interesting to note that there was a trend of younger cohorts making greater improvements (larger changes in function) than older cohorts. These changes were not statistically significantly different and other variables such may be influencing functional change rather than age. Kugler, Altenhöner, Lochner and Ferbert (2003) and Black-Schaffer and Winston (2004) similarly report that younger patients make greater functional changes than older patients, but acknowledge the greater predictive power of admission FIM score which may be a possible confounder.

In the study by the researcher LOS was very similar across all age groups and no statistically significant differences were noted between groups. Older patients had longer median LOS, but there were no statistically significant differences between groups. Further analysis was done with correlations. Age was not significantly correlated with LOS at a significance level of $p < 0.1$ and was not included in the regression analysis. This is supported by the work of Nakayama, Jorgensen, Raaschou and Olsen (1994) Chang *et al.* (2002), Black-Schaffer and Winston (2004), Appelros (2007) and Rollnik and Janosch (2010) who found that age had no independent influence on LOS. In the studies by Franchignoni *et al*. (1998) and Valach, Selz and Singer (2004) where age was found to influence LOS, the variance in LOS predicted by age was very small and admission functional score was found to be a much stronger predictor in both.

5.3 Clinical Characteristics

5.3.1 Stroke Side and Stroke Type

Left and right-sided strokes were almost equally common (45.5% and 51.5%), with very few patients suffering from bilateral strokes (3%). Gialanella, Bertolinelli, Lissi and Prometti (2011) found that patients with left-sided strokes have worse outcomes and longer recovery due to the presence of aphasia and associated communication difficulties - a common symptom of left-sided lesions. There was no association with stroke side and LOS in the study by the researcher, but there was an association with speech impairment and LOS. This suggests that speech impairment may have been a stand-in variable for factors which may affect the ability to communicate and may not have reached significance on their own in the study by the researcher (*i.e.* stroke side, arousal, confusion and cognition). The work of Jorgensen, Nakayama, Raaschou and Olsen (1997) reports similar findings in 1 197 acute stoke unit stroke patients, *i.e*. stroke side had no influence on LOS.

A greater number of patients in the study by the researcher had ischaemic strokes (73.3%). This is in keeping with the 80% reported by Benjamin *et al*. (2017) and is likely due to the high prevalence of risk factors in the researcher's study sample that predispose patients to ischemic stroke (hypertension, hypercholesterolaemia and cardiac conditions).

5.3.2 Co-morbidities

Premorbid conditions were common in patients in the study sample, and just over two thirds of the patients had more than three comorbidities, the most common of these being hypertension, hypercholesterolaemia, cardiac conditions and diabetes mellitus. These are very similar to the findings in other patients post-stroke reported by Caro, Huybrechts and Duchesne (2000); Kugler, Altenhöner, Lochner and Ferbert (2003); Saxena *et al.* (2007); Karatepe, Gunaydin, Kaya and Turkmen (2008) and Chang *et al*. (2015).

Patients with several coexisting co-morbidities require more intensive medical management (Harvey, *et al*., 1998). There was a small negative correlation (r= -0.13) between the number of co-morbidities (>3) and LOS (p= 0.052) in the bivariate analysis, but this did not meet the criteria for inclusion in the regression model when other, more significant variables were included.

When examining the effects of individual co-morbidities on LOS in the bivariate analysis the presence of the following conditions were found by the researcher to correlate with LOS: any cardiac condition, a valve replacement, a cardiac murmur, the presence of any orthopaedic condition, spinal surgery and the presence of any psychiatric condition. Mohammed *et al*. (2015) found cardiac conditions to be associated with a longer LOS. In the study by the researcher, the only variable that remained an independent predictor of LOS in the regression analysis was the presence of a psychiatric condition. The presence of a premorbid psychiatric condition decreased LOS by just more than eight days.

Some impairments may predispose patients to complications which may affect the patient's functional outcomes and LOS (Pikus, *et al*., 2003; Duncan, *et al.*, 2005; Bryer *et al.*, 2010; Alsumarain, *et al*., 2013). Additional clinical characteristics of the patients recorded at admission included respiratory function and whether or not respiratory support was required, swallowing function, speech ability, the presence of unilateral spatial neglect and continence.

5.3.3 Respiratory function

Patients who cannot maintain adequate oxygen saturation on room air require oxygen supplementation. Poor saturation may occur as a result of underlying cardiac or respiratory pathology, particularly pneumonia and is associated with poor outcomes and higher mortality in patients post-stroke (Kwan & Hand, 2007). In the study by the researcher a small proportion of patients (7%) required oxygen supplementation from a face mask or nasal cannula at admission. It may have represented greater illness/ co-morbidities in patients and poorer capacity for rehabilitation.

There was an association between requiring additional oxygen support and LOS and it remained a significant independent predictor of LOS in the regression analysis. Requiring additional oxygen support on admission increases LOS by just over nine days.

5.3.4 Swallowing function

Patients with more severe strokes often have impairments such as reduced consciousness and poor swallow (Bryer, *et al.*, 2010), therefore suffering a high risk of aspiration (Duncan, *et al.*, 2005). The risk of pneumonia may be up to ten times higher in patients with aspiration post-stroke (Pikus, *et al*. 2003). In the study by the researcher, data were collected on patients' ability to swallow safely because of the link between swallowing function and aspiration pneumonia. Although 23% had unsafe swallowing function, there was no correlation found in the study by the researcher between poor swallow and LOS, but it may have contributed to the large number of patients that developed pneumonia.

5.3.5 Speech function

Speech disorders may affect up to 82.3% of patients after acute stroke (Vidović, *et al*., 2011), and in the researcher's study sample, impaired speech was a common problem, affecting 57.6% of patients. The lower percentage of impaired patients in this study may be due to recovery of speech function in acute facilities prior to referral to this sub-acute rehabilitation facility. Sinanović *et al*., (2011) and Dobkin (2005) describe the spontaneous recovery of speech function, particularly aphasia in the early phase after stroke (within the first few weeks). This improvement is attributed to recovery of neurotransmission in the ischaemic penumbra (Dobkin, 2005; Sinanović *et al*., 2011).

Gialanella, Bertolinelli, Lissi and Prometti (2011) found that aphasia increases rehabilitation LOS in patients post-stroke, and the study by the researcher found a similar trend. Having any speech impairment at admission was highly significantly associated with a longer LOS, specifically, the presence of speech apraxia. In the regression analysis, the presence of any speech impairment on admission was an independent predictor of LOS when other variables were controlled for ($b= 0.15$, $p= 0.007$). Impaired speech on admission prolonged LOS by approximately five days. Patients with impaired communication abilities may have more difficulty participating in rehabilitation and making their needs known (Sjöqvist-Nätterlund, 2010). They may also struggle to follow instructions which may hinder learning of ADLs (Mayo, Korner-Bitensky & Becker, 1991). They may need a longer LOS, to achieve the same milestones as patients without speech impairments, to be considered safe and ready for discharge (Gialanella, Bertolinelli, Lissi & Prometti, 2011).

5.3.6 Presence of unilateral spatial neglect

Paolucci, Antonucci, Grasso and Pizzamiglio (2001) found neglect to occur in 23% of patients post-stroke in the very early phase. In the study by the researcher it occurred in a slightly smaller proportion of patients (18.1%). In the literature, Gillen, Tennen and McKee (2005) and Feigenson *et al*. (1977) identified a correlation between LOS and unilateral neglect, so it was expected to significantly influence the LOS in the researcher's study. However in this study there was no significant correlation found between neglect and LOS. It may be due to the fact that only patients with right hemisphere lesions were studied by Gillen, Tennen and McKee resulting in a higher incidence and larger effect of USN in their study (29% vs 18.1% in this study). It may also have been due to the fact that neglect was reported subjectively in therapists' notes and not diagnosed and documented according to standardised outcome measures. This is a factor known to affect the reliability of results reported (Bowen, McKenna & Tallis, 1999). The effect of USN may have been underestimated in this study.

5.3.7 Continence

More than half of the patients suffered from incontinence of the bladder or bowel in the researcher's study, and just under a sixth of the patients experienced constipation and UTIs. This is similar to the findings of Nakayama *et al*. (1997) who reported that about 50% of patients become incontinent after a stroke. Incontinence on admission is routinely managed with the use of urinary catheterisation which is associated with the development of UTIs, poor outcome and greater disability (Jongbloed, 1986; Nakayama, *et al*., 1997; Bryer, *et al.*, 2010; Mohamed, *et al.*, 2015) as well as longer LOS (Ingeman, *et al*., 2011).

Feigenson *et al*. (1977) found that patients without bladder and bowel control require a longer LOS to promote maximal functional improvement. There was a significant association between incontinence and LOS in this sample ($r= 0.12$, $p= 0.059$), but this variable had no independent influence on the variance in LOS when other variables were added to the regression model. In a larger sample this may have reached significance.

5.3.8 Complications

A high number of patients developed one or more complication during their stay at this rehabilitation facility (71.2%), which is similar to the 77% reported for patients in rehabilitation hospitals post-stroke by Saxena *et al*. (2006) and 63.8% for patients in a stroke unit in the early phase by Indredavik, Rohweder, Naalsund and Lydersen (2008). In this study, the most common complication was pneumonia, occurring in 20.8% of patients. This is relatively high in comparison to studies by Ingeman *et al.* (2011) and Mohammed *et al.* (2015) (9% and 1.8% respectively). As patients in this study were more severely impaired than those in the aforementioned studies, they may have been at greater risk of developing pneumonia. It may also be a result of the relatively high number of patients with an unsafe swallow recorded in the study by the researcher (23%).

a) Depression

Depression may occur as a complication of stoke and was diagnosed in nine percent of patients admitted to a rehabilitation facility by Gillen *et al*. (2001). The incidence of post-stroke depression was 19.7% in the researcher's study. Depression was recorded based on subjective information in patient files, and not on medical diagnoses, or with the use of any standardised outcome measures. This may have resulted in the higher incidence in this study.

No relationship was found in the study by the researcher between depression and LOS. This is supported by the findings of Gillen *et al*. (2001) who reported that while a history of depression is associated with a longer LOS, but the development of depression is not, despite the fact that patients make poorer use of rehabilitation services. The use of objective measures and diagnoses may have improved the validity of the findings and may have resulted in significant associations between depression and LOS in this study.

b) Pneumonia

In the researcher's study, pneumonia was found to be both associated with LOS in the bivariate analysis, and an independent predictor of LOS in the regression analysis. The development of pneumonia was found to reduce LOS by just over nine days. This differs from other studies that found pneumonia to be associated with a longer LOS (Ingeman, *et al.*, 2011; Alsumarain, *et al*., 2013; Mohamed, *et al.*, 2015). Their findings were recorded in a stroke unit and amongst relatively mildly impaired patients respectively. The care and management practices of patients with pneumonia in such different facilities may account for the differing LOS. Other studies have found that there is a negative correlation between pneumonia and LOS, likely because pneumonia is a common cause of mortality (Jorgensen, Nakayama, Raaschou & Olsen, 1997; Alsumarain, *et al*., 2013). As no patients who passed away before discharge were included in this study, the reason for the negative correlation between LOS and the development of pneumonia (r= -0.22, p= 0.000) must be due to different factors. It could be that patients in a rehabilitation setting who make poor functional gains due to illness and the inability to participate in rehabilitation, are discharged sooner to institutional care or back to acute facilities, resulting in a shorter LOS. Feigenson *et al*. (1977) stated that slow functional recovery mandates early discharge. It was beyond the scope of this study to perform these investigations but may be of interest for future studies.

5.4 Functional Outcomes

Both discharge FIM scores and FIM change scores were used in describing patient outcomes. Admission functional status has been found to be the strongest predictor of functional outcomes. As demonstrated in the schematic used in the literature review, however, several factors may influence admission function, making it a proxy for several variables. Both admission function, and the variables which have an effect on admission function should be studied as novel variables may be identified as predictors of function if they are found to have an independent effect on function. Some of the variables include: patient age, previous functional level, and stroke severity.

In the study by the researcher, cohort level assessments were done based on age and admission function, and their effects on functional outcome. Information on stroke severity was not available but would have been useful to include because of its importance in predicting admission function and discharge function. There was also no cohort level assessment of prior level of function as only nine patients were dependent prior to admission.

5.4.1 The Effect of Admission FIM Score on Functional Outcomes

Most patients (n= 115) had admission FIM scores between 40-80 points and could be classified as moderately to severely impaired (Musicco, Emberti, Nappi & Caltagirone, 2003). The median admission FIM score of 43 is quite low when compared to other samples of post-stroke patients selected for similar studies, such as Black-Schaffer and Winston (2004) and Valach, Selz and Singer (2004) with mean admission FIM scores of 60.7 and 79.4 respectively. These lower admission scores are similar to those recorded in patients post-stroke receiving rehabilitation across 23 private hospitals in South Africa (between 40-65 points) (Green, *et al*., 2005). The admission criteria may be similar for private, South African rehabilitation facilities resulting in similar mean admission scores for patients post-stroke. The reason for differing scores abroad could be the facility policies. More stringent admission criteria may limit more severely impaired patients from accessing rehabilitation as they are seen as unlikely to make sufficient functional gains. They are instead referred to nursing facilities (Kane, Chen, Blewett & Sangl, 1996; Buntin, *et al.*, 2010).

It is a common finding that admission FIM score is the strongest predictor of discharge FIM score (Alexander, 1994; Bagg, Pombo & Hopman, 2002; Kugler, Altenhöner, Lochner & Ferbert, 2003; Black-Schaffer & Winston, 2004; Karatepe, Gunaydin, Kaya & Turkmen, 2008; O'Brien, Xue, Ingersoll & Kelly, 2013). The results of the study by the researcher support these findings. For every FIM admission cohort group in this study, pairwise comparisons showed that the FIM discharge scores were statistically significantly different ($p< 0.05$). Patients who come in with low admission FIM scores have significantly lower discharge FIM scores when compared to those who have moderate or high FIM scores on admission. Patients had markedly different outcomes based on their admission scores, and thus the admission FIM score of a patient may be useful in predicting their functional outcomes.

Functional outcomes include FIM score and discharge and FIM change. Both represent patient recovery. The effect of admission FIM score on discharge FIM score has been described. Its effect on FIM change should also be noted. Interestingly, FIM change appears to be greatest in the patients with moderate impairments (25 points), while mildly impaired and severely impaired patients have smaller FIM change median scores (11 and 20 points respectively). For every FIM admission cohort group, pairwise comparisons showed that the FIM change scores were statistically significantly different ($p< 0.05$), except in the <40 and 40-80 cohort ($p> 0.05$). Very severely impaired patients may not have as much potential for improvement as those with moderate impairment, and those with the highest FIM scores may not show the same gains due to the ceiling effect of the FIM in highly functional patients (Alexander, 1994).

5.4.2 The Effects of Admission FIM Score on LOS

Admission functional score (measured with FIM or BI) has been found to be a predictor of LOS in several studies (Franchignoni, *et al.*, 1998; Harvey, *et al.*, 1998; Chang, *et al*., 2002; Sebastia, *et al.*, 2006; Rollnik & Janosch, 2010; McClure, *et al*., 2011). Admission functional status may have an influence on LOS in this study based on the statistically significant differences in LOS for all pairwise comparisons of admission FIM cohorts. Patients with the least severe functional impairment (*i.e.* the highest FIM scores) on admission had the shortest LOS, followed by those with moderate impairments (51 and 42 days respectively). Patients with the least severe functional impairments on admission had the shortest LOS (27 days). Patients with more severe functional impairments require longer LOS to be ready for home discharge also suggest that patients who are more functionally affected may need more time to reach the functional goals desirable for discharge.

The FIM motor score is the most suitable sub-scale for evaluating patients' mobility outcomes at discharge and monitoring a change in mobility from admission to discharge (Brock, Goldie & Greenwood, 2002). In this study, an increase in admission FIM motor score was found to reduce LOS (a one point increase reduces LOS by 0.4 days). This was also found by Gialanella, Bertolinelli, Lissi and Prometti (2011) and McClure *et al.* (2011). It stands to reason that patients who have greater mobility are more able to participate in rehabilitation transfers and ADLs. They make more rapid gains with therapy and may be ready for discharge earlier (Harvey, *et al*., 1998). Patients who cannot mobilise need longer LOS to promote maximal functional improvement (Feigenson, *et al*., 1977).

The admission FIM motor score was the strongest individual predictor of LOS in this study (41%) when all other variables were controlled for. This is not a novel finding and is supported by the work of Harvey *et al*. (1998), who also found FIM motor score to be a significant predictor of LOS.

Patients with more severe strokes require longer LOS (Jorgensen, Nakayama, Raaschou & Olsen, 1997; Gassaway, *et al.*, 2005). Stroke severity was not specifically measured in this study, but admission FIM may be used as a proxy for stroke severity (Alexander, 1994; Black-Schaffer & Winston, 2004). This lends further support to the findings of this study that patients with lower functional scores have longer LOS.

5.4.3 Description of LOS

The mean LOS for patients at this facility was 42.9 days. This is comparable to the LOS of patients in German and Swedish hospitals in the early nineties (32 days, 37.4 days and 44.6 days) (Nakayama, Jorgensen, Raaschou & Olsen, 1994; Jorgensen, Nakayama, Raaschou & Olsen, 1997; Rollnik & Janosch, 2010). It is also similar to the LOS reported by two studies of patients post-stroke at a specialised state-run rehabilitation facility in the Western Cape (South Africa) with 62 days and 51.6 days respectively (Rouillard, De Weerdt, De Wit & Jelsma, 2012; Joseph & Rhoda, 2013). It is markedly longer than the LOS reported by other authors conducting similar studies in IRFs abroad in more recent times (18.6 days and 16.5 days) (Gassaway, *et al*., 2005; Granger, *et al.*, 2009).

The LOS in acute facilities abroad and in South Africa is often shorter. A study by Mamabolo *et al.* (2009) reported that up to 47% of South African stroke patients have hospital LOS shorter than two weeks in state-run hospitals in Gauteng. This is consistent with the findings of Chang *et al*. (2002), Appelros (2007), Parekh and Rhoda (2013) and Chang *et al*. (2015) who all report LOS to be between seven and 24 days. Acute facilities cannot be accurately compared with the facility selected for this study. Possibly the implementation of prospective payment systems in many rehabilitation facilities overseas has lead to a shorter LOS compared to South African facilities. The differences may also be due to the differing rehabilitation programmes and services offered in different countries and by different service providers (private or state-run facilities).

5.5 Prediction of LOS

With the stepwise multiple regression model, the following patient characteristics were found to be predictors of LOS: the presence of a premorbid psychiatric condition, impaired speech on admission, requiring additional oxygen support, the development of pneumonia and the admission FIM motor score. Individual predictors have been discussed in some detail in the paragraphs above, and the implications of the findings will follow. The overall variance predicted by the model, and the usefulness of such a model in stroke rehabilitation will also be discussed in the next paragraphs.

The overall variance predicted by the model using this combination of variables was 26.3%. This is rather lower than the models of LOS prediction put forward by Chang *et al*. (2002) at 37% (predictors: small vessel occlusion, male gender, smoking, lower BI on admission), Harvey *et al.* (1998) with 35.9% (predictors: FIM motor score on admission and NIHSS score) and Sebastia *et al*. (2006) with 34.3% (predictors: admission FIM score and trunk control test combined). It was comparable to Valach, Selz and Singer (2004) who found that 26% of the variance in LOS was predicted by transfer items of the FIM (bed, chair, and wheelchair transfers), and higher than the 16% predicted by Saxena *et al.* (2006) (predictors: BI score on admission and medical complications). It is difficult to compare the models used in different facilities as the time frames in studies, facility types, inclusion and exclusion criteria for samples, and outcome measures used, differ greatly.

All the models however, include admission functional score as measured with the FIM or BI. The agreement in this study and others that admission FIM score (particularly the motor component) is a predictor of LOS indicates the robustness of the FIM score as an outcome measure in rehabilitation research. Aside from this common variable, there is much variation. This study's model introduces some novel variables that have not previously been described, such as the necessity for oxygen support increasing LOS and the presence of a psychiatric condition reducing LOS.

Patients who required oxygen support via nasal cannula or facemask may have been more difficult to mobilise (*i.e*. due to additional lines or mobile oxygen tanks) (Barber, *et al*., 2015). They may also have required shorter and less vigorous therapy sessions due to poor endurance, and thus they may have required rehabilitation over a longer period of time to achieve the necessary outcomes for safe discharge. The reason that this variable may have been a novel predictor of LOS in the study by the researcher is that other studies may have used different variables to document cardiorespiratory function and endurance. The generally lower admission functional scores of patients in the study by the researcher may also have indicated a more severely ill/ impaired sample. Other studies may have excluded more severely ill/ impaired patients and thus did not identify a significant relationship between poor cardiorespiratory function and LOS.

Premorbid psychiatric conditions predicted shorter LOS in the study by the researcher. This is also a novel finding in stroke rehabilitation literature. It may be that patients with psychiatric conditions are less compliant with rehabilitation and may not make sufficient gains with therapy to justify a prolonged stay in a rehabilitation facility. They may thus be discharged sooner to institutional care (Appelros, 2007). These patients may also already have care structures in place at home and do not have to wait for placement (Appelros, 2007).

The model as a whole, as well as the individual predictors may be useful in identifying the "high risk" characteristics leading to reduced or prolonged LOS in patients post-stroke. This information is vital as it aids clinicians in developing the best strategies for the prevention of complications, *i.e*. for the prevention of pneumonia, routine swallow screening for early detection of dysphagia needs to be implemented along with rapid dysphagia-management strategies (Lakshminarayan, *et al*., 2010). For patients with speech impairments, early referral and intensive speech and language therapy may be beneficial (Breitenstein, *et al*., 2017). It may also guide the development/ adaptation of admission criteria of the rehabilitation facility. Patients with premorbid psychiatric conditions may be more appropriately managed with out-patient or home-based care, or referral to an appropriate nursing facility as they may not make sufficient gains to warrant prolonged in-patient rehabilitation. Patients who still require oxygen therapy may be better managed with longer stays in acute facilities to ensure that their cardiorespiratory function and endurance is greater prior to referral. This may improve their potential for participation in rehabilitation.

Being able to predict LOS at the earliest stage possible stage (*i.e*. on admission) may also be useful for facilities who need to manage bed occupancy and resources. Low admission FIM motor scores on admission may be used to motivate for additional funding and longer LOS from medical aid schemes. The longer stays may give patients additional time to improve their functional outcomes and prospects for home discharge with fewer impairments. More fully rehabilitated patients are less of a burden on medical aid schemes. The short-term increase in costs in the interest of long-term savings may provide motivation for improved coverage for stroke patients requiring rehabilitation in South Africa's private healthcare sector. High admission FIM motor scores may also be used as justification for shorter stays, earlier discharge and appropriate referral to out-patient therapy. All of which reduce the cost of care post-stroke to the facility, medical aid scheme and patient themselves. A sub-acute rehabilitation service that is tailored to meet the specific needs of patients and is managed efficiently from the time of a patient's admission is in the favour of all parties.

5.6 Limitations

As a retrospective review, this study was based on the quantity and quality of information available in patient files. Much of the medical and clinical data were reported subjectively by patients or their family members to nursing staff on admission to the facility. Although standardised admission sheets were used to capture the information consistently for most patients, validated or reliable outcome measures were rarely used. For example, only the presence of pneumonia and UTIs were confirmed with laboratory results (sputum samples and blood work). Other complications were subjectively commented on in patients' daily observations, progress notes or therapists' progress notes. Similarly co-morbidities were not recorded with the use of a weighted co-morbidity index and were based on the patient's subjective history. Depression was documented subjectively and not with a recognised depression scale or based on medical diagnosis and previous management.

All these factors could have influenced the reliability of this study's findings. It does however reflect standard clinical practice and findings may be clinically relevant. To minimise the effect of poor quality data, analyses were run on variables that were consistently available and recorded in the same format in most files (*i.e.* standardised admission forms) and as far as possible based on standardised measures (*i.e.* FIM). For many variables, data were dichotomised into categories “present or absent” as no other rating scale or classification could be used.

Patient files rarely contained details of the acute management beyond the name of the referral facility, thus little can be said about the duration or therapeutic intervention received prior to their admission to the rehabilitation facility. Patients admitted to the rehabilitation facility may have been at different stages of their recovery, and the date of incident was not consistently available. For this reason admission and discharge dates to and from the rehabilitation facility were used.

There is much variation in stroke rehabilitation practices from one patient to another and one centre to another. The content and quality of therapy could not be controlled for in this retrospective review and thus functional outcome of patients at this facility cannot accurately be compared to those of patients at other facilities. This study reflects practices and therapeutic conditions in this private rehabilitation facility only.

Many predictors of LOS and functional outcome have been proposed by previous research. This study may not have identified the same variables as other similar studies, and it should be noted that some variables identified in the regression model may be stand-ins for other variables/ processes that may not have been strong enough to emerge as independent predictors. The predictors, and the variance in LOS that the model predicts are specific to this cohort of patients at this facility and results may not be generalisable to other studies of patients with first-time strokes in a rehabilitation setting.

CHAPTER 6

6 CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter provides conclusions made from this study with respect to the set objectives and the recommendations for clinical practice and further research.

6.2 Conclusion

The secondary objectives provide information that help to answer the primary objective of this study. These included the establishment of the demographic and clinical profile of patients at the facility, a description of their LOS and their functional outcomes. The primary objective was to determine the predictors of hospital LOS for patients admitted to this sub-acute rehabilitation facility, post-stroke between 1 January 2015 and 31 January 2017.

6.2.1 Demographic and Clinical Profile of Patients

In this sample of 243 patients admitted for sub-acute rehabilitation post-stroke, the mean age of patients was 60.7 (14.4) years. The proportion of males and females was very similar (44% and 56% respectively) and the majority were medically insured (97.9%). Almost all the patients were functionally independent prior to the stroke (96.3%) and 62% were married. More than half of the patients were employed prior to the stroke (53.5%).

Of the sample 51.4% of patients had right-sided strokes, 45.7% had left-sided strokes and 2.9% experienced bilateral strokes. The majority of strokes were ischaemic (73.3%). The most common co-morbidities were hypertension (66.3%), hypercholesterolaemia (35.4%), cardiac conditions (33.3%) and diabetes mellitus (27.2%).

The majority of patients needed no additional respiratory support, but 23.0% had an unsafe swallow and 7.8% had a compromised ability to cough. In this study sample, 2.9% of patients required an NG tube for feeding and 9.9% required a PEG. More than half of the sample presented with impaired speech on admission (57.6%). The most common impairments were dysarthria (45%) followed by apraxia (35%) and aphasia (32.9%). Some patients had a combination of speech impairments. Hemi-spatial neglect occurred in 18.1% of patients. Incontinence of the bladder and bowel was recorded in 51% of the patients in the sample.

The most common complications were the development of pneumonia (20.8%), depression (19.7%) and pressure sores (18.5%).

6.2.2 Hospital LOS of Patients

The LOS of patients ranged between three and 112 days, and the median LOS was 43 days. This is markedly longer than the LOS reported in rehabilitation literature abroad, but is similar to the data collected in one state-run rehabilitation facility in South Africa (Rouillard, De Weerdt, De Wit & Jelsma, 2012; Joseph & Rhoda, 2013). There is a need for more data from other private rehabilitation providers in South Africa for accurate comparison.

6.2.3 Functional Outcomes of Patients

Older patients with lower admission FIM scores were found to have worse outcomes based on discharge FIM scores than their younger, less functionally impaired counterparts. Only admission FIM score seemed to have an influence on functional change/ gain. The fact that admission FIM score is a proxy for several variables may have contributed towards its greater strength in influencing patient outcomes. Age and co-morbidities have been identified in literature as having an influence on admission FIM score and may thus have contributed towards the effect noted in this study of admission FIM on discharge FIM scores and FIM change scores.

6.2.4 Predictors of Hospital LOS

LOS appears to be influenced only by admission FIM based on the significantly different LOS recorded for admission FIM cohorts in this study. In the bivariate analysis several factors were found to be correlated with LOS but only five made it into the regression analysis. The presence of a premorbid psychiatric condition decreased LOS by just more than eight days. Impaired speech on admission prolonged LOS by approximately five days. Requiring additional oxygen support on admission increased LOS by just over nine days. The development of pneumonia was found to reduce LOS by just over nine days and a one point increase in admission FIM motor score was found to reduce LOS by 0.4 days.

This study's model introduces some novel variables that have not previously been described, such as the necessity for oxygen support increasing LOS and the presence of a psychiatric condition reducing LOS. Patients who required oxygen support may have been more difficult to mobilise (Barber, *et al*., 2015) and had poor endurance with rehabilitation therapies. They may have required rehabilitation over a longer period of time to achieve the necessary outcomes for safe discharge. Other studies may have used different variables to document cardiorespiratory function and endurance. Patients with psychiatric conditions may be less compliant with rehabilitation and may not make sufficient gains with therapy to justify prolonged rehabilitation. They may thus be discharged sooner to institutional care (Appelros, 2007). These patients may already have care structures in place at home and do not have to wait for placement (Appelros, 2007).

The model's individual predictors may be useful in identifying the "high risk" characteristics leading to reduced or prolonged LOS in patients post-stoke. This information aids clinicians in developing the best strategies for the prevention of complications (*i.e*. pneumonia) and for early referral and intensive treatment for specific impairments (*i.e.* speech and language). It may also guide the development/ adaptation of admission criteria of the rehabilitation facility. Patients with premorbid psychiatric conditions may be more appropriately managed with out-patient or home-based care, or referral to an appropriate nursing facility while patients who still require oxygen therapy may be better managed with longer stays in acute facilities to ensure that their cardiorespiratory function and endurance is greater prior to referral.

The admission FIM motor score was the strongest individual predictor of LOS in this study (41%). This is not a novel finding and is supported by the work of several authors. The agreement in this study and others that admission motor FIM score is a predictor of LOS indicates the robustness of the FIM score as an outcome measure in rehabilitation research despite the great variability in healthcare systems, facilities and samples. Low admission FIM motor scores on admission may be used to motivate for additional funding and longer LOS from medical aid schemes. The short-term increase in costs in the interest of long-term savings may provide motivation for improved coverage for stroke patients requiring rehabilitation in South Africa's private healthcare sector. High admission FIM motor scores may also be used as justification for shorter stays, earlier discharge and appropriate referral to out-patient therapy. All of which reduce the cost of care post-stroke.

The overall variance predicted by the model was fair at 26.3%. In the literature, the variance of LOS predicted by models differs greatly. It may be due to different types of facilities, time frames, inclusion and exclusion criteria for samples, and outcome measures used. The results may not be generalisable to other populations of patients post-stroke, but may provide preliminary evidence for comparison with and further investigation by other studies, especially in private South African rehabilitation facilities.

6.3 Recommendations

6.3.1 For Clinical Practice

While the results of this study may not be directly comparable to other rehabilitation studies in other countries, it may be useful for this particular facility for planning and organising its rehabilitation service. It may also be useful for comparison of LOS and functional outcomes over time in the same facility, or with other South African studies on stroke rehabilitation and LOS in the private sector. It does also identify common predictors of LOS and factors which influence functional outcome found in other studies across the world despite differences in facility type, sampling criteria and study methodology.

Being able to predict LOS at the earliest stage possible stage (*i.e*. on admission) may be useful for rehabilitation facility administrators who need to manage bed occupancy, human and clinical resources. A sub-acute rehabilitation service that is tailored to meet the specific needs of South African stroke patients and is managed efficiently from admission to discharge is in the favour of all rehabilitation service providers, financial stakeholders and patients.

The demographic, clinical and functional profile of patients admitted to the facility is useful as it provides an overview of the type of patients that make use of private rehabilitation services in Gauteng, South Africa. It also gives an idea of their care needs. For instance, if more severely impaired patients with swallowing difficulty and speech impairments are admitted regularly, facilities may need to ensure that they are able to allocate enough beds to patients that need a longer LOS, ensure adequate numbers of speech therapists to manage a high case-load and ensure early screening to prevent the development of pneumonia.

This information in conjunction with the regression model's findings can also be useful in developing admission criteria for the facility and motivating for more comprehensive funding/ insurance coverage form medical aid schemes when needed. If patients with low admission FIM motor scores form a large proportion of the normal case-load, the facility may note poor gains with rehabilitation, long stays in order to make gains and a high number of these patients being discharged with moderate impairments. In response the facility may adapt the admission criteria to exclude patients with very low admission FIM motor scores in order to ensure that patients in the facility make full use of the rehabilitation services instead of blocking beds that could be used by patients with greater rehabilitation potential. They could also develop a slow-stream service for these patients that allows them more time with less intensive therapy which requires less resources, while these patients build up their tolerance for rehabilitation.

Low admission FIM motor scores on admission may be used to motivate for additional funding and longer LOS from medical aid schemes. The short-term increase in costs in the interest of long-term savings may provide motivation for improved coverage for stroke patients requiring rehabilitation in South Africa's private healthcare sector. High admission FIM motor scores may also be used as justification for shorter stays, earlier discharge and appropriate referral to out-patient therapy. All of which reduce the cost of care post-stroke.

The use of standardised outcome measures for the documentation of many of the clinical characteristics, co-morbidities and complication would have improved the reliability of the information documented and should be considered by rehabilitation facilities to improve record keeping.

The findings of the study by the researcher will be sent to the rehabilitation facility in which the study was done. The results of the study may be used within the facility as an educational resource for therapists and administrative staff. South African journals featuring articles on stroke and disability will also be approached for publication of the study findings, to make disseminate them to South African therapists/ individuals interested in stroke rehabilitation and LOS research.

6.3.2 For Further Research

The use of standardised outcome measures for recording clinical characteristics and clinical functions of patients may improve the quality and accuracy of the data obtained in future studies.

It may be useful for future studies to perform multiple regression analyses on cohorts of patients with stroke to more accurately determine specific predictors of LOS for patients admitted to rehabilitation facilities after a stroke. Some cohort level analyses were done when examining functional outcome and LOS, but required the application of non-parametric statistics as the distributions were not always normal in small groups. A larger sample is recommended for future studies in order to improve the statistical analysis and quality of the results.

The development of a regression model for the predictors of functional outcome was beyond the scope of this particular study, which aimed primarily to determine predictors of LOS. Future studies on functional outcomes in rehabilitation should include this level of assessment.

When considering functional outcomes, it would have been more useful to study patient outcomes at set times after the stroke as several non-medical factors may affect discharge date. Future studies may consider recording functional outcomes at set times post-stroke as well as at discharge. Future studies should also consider examining non-medical factors which influence LOS, *i.e.* placement in institutional care, payment systems used by patients and quantity/ quality of therapy received.

Stroke severity is a strong and reliable predictor of LOS but was not recorded at this facility. Future studies may consider assessing this variable in addition to FIM scores for greater accuracy.

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Appendix A- Self-Developed Data Extraction Tool

Demographic information		
Patient code		
Age		Number of years
Gender	□ Male □ Female	0 1
Marital status	□ Single □ Married/ living with a partner full time □ Widowed	0 1 2
Medical insurance	□ Uninsured □ Insured	0 1
Level of assistance at home prior to CVA	□ Independent □ Dependent	0 1
Vocation	□ Unemployed □ Employed □ Retired	0 1 2
Date of CVA		Day/month
Date of Admission		Day/month
Date of referral to rehabilitation		Day/month
Date of discharge		Day/month
Length of stay (LOS)		Number of days
Stroke type	□ Haemorrhage □ Ischaemic	0 1
Location of lesion	□ Left side □ Right side □ Bilateral	0 1 2
Clinical information		
Co-morbidities		0 (No condition) 1 (condition present)
□ Cardiac conditions		0/1
□ CABG		0/1
□ MI		0/1
□ AF		0/1
□ CCF		0/1

□ Valve replacement	0/1
□ Cardiomegaly	0/1
□ Pacemaker	0/1
□ Cardiac murmur	0/1
□ IHD	0/1
□ HIV status	0/1
□ Neoplastic condition	0/1
□ Hypertension	0/1
□ Hypercholesterolaemia	0/1
□ Diabetes Mellitus	0/1
□ Depression	0/1
□ Renal diseases	0/1
□ Nephrectomy	0/1
□ Renal failure	0/1
□ Respiratory condition	0/1

□ Emphysema	0/1
□ COPD	0/1
□ Asthma	0/1
□ Pneumonia	0/1
□ Bronchitis	0/1
□ SOB	0/1
□ Orthopaedic conditions	0/1
□ Spinal surgery	0/1
□ Joint replacements	0/1
□ Arthritis	0/1
□ Psychiatric condition	0/1
□ Prostate condition	0/1
□ Hysterectomy	0/1
□ Gastric condition	0/1
□ Thyroid condition	0/1
□ Visual impairment	0/1
□ Auditory impairment	0/1
□ Smoking	0/1
Complications	
□ Respiratory infections	0/1
□ Pneumonia	0/1

□ Urinary tract infections		0/1
□ Pressure sores		0/1
□ Constipation		0/1
□ Diarrhoea		0/1
□ Vomiting		0/1
□ Sepsis		0/1
□ Depression		0/1
Clinical Functions		
Respiratory support		0- None 1- Oxygen 2- Trachy 3- Ventilator
Unsafe swallow		0/1
Speech impairment		0/1
Aphasia		0/1
Apraxia		0/1
Dysarthria		0/1
Hemianopia		0/1
Hemi-neglect		0/1
Continence		0-Continent 1-Incontinent
Functional Information		
Admission scores		
Admission FIM-Total score		Numerical score
Admission FIM- Motor score		Numerical score
Admission FIM- Cognitive score		Numerical score
Discharge scores		
Discharge FIM-Total score		Numerical score
Discharge FIM- Motor score		Numerical score
Discharge FIM- Cognitive score		Numerical score
Change in FIM scores (admission to discharge)		Numerical score
Change in FIM total score		Numerical score
Change in FIM motor score		Numerical score
Change in FIM cognitive score		Numerical score

Appendix B- Ethical Approval

R14/49 Miss Thea Bijl

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M160936

NAME: (Principal Investigator)	Miss Thea Bijl
DEPARTMENT:	Physiotherapy [redacted] Rehabilitation Hospital [redacted]
PROJECT TITLE:	Predictors of Patient Length of Stay Post-Stroke in a Sub-Acute Rehabilitation Setting in Gauteng
DATE CONSIDERED:	30/09/2016
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Nicolette Comley-White and Witness Mudzi
APPROVED BY:	Professor P Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	06/02/2017

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 Research Office Secretary in Room 301, Third Floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. 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**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in September and will therefore be due in the month of September each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

08/10/2016

Principal Investigator Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix C- Permission from the Rehabilitation Facility

Approval number: UNIV-2016-0073

Ms Thea Bijl

E mail: bijlthea@gmail.com

Dear Ms Bijl

RE: PREDICTORS OF PATIENT LENGTH OF STAY, POST-STROKE, IN A SUB-ACUTE REHABILITATION SETTING IN GAUTENG

The above-mentioned research was reviewed by the Research Operations Committee's delegated members and it is with pleasure that we inform you that your application to conduct this research at private Hospital, has been approved, subject to the following:

i) Research may now commence with this FINAL APPROVAL from the Committee.

ii) All information regarding the Company will be treated as legally privileged and confidential.

iii) The Company's name will not be mentioned without written consent from the Committee.

iv) All legal requirements regarding patient / participant's rights and confidentiality will be complied with.

v) The research will be conducted in compliance with the GUIDELINES FOR GOOD PRACTICE IN THE CONDUCT OF CLINICAL TRIALS IN HUMAN PARTICIPANTS IN SOUTH AFRICA (2006)

vi) The Company must be furnished with a STATUS REPORT on the progress of the study at least annually on 30th September irrespective of the date of approval from the Committee as well as a FINAL REPORT with reference to intention to publish and probable journals for publication, on completion of the study.

vii) A copy of the research report will be provided to the Committee once it is finally approved by the relevant primary party or tertiary institution, or once complete or if discontinued for any reason whatsoever prior to the expected completion date.

viii) The Company has the right to implement any recommendations from the research.

ix) The Company reserves the right to withdraw the approval for research at any time during the process, should the research prove to be detrimental to the subjects/ Company or should the researcher not comply with the conditions of approval.

x) APPROVAL IS VALID FOR A PERIOD OF 36 MONTHS FROM DATE OF THIS LETTER OR COMPLETION OR DISCONTINUATION OF THE TRIAL, WHICHEVER IS THE FIRST.

We wish you success in your research.

Yours faithfully

Prof Dion du Plessis **06/12/2016**

Full member: Research Operations Committee & Medical Practitioner evaluating research applications as per Management and Governance Policy

Shannon Nell

Chairperson: Research Operations Committee

Date: 09/12/2016

This letter has been anonymised to ensure confidentiality in the research report. The original letter is available with author of research

Appendix D- The Functional Independence Measure

Subscale	**Category**	**Item**
Motor	Self-care	Eating
		Grooming
		Bathing
		Dressing upper body
		Dressing lower body
		Toileting
	Sphincter control	Bladder management
		Bowel management
	Transfers	Bed/chair/wheelchair
		Toilet
		Bath/shower
	Locomotion	Walk/wheelchair
		Stairs
Cognitive	Communication	Comprehension
		Expression
	Social cognition	Social interaction
		Problem solving
		Memory

(Ottenbacher, Hsu, Granger & Fiedler, 1996)

Appendix E- Turnit-In report

Thea Bijl Masters research project

ORIGINALITY REPORT

16%	12%	10%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.strokecenter.org.tw Internet Source	1%
2	Submitted to University of Witwatersrand Student Paper	1%
3	scholar.sun.ac.za Internet Source	1%
4	www.docstoc.com Internet Source	<1%
5	Handbook of Disease Burdens and Quality of Life Measures, 2010. Publication	<1%
6	espace.library.uq.edu.au Internet Source	<1%
7	"Abstracts for the 10th World Stroke Congress, 2016", International Journal of Stroke, 2016 Publication	<1%
8	www.ebrsr.com Internet Source	<1%