THE EFFECT OF INSTRUMENTAL ACTIVITIES OF DAILY LIVING AND DEPRESSIVE SYMPTOMS ON DISCHARGE DESTINATION FOLLOWING STROKE REHABILITATION

by

Sahar S. Abdulaziz

Bachelor of Science, Physical Therapy, King Saud University, 2009

Masters of Science, Physical Therapy, University of Pittsburgh, 2012

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This dissertation was presented

by

Sahar S. Abdulaziz

It was defended on

August 14, 2017

and approved by

Nancy C. Landgraff, DPT, PhD, Professor, Department of Physical Therapy, Youngstown State University

Gregory F. Marchetti, PT, PhD, Associate Professor, Department of Physical Therapy, Duquesne University

Elizabeth R. Skidmore, PhD, OTR/L, Professor, Occupational Therapy, University of Pittsburgh

Patrick J. Sparto, PT, PhD, Associate Professor, Department of Physical Therapy, University of Pittsburgh

Dissertation Advisor: Susan L. Whitney, DPT, PhD, Professor, Department of Physical Therapy, University of Pittsburgh

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Sahar S. Abdulaziz, PhD

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Purpose: Accurate prediction of discharge destination following stroke rehabilitation is important in facilitating optimal services, guiding discharge planning and minimizing costs associated with stroke rehabilitation. Therefore, the aims of this dissertation were to evaluate the predictive validity of the Lawton Instrumental Activities of Daily Living scale in predicting discharge destination after stroke rehabilitation and determine if depressive symptoms measured at admission and changes in depressive symptoms during rehabilitation have an impact on discharge destination for patients admitted to inpatient rehabilitation facilities.

Subjects: Of 364 subjects, 210 (58%) had complete data on discharge destination and were eligible for study inclusion. Twenty-three subjects were excluded because they were discharged back to acute hospital settings. Analysis was based on 187 subjects.

Methods: Retrospective data obtained from charts of persons who had been admitted to rehabilitation between 2004 and 2010 were analyzed. Variables collected at admission included patients' demographic data, clinical characteristics and functional status, including our variables of interest (the Lawton scale and depressive symptoms). Discharge destination was dichotomized as discharge to the community versus an institutional setting.

Results: Univariate analyses showed that patients with a better functional status on admission in both basic and instrumental activities of daily living (ADL) were less likely to be discharged to institutional settings and that patients with possible depressive symptoms on admission were more often discharged to an institutional setting rather than to the community. Moreover, discharge to an institutional setting was associated with a longer rehabilitation stay, increased stroke severity and higher cognitive impairment at admission. However, neither the impairment of IADL functioning nor the presence of depressive symptoms at admission were significant in the multivariate model. Only basic ADL functioning and stroke severity were significantly associated with a higher risk of institutionalization.

Conclusion: Instrumental ADL functioning as measured by the Lawton scale and depressive symptoms assessed on admission to rehabilitation were predictive of discharge from rehabilitation to an institutional setting, but not after accounting for basic ADL functioning.

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PREFACE

In the name of Allah, the Most Gracious and the Most Merciful

First and foremost, all praises to Allah, the almighty, for giving me the patience, inspiration, and ability to work hard successfully. Without his blessings and mercy, I would not have been able to finish this work.

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1.0 INTRODUCTION

Stroke is the leading cause of disability in the United States, with an estimated 795,000 people experiencing a new or recurrent stroke every year.[2] Approximately 25% to 74% of stroke survivors will require some assistance or are fully dependent on family members for activities of daily living.[3] Therefore, many require rehabilitation services to limit their degree of disability and improve their functional independence at home. Since the aging population is increasing, more health resources will be needed to care for persons post stroke in the future.[4] Thus, careful planning is necessary in terms of optimizing health care services and minimizing the costs of health care.[4]

Early identification of persons post stroke who will require extended inpatient rehabilitation compared to those who can be safely discharged home is necessary for the efficient utilization of rehabilitation services. Therefore, an important aspect of stroke rehabilitation is using appropriate tests and measures that can accurately determine the most suitable discharge setting for a given patient. Accurately predicting the discharge destination could enhance optimal treatment strategy by planning individualized goals and utilizing appropriate therapeutic interventions.[5] Patients' admission information may be useful early in the rehabilitation process to determine which patients will require institutional care and which ones will return home independently.

There are several studies that have looked at clinical data at admission, including patients' demographic information and functional abilities and the association between these and discharge destination after stroke rehabilitation.[5-8] In the stroke outcome literature, several predictors have been identified with discharge destination, such as age, gender, marital status, lesion side and type, social support, admission and discharge functional status.[7] However, the results of these particular studies yielded inconsistent findings on how these factors can be used to predict discharge destination for stroke patients.[7] For example, several studies have found that age was a significant predictor of discharge destination,[9, 10] but other studies found no such association.[11] In addition, most of these studies were examined in acute care hospitals, whereas we are interested in the population in the inpatient rehabilitation setting.

Therefore, the focus of this dissertation project was to conduct a retrospective chart review provided by the Steward Health System in Youngstown to analyze a wide range of key variables known at inpatient admission for rehabilitation, such as demographic factors (e.g., age, gender, race and marital status) clinical factors (e.g., stroke type and severity, comorbidities and risk factors) and functional outcome measures (e.g. cognitive, basic and instrumental activities of daily living and psychological status) to identify variables that predict discharge destination at rehabilitation discharge. Specifically, this research study examined the predictive ability of the Lawton Instrumental Activities of Daily Living scale and determined which items were most important in predicting discharge destinations for persons post stroke. Additionally, this study aimed to obtain a detailed look at the patients' depressive status at admission, and determined in particular whether depression on admission or changes in depression during rehabilitation have an impact on discharge destination.

1.1 STATEMENT OF THE PROBLEM

Despite the fact that there has been a decline in stroke-related death rates and that stroke has moved from the third to the fourth leading cause of death over the past decade, stroke remains one of the leading causes of disability and death in the United States.[12] Among the population of people post stroke discharged from the hospital, approximately 45% return directly home, 32% use home health-care services, 24% are discharged to inpatient rehabilitation facilities and 31% require institutional care.[13] Ideally, individuals after stroke would receive rehabilitation services to enhance the recovery process and minimize functional disability. However, stroke rehabilitation is time consuming and costly, with an estimated combined direct and indirect cost of $36.5 billion in 2010.[2] Therefore, the early identification of persons post stroke who could receive the maximum benefit from rehabilitation, such as those who have the ability to return home, may promote the most efficient use of rehabilitation resources.

Functional status at admission to rehabilitation has consistently been shown to be an important predictor of discharge destination.[14] This relationship has been shown with the Functional Independence Measure (FIM) and the Barthel Index.[14-16] Studies have shown that patients with higher FIM scores upon admission are more likely to be discharged to the community.[17] Furthermore, other studies have examined the specific items of the FIM and attempted to correlate the FIM sub-scores with discharge destination.[18] Mauthe et al. (1996) identified six items from the FIM including bathing, bowel control, toileting, social interaction, dressing the lower body and eating as the most predictive items.[18] In addition to these known measures of activity limitations, the Lawton Instrumental Activities of Daily Living (Lawton's IADL) scale is a self-report measure that assesses complex activities of daily living (ADLs) scale.[19]

Measures of instrumental activities of daily living that involve more complex activities related to domestic and community participation have received growing attention in the stroke outcome research. The Lawton scale may be a significant predictor of discharge destination from the rehabilitation hospital setting, but it has not been researched for that purpose. Therefore, the purpose of this study was to analyze the total score and sub-items of the Lawton's IADL scale and to determine which items were most important in predicting discharge destinations for persons post stroke.

Furthermore, several factors have been associated with recovery after stroke, such as initial disability, type and location of the lesion, prior functional status, social support and access to rehabilitation services.[20, 21] Depression also has been found to have a strong effect on recovery from a stroke.[22] Depression is very common after stroke, occurring in about one-third of all stroke survivors at some time after the onset of the stroke.[23] Studies have shown that depression has an adverse impact on the outcome of rehabilitation.[22] However, most of these studies have analyzed the relationship of depression and length of stay in the rehabilitation setting. [24, 25] Little is known about the impact of depression on other stroke outcomes such as discharge destination and quality of life. One study examined the impact of prior depression at the time of hospital admission on length of hospital stay and discharge destination.[26] They found that patients who were depressed at admission were more likely to be discharged to institutional care rather than to home after acute stroke hospitalization.[26] However, no studies have assessed the impact of post-stroke depression on predicting discharge destinations for persons post stroke within the inpatient rehabilitation setting.

Therefore, the secondary purpose of this study was to examine the impact of depression as assessed by the Geriatric Depression Scale (GDS)[27] of persons post-stroke who are in a rehabilitation setting on the discharge destinations. We also wanted to identify whether changes in depressive symptoms during rehabilitation have an impact on discharge destinations.

1.2 SPECIFIC AIMS

1.2.1 Aim one

To evaluate the predictive validity of the Lawton Instrumental Activities of Daily Living scale in determining the discharge destination after stroke rehabilitation and to identify whether a subset of items at admission could predict discharge destination.

Hypothesis 1: Patients with high total Lawton IADL score at admission were less likely to be discharged to an institution than the community.

Hypothesis 2: Specific items on the Lawton scale (such as telephone use, ability for taking medication and ability to handle finance) would be identified as better predictors of discharge to institutional settings than the total score.

1.2.2 Aim two

To examine the impact of depressive symptoms on discharge destination among persons post stroke in rehabilitation settings and to identify whether changes in depressive symptoms during rehabilitation have an impact on discharge destination.

Hypothesis 1: Patients with a high level of depressive symptoms at the time of admission (GDS> 5) were more likely to be discharged to an institution than the community.

Hypothesis 2: Patients who were depressed at the time of admission and showed improvements in depressive symptoms at the time of discharge from the rehabilitation hospital were more likely to be discharged to the community, while patients with persistent or worsening depressive symptoms at discharge from the rehabilitation hospital were more likely to be discharged to an institution.

2.0 BACKGROUND

For the purpose of this project, the following sections will first provide an overview of the epidemiology of stroke, describe the blood supply to the brain, and discuss the major mechanisms of stroke pathophysiology and the common clinical consequences of stroke. Then, an overview of stroke care and rehabilitation will provide a detailed look at the common assessment tools used in the stroke population, focusing particularly on activity and functional measures. This will be followed by a brief background on Basic and Instrumental Activities of Daily Living scales. Finally, an overview will be provided on common predictors of discharge destinations in persons post stroke after rehabilitation, highlighting the association of functional status and depression with discharge destination.

2.1 INTRODUCTION TO STROKE

Stroke is recognized as being a serious and disabling global health problem. It is the second leading cause of death globally, responsible for 11.3% of total deaths worldwide.[28] According to the American Heart Association's 2015 Heart Disease and Stroke Statistics Update, "on average every 40 seconds, someone in the United States has a stroke, and every 4 minutes someone died of stroke."[28]

The incidence of stroke has been associated with older age, and approximately three-quarters of all strokes occur in persons over the age of 65 years.[29] The analysis of data from the Framingham Heart Study shows that women have a higher lifetime risk of stroke than men, given their longer life expectancy and the higher incidence of stroke at older ages.[30] The life time risk of stroke was 1 in 5 for women (20% to 21%) and 1 in 6 for men (14% to 17%) among those who were 55 to 75 years of age. [30] When compared to men of the same age, women have also been shown to have poorer outcomes after stroke in terms of mortality and disability.[31] According to data from the Northern Manhattan Study (NOMAS), Mexican Americans and African Americans have a higher incidence of stroke compared with non-Hispanic Whites.[32] Compared to the most recent study, the Greater Cincinnati/Northern Kentucky Stroke Study (GCNKSS), the incidence of stroke decreased in white people, but there were no changes in the incidence of ischemic or hemorrhagic stroke among blacks.[33] According to the American Heart Association statistics, there has been a decline in stroke mortality over the past few decades; it is estimated that from 2001 to 2011, the annual stroke death rate decreased 35.1% and the actual number of stroke deaths declined 21.2%.[28]

2.1.1 Cerebral blood flow

The brain derives its blood supply from the anterior circulation provided by the bilateral internal carotid arteries, and posterior circulation arises from the vertebral arteries.[34] The internal carotid artery (ICA) arises from the common carotid artery, which originates from the aorta or the brachiocephalic arteries.[34] This artery enters the cranial cavity through the carotid canal in the temporal bone, and along its course, it gives rise to a number of major branches including the ophthalmic artery, the superior hypophysial artery, the posterior communicating artery and the anterior choroidal artery.[1] This is the main blood supply to the anterior part of the brain, which divides into two terminal branches, the anterior and middle cerebral arteries.[34]

The anterior cerebral artery (ACA) runs on the medial surface of the cerebrum; thus, it supplies most of the medial aspects of the anterior surface of the cerebral hemisphere including the frontal and parietal lobes.[34] The middle cerebral artery (MCA) is the largest branch of the ICA, and it runs on the lateral surface of the cerebral hemisphere, supplying the lateral surface, frontal and temporal lobes and several portions of the parietal lobe.[34] These are the main cerebral arteries and the areas of the brain supplied by the anterior circulation. There are also small penetrating branches that arise from these main arteries that are also important in supplying the deep structures of the brain, such as the basal ganglia, thalamus and internal capsule.[34]

The posterior circulation of the brain, also known as the vertebrobasilar system, represents about 20% of the cerebral blood flow[35] and includes the vertebral arteries, which can be divided into extracranial and intracranial parts, the basilar artery and the posterior cerebral arteries and their branches.[36, 37] The vertebral arteries originate from the subclavian arteries and, occasionally, directly from the aortic arch. Each vertebral artery is divided into four segments: three are extracranial, and one is intracranial.[36] The first segment (V1) is from the origin which is the subclavian and ascends through the transverse foramen of the upper six cervical vertebrae C6 through C2. The second segment (V2) extends from the final cervical transverse foramen until exiting as the third segment (V3) behind the lateral mass of the atlas and heading toward the foramen magnum. The final segment (V4) is intracranial and begins as the artery pierces the dura and arachnoid mater and ascends into the cranial cavity, where it ends as it meets the opposite vertebral artery to form the single midline basilar artery.[36, 38]

Prior to union, the vertebral artery gives off the posterior inferior cerebellar artery (PICA), which is the largest branch of the vertebral artery. It supplies the lateral surface of the medulla oblongata, including the vestibular nuclei and the posterior inferior surface of the cerebellum.[39]

The basilar artery forms at the base of the skull by the union of the two vertebral arteries, and then courses along the anterior surface of the pons. The largest branches of the basilar artery are the anterior inferior cerebellar arteries (AICAs) and the superior cerebellar artery (SCAs). Afterward, the basilar artery ends by splitting into the two posterior cerebral arteries (PCAs), which connect to the internal carotid arteries of the anterior circulation via the posterior communicating arteries (Pcomms).[34] There are also smaller branches of these major arteries that provide blood supply to the brainstem; the Paramedian branches supply the right or left paramedian region of the pons. The short and long circumferential arteries are penetrating branches from large cerebellar arteries that supply the lateral portions of the brainstem.[34]

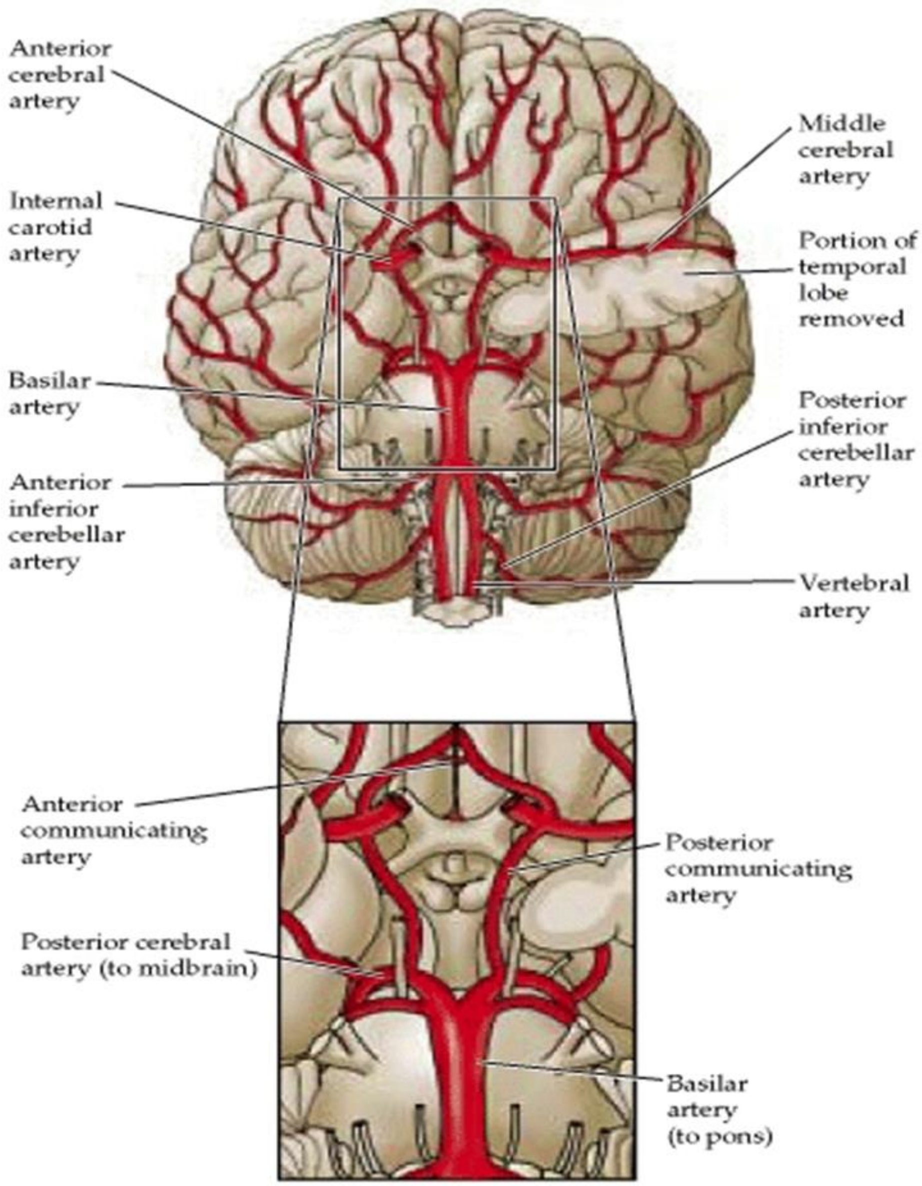

Figure 1. Ventral view of brain showing the major arteries and circle of Willis. [From Young PA, Young PH, Tolbert DL. Basic clinical neuroscience. Lippincott Williams & Wilkins; 2008, with permission][1]

2.1.2 Pathophysiology

Stroke can be classified into two major types: either ischemic, in which vascular occlusion and hypoperfusion occur, or hemorrhagic, which occurs due to the disruption of blood vessels and bleeding into the brain tissue or subarachnoid space.[40] About 87% of all strokes are due to ischemia,[12, 28] which commonly results from an atherosclerotic stenosis or the occlusion of the major cervicocerebral arteries, including the internal carotid artery, the middle cerebral artery, the vertebral artery and the basilar artery.[41, 42]

Ischemic stroke occurs most often due to the lack of blood supply to a region of the brain, resulting in the death of brain tissue or infarction if it lasts for long periods of time.[34] Ischemic stroke may result from large vessel stenosis, the occlusion of vertebral, basilar or carotid arteries, small vessel stenosis, penetrating artery disease, or cardiac-origin or artery-to-artery embolism.[43] The pathology of stenotic and occlusive cerebrovascular disease involves damage to the vessel wall, especially the endothelium of the intima. Following the intimal damage, blood platelets and certain substances, including cholesterol, lipids and phospholipids, aggregate inside the arterial wall and form a fibrous plaque (thrombus) that protrudes partially (stenosis) or completely (occlusion) into the lumen of the involved vessel.[44] The atherosclerotic plaque in these stenosed or occluded arteries may give rise to emboli that travel through the bloodstream and lodge in the distal arteries on the same side, resulting in ischemic stroke caused by embolism.[34, 44] Therefore, patients with arterial stenosis or occlusion are at a high risk for stroke due to decreased blood supply to a specific area of the brain distal to this blockage, which leads to cerebral infarction by two mechanisms—either embolic or hemodynamic compromise.

On the other hand, hemorrhagic stroke occurs when a blood vessel ruptures and bleeds into the brain tissue (intracerebral hemorrhage), which accounts for 10% of all strokes, [28] or when the hemorrhage occurs in the space between the brain and the skull (subarachnoid hemorrhage), which accounts for 3% of all strokes.[28] In both, normal brain metabolism is disrupted due to an increase in intracranial pressure, which compresses and injures brain tissue, or due to ischemic infarction of the brain, which frequently accompanies a subarachnoid hemorrhage, resulting from the reduced perfusion pressure and vasospasm. Symptoms are produced when the hematoma presses on nearby cranial nerves or brain tissue, which can cause a wide variety of neurological deficits depending on the location of the cerebrovascular injury.[40]

Research into atherosclerotic carotid artery disease has indicated that carotid artery stenosis accounts for 15–20% of strokes[45] and depends on the severity of stenosis. According to the North American Symptomatic Endartectomy Trial, the risk of stroke ranged up to 27% for those with 75–94% stenosis in symptomatic patients and up to 18.5% in asymptomatic patients.[46] However, recently, the Oxford Vascular Study Group found that among patients presenting with posterior circulation TIAs or minor stroke, about 26.2% had $\geq$ 50% vertebrobasilar stenosis compared with the 11.5% with $\geq$ 50% carotid stenosis in patients with carotid events.[47] Additionally, vertebral and basilar artery stenosis was more often associated with multiple ischemic events and a higher risk of early recurrent stroke, reaching up to 22.0% within the first 90 days after an index event.[47]

2.1.3 Clinical consequences of stroke

Stroke is typically an acquired brain injury that can lead to a wide variety of clinical signs and symptoms. Disability, which is complex and multidimensional in its determination, varies according to the severity and the site of the lesion, the types and degrees of functional limitations, and the personal and environmental factors.[48] Because of this, the role of rehabilitation professionals in maximizing function and quality of life on an individual basis is paramount.

From rehabilitation frameworks and disability model perspectives, the World Health Organization (WHO) uses the International Classification of Functioning (ICF) as an organizational framework and classification system that provides a standardized language for classifying health and functional status.[49] It views disability and functioning as complex interactions between the pathophysiologic processes related to the stroke and the contextual factors, such as personal and environmental resources.[49] As rehabilitation scientists, the ICF provided us with a shared viewpoint for understanding, discussing and researching disability.

As a result, the effect of different disorders or diseases such as stroke on a person's heath can be described into problems in the body structures and functions in terms of impairments such as hemiplegia, spasticity and aphasia. Stroke survivors also experienced activity limitations, that is, the reduced ability to perform basic and instrumental activities of daily living such as dressing, bathing or walking. Finally, stroke survivors encountered participation restrictions in areas of life such as transportation, employment or leisure activities.[50] Other factors that affect the level of functioning include personal (gender, comorbidities, intrinsic motivation and self-esteem) and environmental (natural and human-made environment, family support and healthcare resources) factors.[50]

The clinical manifestations of stroke will vary according to the site of the stroke lesion and whether the arterial territory affected is the cerebral hemispheres or the brainstem and cerebellum. Studies of cerebrovascular disease have shown that signs and symptoms resulting from the anterior circulation stroke are significantly different than those associated with posterior circulation stroke. In one study, data from a consecutive sample of 216 patients with posterior circulation stroke or TIA and 220 patients with anterior circulation stroke or TIA were analyzed. Symptoms, such as visual disturbance, unsteadiness and nausea or vomiting, presented more commonly in patients with posterior circulation stroke than in those with anterior circulation stroke.[51] The most frequent symptoms that presented with the anterior circulation stroke were focal sensory or motor deficit, agnosia, dysarthria and dysphasia.[51] Table 1 gives an overview of the clinical manifestations and possible affected areas associated with major stroke syndromes and presents different impaired body functions and activity limitations associated with these impaired structures.[34, 52]

According to the original Framingham cohort study among stroke survivors who were at least 65 years of age, 50% of them experienced residual hemiparesis, 30% were unable to walk without assistance, 26% needed assistance with activities of daily living, 19% were dysphasic, and 35% were clinically depressed at 6 months after stroke.[53] The impairments associated with stroke are important in defining individualized rehabilitation goals, as they are helpful in determining the expected discharge functioning, length of rehabilitation stay and discharge destinations.

Table 1. List of major stroke syndromes and possibly affected areas expressed in ICF terms.

Stroke Syndrome	Body Structures	Body Functions	Activities & Participation
Internal Carotid Artery	Supply the major arteries of the brain, including the MCA and ACA	Motor and movement-related functions Sensory function Visual and speech functions	Mobility Self-care General tasks and demands Communication Reading & writing
Anterior Cerebral Artery	Superior and medial aspects of the frontal and parietal lobes Parts of the basal ganglia and corpus callosum	Motor and movement-related functions Sensory function Visual and speech functions Cognitive function and emotions Bowel and bladder control	Moving around and walking Maintaining posture Communication Learning and applying knowledge Self-care
Middle Cerebral Artery	Lateral surfaces of the frontal, temporal and parietal lobes Inferior surface of part of the frontal and temporal lobes	Motor and movement-related functions Sensory function Speech function Perceptual function	Mobility and transfer Hand and arm use Speaking and conversation Domestic and community life
Posterior Cerebral Artery	Medial and inferior surfaces of the temporal and occipital lobes, thalamus and hypothalamus	Sensory and motor system Control of eye movement Regulate consciousness, mood, pleasure and pain Long-term memory, recognition of faces, recent memory Vision	Mobility and transfer General tasks and demands Focusing attention and solving problems Social and civic life
Vertebral Artery	Lateral medulla, most of the inferior surface of the cerebellum	Balance and vestibulo-ocular control Sensory function related to pain and temperature Regulate aspects of visceral function Motor planning for extremities	Changing and maintaining body position Lifting and carrying objects Self-care Moving around and using transportation

Table 1 (continued)

Basilar Artery	Anterior and lateral aspects of the pone Superior aspects of the cerebellum	Balance and vestibulo-ocular control Sensory function Distal limb coordination in the arms and legs Auditory function Equilibrium and eye movements Control body posture Limbs and trunk muscle control	Moving around in different locations Undertaking single or multiple tasks Communication Carrying out daily routine Community and social life

2.2 STROKE CARE AND REHABILITAION

Since stroke is a complex disease process, an interdisciplinary approach to stroke management that involves diverse professionals plays a central role in care coordination throughout the recovery process.[54] Stroke rehabilitation starts early during the acute hospitalization once the diagnosis of stroke is identified and medical stability has been achieved. The main goal during this stage is to prevent the recurrence of stroke, manage comorbidities and prevent complications.[55] The Agency for Healthcare Policy and Research Guidelines for Post-Stroke Rehabilitation (AHCPR, 1995) defined the acute stage as the period of time immediately following the onset of an acute stroke.[56] The post-acute stage is defined as the period of time immediately after discharge from acute care. During this stage, rehabilitation services can be conducted either in inpatient rehabilitation hospitals or rehabilitation units in acute care hospitals for patients needing intensive and interdisciplinary rehabilitation programs, in skilled nursing facilities for patients requiring medical or nursing care, in patients' homes, or in outpatient facilities that are either freestanding or hospital-based.[55, 56] The most important goal during this stage is to help stroke survivors become as independent as possible, focusing on the management of any residual deficits and compensation for residual impairment.

2.2.1 Assessment of persons after stroke

A comprehensive assessment of all aspects of a stroke is essential to enhance patient care and to identify the appropriate strategy for clinical management.[55] Clinical rehabilitation guidelines recommend the use of standardized and valid screening tools in evaluating stroke patients. Monitoring a patient's status through the use of standardized and appropriate outcome measures will help clinicians to quantify observations of the patient's stroke-related impairments and functional status, as well as to evaluate the patient's progress over time.[55] Furthermore, the use of a standardized assessment in stroke rehabilitation is becoming the foundation for predicting patient outcomes in clinical rehabilitation.[57] Bland et al. found that standardized assessment scores from the initial acute care evaluation as well as demographic variables are guiding rehabilitation in clinical practice and contributing to discharge recommendations for post-stroke rehabilitation services.[57] Table 2 includes a list of common outcome measures recommended by the StrokeEDGE and AHCPR guidelines for stroke patient assessment.[56, 58]

Outcome measures at the level of activity and participation are important for assisting rehabilitation clinicians to determine whether the selected intervention is appropriate and effective in making important changes in the daily lives of stroke survivors.[59] In response to the AHCPR Post-Stroke Rehabilitation Guidelines, which recommends the use of reliable and valid outcome measures for stroke patient assessments, Duncan et al. (1999) developed the comprehensive assessment toolbox for clinical and research use with stroke patients.[60] This toolbox was designed to provide comprehensive information about a patient's demographic information, current and prior functional status, disability and quality of life over the course of rehabilitation.[60] Furthermore, Landgraff et al. examined the implementation of this toolbox within a rehabilitation hospital as part of the development of a stroke center of excellence at the hospital.[61] They found that using the toolbox helped clinicians to determine patient prognosis and to make decisions about their patients in terms of selecting appropriate interventions and determining who will need additional rehabilitation services.[61]

Table 2. Examples of assessment tools that can be used with stroke survivors.

Domain	Outcome Measure	Practice Setting	ICF Category
Stroke severity	NIH Stroke Scale[62] Orpington Prognostic Scale[63]	Across all settings Acute & inpatient rehabilitation	Body structure/ function Activity
Global disability scale	Modified Rankin Scale[64]	Across all settings	Activity
Motor assessment	Fugl-Meyer Assessment of Motor Performance[65] Chedoke-McMaster Stroke Assessment[66] Rivermead Motor Assessment[67] Stroke Rehabilitation Assessment of Movement (STREAM)[68]	Across all settings	Body structure/ function Activity Body structure/ function Activity
Endurance	6 Minute Walk Test[69] 10 Meter Walk Test[70]	Across all settings	Body structure/ function & Activity Activity
Upper extremity function	Action Research Arm Test[71] Motor Activity Log[72]	Across all settings Not acute	Body structure/ function & Activity Activity

Table 2 (continued)

Balance	Berg Balance Scale[73] Dynamic Gait Index[74] Timed Up and Go[75] Functional Reach Test[76] Postural Assessment Scale for Stroke Patients[77]	Across all settings	Activity Activity Activity Body structure/ function & Activity Body structure/ function
Activities of daily living (ADL)	Barthel Index[78] Functional Independence Measure[79]	Inpatient rehabilitation	Activity
Instrumental activities of daily living (IADL)	Frenchay Activities Index[80] Philadelphia Geriatric Center (PGC) Instrumental Activities of Daily Living[81]	Inpatient rehabilitation	Activity
Cognitive assessment	Mini-Mental State Examination[82] Montreal Cognitive Assessment[83] Neuropsychological Testing[84]	Inpatient/outpatient rehabilitation	Body structure/ function
Depression	Beck Depression Inventory[85] The Patient Health Questionnaire 9-Item Depression Scale[86] Geriatric Depression Scale[27]	Inpatient/outpatient rehabilitation	Body structure / function & contextual factors
Quality of life	Stroke Impact Scale[87] Short Form Health Survey-36[88]	Not in acute or inpatient settings	Participation

2.2.2 Assessment of activity and functional status

As stroke represents the leading cause of adult disability,[2] an important aspect in any clinical practice of stroke rehabilitation, as well as in any research on stroke recovery, is functional recovery and assessments of functional status. Hence, functional assessments can objectively quantify impairments, activity limitations and participation restriction.[89] The information obtained from functional assessments can be used to assist rehabilitation clinicians to communicate and develop a common language between practitioners, to track change over time and determine patient prognosis, and in their clinical decision-making as they develop treatment plans and determine the need for additional services.[90]

Rubenstein et al. (1989) described functional status as "the person's ability to perform ADL and fulfill social roles, at a specific point in time." [91] Duncan et al. (2000) suggested that measures at the level of activities are the most important functional status measure in acute stroke rehabilitation because they are relatively objective, simple and relevant to the patient.[92] However, there is an ambiguity in what and how to measure when assessing functional status.[93] One common approach is to assess independence in performing functional activities, particularly in the individual's ability to perform daily activities.[94] There are multiple assessment scales to measure functional independence in stroke survivors. Clinical practice guidelines recommend that standardized assessment tools should be used to assess functional status.[56, 95] Clinicians should assess the individual's ability to perform the activities of daily living using standardized and validated tools such as the Barthel Index (BI)[78] or the Functional Independence Measure (FIM),[79] which are the most commonly used measures of functional status.

2.2.3 Activities of daily living (ADL)

In their review of indexes of functional disability, Feinstein et al. (1986) indicated that the first-published disability index that included "assessment of everyday activities" was by Sheldon in 1935.[96, 97] However, the first-published use of the actual term "activities of daily living" was by Edith Buchwald in 1949.[98] Since then, many studies have examined the ADL concept, and many instruments have been developed to evaluate activities of daily living. Activities of daily living (ADL) are usually classified into the basic ADL that are performed in everyday life such as mobility, self-care, transfers and other activities that are necessary to be independent.[97] Instrumental ADL includes more complex activities that are necessary for community living such as shopping, driving and transportation.[97]

Although there is no single accepted definition of the ADL concept nor is there is any consensus on how to measure ADL performance or what activities should be included in ADL assessment,[93, 99] most of the research in the area of functional recovery and independent living in rehabilitation has focused on the basic activities of daily living.[100] However, a substantial literature has shown that functional measures that focus only on basic ADL show a ceiling effect, which means that these measures are too easy for patients who are functionally more independent.[101] This limitation of the basic ADL has been addressed by adding more complex activities to the set of basic ADL items.[19]

There are many instruments that have been developed to assess basic or personal care activities that focus on the individual's ability to live independently at home. The Barthel Index (BI) and the Katz ADL Index are among the earliest measures of ADL that assess the basic self-care activities. The Barthel Index is a widely-used measure that assesses ADL performance in 10 common activities related to personal care, including bathing, grooming, dressing, toileting and eating, as well as mobility activities, such as transfers and ambulation.[78] This measure has demonstrated excellent reliability and validity and adequate responsiveness to change in more acutely involved individuals.[102] However, the BI is limited by its low sensitivity, and a lack of comprehensiveness results from inherent ceiling and floor effects that make it less effective in chronic or highly independent patients.[102]

The Katz Index of independence in ADL was developed to measure physical functioning in elderly and chronically ill patients.[103] It evaluates independence in six activities including bathing, dressing, toileting, transferring, continence, and feeding.[103] Although it has been used for many years in different clinical settings, its psychometric proprieties have not been well documented.[94] In addition, the Katz ADL Index is not sensitive to change in patients with mild disability ; it is more appropriate for severely ill patients.[94, 104]

Since the 1980s, many instruments have changed their approach for assessing ADL performance and started to focus on what the person with the disability actually does (i.e., performance), rather than other measures (e.g., Barthel Index) that assess what the person is able to do. One example of these measures is the Functional Independence Measure (FIM), the predominant measure of the Uniform Data System for Medical Rehabilitation, which collects information about rehabilitation outcomes.[79] It is composed of 18 items that assess independence in six areas of functioning including self-care, sphincter control, transfers, locomotion, communication and social cognition.[79] It has been used commonly in inpatient rehabilitation to monitor patient progress, to predict rehabilitation outcomes and to provide data for program evaluation. However, it takes approximately 30 minutes to administer and score, which makes it less feasible in some stages of rehabilitation. It also requires training, which may limit its use in clinical practice.[105]

The second aspect of the functional assessment, which evaluates the individual's ability to perform more complex activities that are necessary for community living (i.e., IADL), has not been developed as extensively as the assessment for the basic activities of daily living.[106] However, the limitations of basic ADL have become increasingly apparent, as demonstrated by decreased sensitivity to losses of ADL function in patients with high levels of physical activities and large reported ceiling effects at later stages of stroke recovery.[101, 107] In contrast, instrumental ADL measures could be more sensitive to changes in functional status, as they assess activities demanding more complex abilities and interaction with the surrounding environment. Therefore, measures of IADL have received growing attention in stroke outcome research.[108]

2.2.4 Instrumental activities of daily living (IADL)

The phrase "instrumental activities of daily living" was coined in 1969 in the work of Lawton and Brody, who developed two scales: the Physical Self Maintenance Scale, which assesses life maintenance and self-care activities that correspond to the general ADL scale, followed by the instrumental activities of daily living (IADL) scale, which assesses the more complex levels of functioning that are necessary for community living. "Instrumental activities" refers to more complex activities that require problem-solving skills involving home-management skills such as cooking, housekeeping and laundry.[19] They are also influenced by environmental factors and personal interests, as they describe the tasks required for independent living in the community such as shopping, transportation, handling money and managing medications.[19]

In addition, instrumental activities are highly dependent on cognitive ability,[109, 110] in particular, executive functions which are a high-order cognitive process that enables an individual to independently perform complex activities that include planning, problem-solving, regulation, and feedback utilization.[111] As a result, a decline in executive function would have an effect on the individual ability in performing and completing complex activities such as managing a home and finances.[112] Several studies have demonstrated a relationship between executive dysfunction and functional impairments, and IADL limitations in both healthy population and clinical group.[113, 114] In fact, compared to other cognitive functions such as memory, language, visuospatial skills and psychomotor speed, executive functions have been shown to have a significant effect on functional impairment and IADL status.[115] Studies have also shown that there is a hierarchy structure of functional loss in which with mild cognitive decline there is a tendency for IADL to be lost whereas with a more severe cognitive impairment would primarily affect performance in basic ADL.[116, 117]

Many measures have been developed to record a patient's ability to perform complex activities in terms of IADL, and Lawton and Brody's scale (1969) is among the most commonly used instruments to assess independent living skills.[19] It was designed to help identify appropriate living environments for older persons.[19] It comprises the following items: use of the telephone, shopping, food preparation, housekeeping, handy-man work, laundry, mode of transportation, responsibility for own medications and ability to handle finances.[19] Responses to each item range from 1 "unable to perform," to 2 "requiring help," to 3 "independent." Thus, the total scores range from 9 (total dependency) to 27 (total independence). Lawton's IADL scale has adequate reliability and validity, with a high internal consistency reliability of 0.92 and an inter-rater reliability of 0.85.[19] It has moderate correlation with four scales that measure functional status including the physical classification scale, Mental Status Questionnaire, Behavior and Adjustment rating scale and the Physical Self-Maintenance scale, which ranged between 0.40 and 0.61.[19] Hokoishi et al. (2001) showed that the Lawton scale has good inter-rater reliability between personnel from different disciplines, and it obtained an interclass correlation coefficient (ICC) ranging from 0.90 to 0.94.[118] This assessment tool has been widely used in clinical and research settings as a valid and reliable measure to assess IADL and reflect the individual's ability to adapt independently to the environment.

A few studies have investigated the predictive ability of the Lawton scale in predicting dementia, and their findings range from no association to a strong correlation.[119, 120] In particular, studies have explored the predictive value of the short form of the IADL (including telephone use, mode of transportation, ability for taking medications and ability to handle finance), and found that these items are the best predictors of dementia for elderly patients.[121, 122] In addition, previous studies have demonstrated that functional measures, and especially IADL measures, are strong predictors of mortality and functional decline in elderly people. [123, 124] However, until now, no one has investigated the ability of Lawton's IADL to predict discharge destination after stroke rehabilitation. Therefore, the purpose of this project is to evaluate the ability of the total Lawton admission scores as well as the individual items to predict patient discharge sites.

One problem in assessing IADL performance is that there is no agreement as to which activities or items should be included in such a measure to be valid for clinical evaluation and outcome measurement. This could be because these activities are variably influenced by gender, culture, education and socioeconomic status (e.g., women performed the cooking and laundering tasks more often than men); or including specific items for certain cultures (such as assessing the ability to make a cup of tea for British people). In 1995, a literature review was carried out on IADL measures used to evaluate outcomes among stroke survivors. It showed that there was no consensus for a clear definition of IADL, nor was there agreement as to which items were most useful in assessing IADL in persons post stroke.[106] Table 3 presents a list of IADL measures that have been used among stroke survivors.

Table 3. A list of IADL measures that have been used in the stroke population.

Outcome Measure	Assessment Format	No. of Items	Domain	Comments
The Rivermead ADL Assessment[125]	Performance-based scale	15 items	Household domains	The first-published IADL measure that was directed specifically toward the stroke population.[106] Rarely used in clinical practice.
The Hamrin Activity Index[126]	Patient interview	22 items	Mental capacity; motor activity and ADL function	Designed to evaluate IADL before and one year after stroke.[106] Although it can be used by any health-care professional, it has not received widespread acceptance.[127]
Frenchay Activities Index[128]	Patient interview	15 items	Domestic tasks and leisure activities; Work and outdoor activities	Assesses a broad range of IADL. One of the clinically useful and recommended measures for use in stroke and elderly patients.[129] It has acceptable psychometric properties.[130]
The Nottingham Activity Index[131]	Self-reported scale	22 items	Mobility; Kitchen tasks; Domestic tasks and leisure activities	Widely used in Europe and other countries.[132] Developed to assess functional status in stroke patients after returning home.[132] Designed to be used as a postal assessment that can be helpful in reducing the burden of data collection in clinical studies.

2.3 DISCHARGE DESTINATIONS IN STROKE

Data from the American Heart Association's (AHA) Heart Disease and Stroke Statistics 2015 update indicated that the total direct cost of stroke is anticipated to increase from $71.55 billion to $184.13 billion by 2030.[133] In the United States, the average expense per patient for direct care was estimated at $28,253, ranging from $7309 to $146,149.[134] Furthermore, it is anticipated that there will be a 20.5% increase in the prevalence of stroke between 2012 and 2030,[133] which will increase the demand for stroke rehabilitation services and place a significant financial burden on families and society. Determining a patient's discharge location may facilitate optimal rehabilitation outcomes, guide appropriate functional goals and determine therapeutic interventions that can lead to a reduction in care costs associated with stroke rehabilitation and to better preparation for patients and their families for post-stoke treatment.[5] Therefore, it is important to determine a patient's discharge destination soon after admission to rehabilitation; however, there are various possible locations including discharge to home, a skilled nursing facility, or outpatient rehabilitation facilities.

2.3.1 Predictors of discharge destinations after rehabilitation

Several studies have examined factors that may have an influence on a patient's discharge destination after rehabilitation, and they have attempted to develop prognostic models that could help rehabilitation clinicians in predicting discharge locations for the stroke rehabilitation population.[7, 135-137] Common factors that have been identified as potential predictors of discharge destination include demographic factors (e.g., age, gender, race and marital status), clinical factors (e.g., functional status, comorbidities and stroke characteristics), social support, prior physical function, and prior living situation.[4, 5, 138]

However, the ability of these factors to predict the discharge destination has varied with the predictive model, the settings of studies (acute vs. sub-acute) and the inclusion/exclusion criteria of the subjects. For example, Pindeo et al. (2014) found that female sex, comorbidities and total functional dependence on admission as measured by the BI were associated with a high risk of institutionalization on discharge.[139] Massucci et al. (2006) found that the absence of bladder dysfunction, absence of dysphagia and living with a family member before the stroke were associated with home return.[136] Using a large stroke population that was admitted to inpatient rehabilitation hospitals throughout the United States, the authors have demonstrated that sex was not a predictive factor of discharge placement, whereas other factors, such as age, marital status and functional status as measured by the admission FIM were significant predictors of discharge placement after stroke rehabilitation.[5]

Available data indicate that there are conflicting findings regarding the influence of some of these factors, such as age, gender, race, lesion site and stroke type, on the discharge destination of a patient.[140] Possible explanations could be small sample size, single center study, retrospective design and incomplete data set which may limit the generalizability of these studies.[141] Several studies have shown that age is an important predictor of discharge destination following stroke rehabilitation, in which a younger age has been associated with discharge to home.[5, 135, 136, 141, 142] However, there have also been reports that age was not a significant factor for discharge destination.[143, 144]

There are other factors that have been consistently shown as important predictors of discharge destination such as functional status, cognitive dysfunction, prior living situations and social supports including marital status and caregiver availability.[7, 135, 137] Nguyen et al. (2015) concluded that stroke patients who are older, separated or divorced and cognitively impaired have a higher likelihood of being discharged from acute inpatient rehabilitation to a skilled nursing facility.[137] Furthermore, several studies have emphasized the importance of screening for cognitive impairments after stroke, as they may influence outcomes at discharge, such that patients with low or minimal cognitive impairments were discharged home more often than patients with severe cognitive impairments.[136, 145] Tanwir et al. (2014) found that patients who live with family members (e.g., spouse or partner) were discharged home more often than patients without a caregiver ($OR=4.07$; $CI=2.05–8.06$; $p<0.01$).[146] Similar findings were also reported by Frank et al. (2010), who indicated that the presence of a living partner was the most important determinant of being discharged to home after stroke.[138]

Despite the fact that several studies have confirmed the importance of functional status and indicated that it is the most important predictor of discharge destination, functional status in terms of instrumental ADLs and their role in determining post-rehabilitation discharge placement have not been studied extensively. In addition, psychiatric symptoms such as anxiety and depression may affect the patient’s functional status and the process of rehabilitation and, therefore, the discharge destination. However, little is known about the effect of depression on discharge destination following inpatient rehabilitation. Therefore, the aim of the present study is to evaluate the predictive ability of the instrumental ADL as well as depression in predicting discharge destination in stroke patients following inpatient rehabilitation.

Table 4. A list of common factors influencing discharge destination after a stroke inpatient rehabilitation.

Factor	Study	Results
Age	Pohl et al.[5]	Older age → discharge to an institution
	Massucci et al.[136]	Younger age → related to home discharge
	Pereira et al.[135]	Younger age → higher odds of being discharged home
	Nguyen et al.[137]	Older age → less likely discharge to home
Sex	Pohl et al.[5]	Sex → not a significant predictor
	Pindeo et al.[139]	Female sex → more likely discharge to institutional facility
Marital status	Pohl et al.[5]	Married → related to home discharge
	Nguyen et al.[137]	Separated/divorced → less likely discharge to home
Insurance	Nguyen et al.[137]	Medicare insurance → less likely discharge to home
Functional status	Pohl et al.[5]	Lower FIM score < 60 at admission → less likely to return home
	Pereira et al.[135]	Higher FIM score at admission → increased odds of returning home
	Nguyen et al.[137]	Higher motor FIM score → increased odds of being discharged home
	Frank et al.[138]	Independent sitting balance on admission → more likely discharge home
	Wee et al.[147]	Higher BBS score at admission → more likely discharge home
	Brown et al.[148]	Higher FIM score at admission → more likely discharge home
	Pindeo et al.[139]	Higher BI score at admission → more likely discharge home
	Brauer et al.[141]	Gait and rolling items of the MAS at admission → highly predictive of discharge from rehabilitation to home.

Table 4 (continued)

Cognition	Massucci et al.[136] Nguyen et al.[137]	Higher MMSE score → related to home discharge Cognitive deficits → less likely discharge to home
Living situation	Massucci et al.[136] Pereira et al.[135] Frank et al.[138] Wee et al.[147] Tanwir et al.[146]	Living alone prior to admission→ more likely unable to return home Caregiver availability → more likely discharge home Presence of a living partner → more likely discharge to home Presence of family support → higher odds of being discharged home Presence of family member → more likely discharge home
Neurological impairments	Massucci et al.[136]	Dysphagia and bladder dysfunction → less likely discharge to home

*FIM= Functional Independence Measure, BBS = Berg Balance Scale, MAS= Motor Assessment Scale, BI= Barthel Index, MMSE= Mini-Mental State Examination

2.3.2 Functional status and discharge destination

Functional status measures have been used to assess outcomes in patients undergoing rehabilitation. Several studies have examined the predictive validity of these measures in determining the discharge destination after rehabilitation. Although there are several factors that have been reported to be significant predictors of discharge destination in patients with stroke patients undergoing rehabilitation, functional ability on admission to rehabilitation has consistently been shown to be useful in predicting discharge destination for stroke survivors.[141]

The most commonly used measures are the Functional Independence Measure and the Barthel Index. Previous studies have shown that there is a correlation between admission or discharge FIM scores with the discharge destination following inpatient rehabilitation.[14, 149, 150] It has been estimated that individuals with high admission or discharge FIM scores of 80 or greater are 90% more likely to return home, whereas those with scores lower than 40 are 70% more likely to be discharged to an institutional facility.[151] This is comparable to other studies that have reported a score of 80 at discharge of being a target value associated with returning home after stroke rehabilitation.[17, 149] In addition to these popular and well-known measures, Tinl et al. (2014) assessed the predicative ability of the Mobility Scale for Acute Stroke (MSAS) and found that this scale could be useful and accurate in determining discharge destination after acute stroke.[152] Chang et al. (2014) examined the various domains of activity limitation using the Activity Measure for Post-Acute Care for their ability to predict discharge destination one month after hospitalization.[153] They found that basic mobility, including walking, climbing stairs, transferring and changing position had the greatest discriminate ability to differentiate between home versus non-home settings.[153]

In addition, other functional measures that assess specific functional areas have also been shown to predict the discharge destinations of stroke survivors, including the Motor Assessment Scale,[141, 154] the Berg Balance Scale,[147] the Cognitive Screening Test,[145] measures of gait ability[155] and trunk control.[156] Scott et al. (2010) investigated the ability of the Motor Assessment Scale (MAS) in predicting discharge destination and found that age and total MAS admission score could predict discharge destination with an overall accuracy of 76.2%.[154] Wee and Wong (2003) found that the admission score of the Berg Balance Scale and the presence of family support were independent predictors of being discharged to home rather than to an institution.[147] In addition, Di

Monaco et al. (2010) showed that both the Trunk Impairment Scale and the Postural Assessment Scale for Stroke Patients significantly predicted the destination of discharge from inpatient rehabilitation.[156]

However, there are limitations in using measures such as the FIM and BI, as they are only limited to basic activities of daily living and often lead to significant ceiling effects, in which most of the subjects show no difficulty or dependency in ADL tasks. Spector et al. indicated that limitations in instrumental activities of daily living were more sensitive predictors of functional decline than basic ADL.[157] Furthermore, other measures are specific and focus only on one particular functional area, which fails to capture a broad range of an individual's activity limitations (e.g., motor function, balance function, cognitive function). In addition, in most of the existing literature that has examined the predictive ability of these measures in determining discharge destination have been applied in the acute care setting, whereas there is little information demonstrating the influence of these functional measures in predicting the destination of discharge from the inpatient rehabilitation setting.

Furthermore, studies have shown that individual items of an outcome measure could be more significant predictors of discharge destination than the total scores. Granger et al. (1989) found that a subset of items in the Barthel Index, including bladder and bowel control plus eating and grooming showed a greater ability to predict discharge destination than the total score at 6 months post stroke.[158] Similar findings have been reported by Mauthe et al. (1996) on the functional independence measure (FIM), as they identified 6 items, including bathing, bowel control, toileting, social interaction, dressing lower body and eating as that most predictive of discharge destination from an acute care hospital for stroke patients.[18] In contrast, Jackson et al. (2013) found that at admission, 7 FIM items, including comprehension, expression, problem solving, memory, grooming, toileting and chair transfers differed from the results of the previous study and were predictive of discharge destination.[4] Ouellette et al. (2015) also identified specific items under the FIM at admission, including bed transfer, toilet transfer, bathing, bladder and memory as significant predictors of discharge destination for stroke patients.[150] Therefore, the purpose of this study was to conduct a detailed analysis of specific items under the Lawton IADL as it is possible that specific variables could be more significant predictors of discharge destination than the total Lawton score.

2.3.3 Depression and discharge destination

Depression after stroke is a very common phenomenon, affecting approximately 33% of all stroke survivors at some point after stroke onset, with the period of highest occurrence being the first months following stroke.[23] Robinson et al. (2003) found an overall prevalence of 35.5% among individuals in acute and rehabilitation settings.[159] Studies have shown that post-stroke depression is associated with multiple negative outcomes such as poor functional recovery,[160] an increase in mortality,[161] cognitive dysfunction,[162] increased stress on family members[163] and reduced quality of life.[164] As a result, individuals who develop depression after a stroke have greater use of health-care services than those who are not depressed. Nuyen et al. (2008) examined the impact of preexisting depression at the time of hospital admission on the use of health-care services and found that it is a relevant factor in determining discharge destination after acute care hospitalization.[26]

Furthermore, several studies have examined the relationship between post-stroke depression and length of stay, and their findings were controversial. A few studies have shown that patients with depression are more likely to stay longer at the hospital than those without depression.[165, 166] However, Gillen et al. (2001) found no such association between depression and length of stay for persons post stroke.[24] However, no study has examined the impact of post-stroke depression at the time of rehabilitation admission on discharge destinations after rehabilitation.

Studies throughout the literature have demonstrated that depression at the time of stroke is associated with an individual's functional ability and capacity to perform ADL, which will affect the recovery process and the success of rehabilitation.[160, 167] Nannetti et al. (2005) found that patients who were not depressed at admission to rehabilitation (within 2 weeks from the onset) had greater functional recovery at 3 months following the stroke onset compared to those patients with post-stroke depression.[168] The presence of depressive symptoms early after a stroke (within 2 weeks) has been shown to be associated with decreased functional independence in ADL within the first 6 months[169] and at long-term follow-ups 1and 2 years after the stroke.[170] In addition, studies have reported that post-stroke depression is associated with cognitive impairment and may have a negative impact on recovery.[171, 172] Nyes at al. (2005) demonstrated that depressive symptoms in the very early phase of stroke recovery are associated with specific cognitive impairments including visuoperceptual, memory and language impairments, and they also found that patients with worse depressive symptoms were 3 times more likely to have cognitive impairments than patients with mild or no depressive symptoms.[162]

Given that depression at admission has been associated with physical functional limitations, cognitive impairments and increased health-care utilization, depression may have a negative impact on the rehabilitation process, which may in turn require more special services and institutionalization of stroke survivors. Depression may thus contribute to the patient's discharge planning process. Therefore, the secondary aim of this study was to determine the impact of depressive symptoms on discharge destination among persons post stroke in a rehabilitation setting and to identify whether changes in depressive symptoms during rehabilitation have an impact on discharge destination. We hypothesize that patients who were depressed at admission to the rehabilitation hospital were more likely to be discharged to an institutional setting versus to their communities.

3.0 RESEARCH DESIGN AND METHODS

This was a retrospective research study that reviewed the comprehensive assessment toolbox charts of patients with strokes who were admitted to the Steward Health acute care hospitals and who were referred to the Hillside Rehabilitation Hospital (HRH) in Youngstown, OH, between 2004 and 2010. The comprehensive assessment toolbox for stroke was implemented across the medical system as a part of a stroke center of excellence.[61] It was developed as a response to the Agency for Health Care Policy and Research (AHCPR) recommendations for post-stroke rehabilitation, which suggested using valid and reliable measures for outcome assessments and emphasized the importance of using standardized assessment tools in evaluating persons post stoke. The toolbox was designed to provide information about a patient's demographic information, stroke characteristics, and functional outcome measures and discharge destinations. The Hillside Rehabilitation Hospital is a community health care provider designed to treat patients with disabling injuries or illnesses. A data set of patients' demographic and clinical information at admission was provided through a data use agreement approved by the University of Pittsburgh's Office of Research. In addition, the Institutional Review Board approved this study, and all data were handled according to HIPAA guidelines.

3.1 PATIENT INCLUSION/EXCLUSION CRITERIA

Patients who were 18 years of age and older at admission and were diagnosed with first or recurrent ischemic or hemorrhagic stroke were included. All patients who were administered the comprehensive assessment toolbox for stroke at admission were included. For patients with multiple admissions, only the first admission was included. Patients with data missing from the outcome variable of interest (discharge destination) were excluded from the analysis.

3.2 RESEARCH DESIGN

Prior to implementing the toolbox across the medical system, it was first presented and discussed with the medical staff and all professionals involved in its administration, including nurses and rehabilitation clinicians. In addition, special training on the appropriate use of assessment tools and proper documentation was provided to all staff members involved in patient assessment either through group sessions or individual meetings.[61] From January 2002 onward, the assessment toolbox was implemented and collected for all patients who were admitted to the Steward Health acute care hospitals and referred to the HRH. Patients were routinely assessed using the stroke toolbox within 72 hours of admission and at discharge by trained health-care professionals who recorded the data in paper format. Following the patient's discharge, the data were entered into the hospital's access database. The database included information about patients' demographic data, comorbidities, stroke characteristics, prior level of functioning, social support, cognition, depression, disability, functional status and discharge destination.

Data from 2002 to 2004 have been previously analyzed and published with the purpose of describing the implementation of the toolbox across the medical system and discussing the clinical interpretation of the collected data.[61] In our database, we are interested in the patient's functional status (instrumental ADL) and psychological status (depression), as well as the ability of these data to predict discharge destinations following rehabilitation.

3.3 VARIABLES OF INTEREST

In the assessment toolbox database, there are several variables that can be used as potential predictors of discharge destination, including sociodemographic and clinical factors. These variables were extracted from the dataset and tested in order to adjust for possible confounders and to identify the most important factors affecting discharge destination after inpatient stroke rehabilitation. The selection of these variables was based on the literature and on the availability of the data in the study dataset.

The following data were included in the dataset: demographic information (age, sex, race and marital status), risk factors (history of previous stroke, smoking, diabetes mellitus, high cholesterol, alcoholism, high blood pressure, atrial fibrillation), stroke characteristics (number of days from stroke onset to rehabilitation, type of stoke [i.e. ischemic, hemorrhagic or other], lesion site and stroke severity as measured by the Orpington Prognostic Scale[63]), comorbidities as measured by the Charlson Comorbidity Index[173], social support (living with someone or alone), prior functional status as measured by the Barthel Index,[78] limitations in physical activities as measured by question 3 of the short form-36 which is a generic health survey that is often used as a measure of health related quality of life,[88] neurological impairments as measured by the National

Institute of Health Stroke Scale (NIHSS),[62] and length of stay at the rehabilitation hospital. Additional data included individually scored items on the Lawton scale and total admission scores on each of the following measures: Mini-Mental Status Examination,[82] Geriatric Depression Score,[27] Barthel Index,[78] Lawton Index[19] and Rankin Scale.[174]

The outcome (dependent) variable is discharge destination. The comprehensive assessment toolbox includes five options for discharge setting including home (independent), home (with assistance), acute hospital, sub-acute rehabilitation program, and long-term nursing home. For this study, discharge setting was divided into 2 groups: community versus institutional settings.

3.4 OUTCOME MEASURES

The outcome measures included in the toolbox were selected because they were recommended by the Agency for Health Care Policy and Research (AHCPR) Panel's post-stroke rehabilitation guidelines (1995),[56] which include the following:

The Orpington Prognostic Score (OPS) is an assessment tool for stroke severity that has been modified from the Edinburgh Prognostic Score, to which a cognitive impairment has been added.[63] The OPS scores patients on motor deficit (arm), proprioception, balance and cognition. The total score ranges between 1.6 and 6.8, with higher scores indicating greater deficit. Stroke severity are categorized as minor (<3.2), moderate (3.2–5.2) or severe (>5.2).[63] The OPS has been shown to be a reliable measure with an excellent test-retest reliability (ICC = 0.95)[175] and an excellent concurrent validity with NIHSS, in addition to showing an excellent predictive capacity with the Barthel Index at 3 and 6 months post stroke.[63, 176]

The National Institute of Health Stroke Scale (NIHSS) is the standard tool for quantifying stroke severity and is used as a quantitative measure of neurological deficit post stroke.[62] It consists of 15 items that assess the severity of impairment in consciousness, language, neglect, eye movements and deficits of the visual field, motor control, ataxia, dysarthria and sensory disorders.[62] The total score ranges from 0 to 42, with higher scores indicating greater severity. Brott et al. (1989) originally recommended the following cutoff scores for stroke severity: 1–5 is considered mild, 5–14 is considered mild to moderately severe, 15–24 is considered severe, and greater than 25 is considered very severe.[62]

The Mini-Mental State Examination (MMSE) is a brief screening tool that was developed to provide a quantitative assessment of cognitive impairment and to record cognitive changes over time.[82] It consists of 11 tasks that evaluate 7 domains including orientation to time, orientation to place, registration of three words, attention and calculation, recall of three words, language and visual construction.[82] It has a total score of 30 with a cut-off score of 23 or less, indicating the presence of cognitive impairment.[177] It has excellent test-retest reliability (r=.998) and moderate to strong relationships with other IQ tests (r=.66-.77).[82]

The Geriatric Depression Score (GDS) is a self-reported screening measure that assesses depressive symptoms in older adults.[27] The original 30 items have been reduced to 15 for older adults who have short attention spans and feel easily fatigued.[178] Scores range from 0 to 15, with a score of >5 indicating depression and a score of >10 being strongly suggestive of depression. The reliability of the GDS has been established in subjects from a variety of populations and has been shown to demonstrate adequate internal consistency (Cronbach alpha ranging from 0.74–0.86)[179] and excellent test-retest reliability (r=.75).[180] In addition, high correlations ranging from 0.58 to 0.89 have been found between the GDS and other depression measures.[181]

The Barthel Index (BI) is the most widely used measure to assess the functional performance of ADL.[78] It consists of 10 items that measure a person's level of functional independence in basic ADL (feeding, bathing, grooming, dressing, bowel control, bladder control, toileting, chair transfer, ambulation and stair climbing).[78] The total score ranges from 0 to 100; the higher the score, the greater the degree of functional independence.[78] It has been shown to have good reliability, validity and responsiveness among stroke patients.[182]

Lawton's Instrumental Activities of Daily Living (Lawton's IADL) is a self-reported measure that assesses ADLs.[19] It measures independent living skills in the following domains: telephone use, shopping, food preparation, housekeeping, laundry, transportation, medication and financial management.[19] Responses to each of the items range from "independence in performing the activity" to "partially able to perform the activity" to "not able to perform the activity at all." The total maximum score is 27; the higher the score, the greater the person's ability.[183] The inter-rater reliability of the Lawton scale has been established at .85,[184] and scores were well correlated and demonstrated concurrency and validity when compared to other functional status measures.[184]

The Rankin Scale is a commonly used measure that is used to assign a global rating of stroke disability.[174] In the original Rankin Scale, a score of 1 indicates no significant disability, and 5 is the most severe level of disability.[174] The modified Rankin Scale is a 6-point ordinal scale ranging from 0 (no symptoms at all) to 5 (severe disability).[185] The Rankin Scale has been found to be reliable when applied to strokes (kappa = 0.95), but the inter-rater reliability is less reliable (kappa w = 0.75).[186]

3.5 DATA ANALYSIS

Descriptive statistics were calculated for all variables, including demographic data and clinical variables, to describe the sample in relation to discharge destination. For continuous variables, the means and standard deviations (SD) were reported. For categorical variables, frequencies and percentages were presented. Statistical analysis was conducted using SPSS with a significance level of $p<0.05$. To identify potential predictors for discharge destination, a univariate analysis was used first in order to determine the relationships between the discharge destinations and each variable of the following domains: demographic data, clinical factors and outcome measures at admission. The independent samples t-test or nonparametric Mann-Whitney U tests were used for continuous or ordinal independent variables. The chi-square test, Fishers exact test or likelihood ratio tests were used for categorical comparisons as appropriate.

The dependent outcome variable was discharge destination (discharged to a community setting or to another institutional settings). Independent variables were grouped into three domains. First, demographic data included age (years), gender, race, health insurance (Medicare, Medicaid, private insurance and non-insured), marital status, social support (no support, full/partial support), length of inpatient rehabilitation stay (days), onset days (days from stroke onset to rehabilitation admission) and year of admission. For race/ethnicity, Hispanic and black or African American were collapsed into one category as "other races" due to the small sample size. For health insurance, the uninsured data were not displayed due to the small sample size. Second, clinical factors included: pre-stroke Barthel index score; pre-stroke Physical Functioning Subscale of the SF-36; comorbidities (low comorbidity was defined as CC1$\leq$ 2 and high comorbidity was defined as CCI $\geq$3); Prior stroke or transient ischemic attack (TIA); risk factors (such as smoking, diabetes mellitus, high cholesterol, alcoholism, high blood pressure, atrial fibrillation); type of stroke (i.e., ischemic or hemorrhagic/uncertain); stroke location; NIHSS score; and stroke severity measured by the OPS. Third, functional measures included the admission scores on each of the following measures: The Mini-Mental Status Examination, the Geriatric Depression Score, the Barthel Index, the Lawton Index and the Rankin Scale.

3.6 STATISTICAL ANALYSIS

A multivariate logistic regression model was used to analyze the data from the total Lawton score at admission and to calculate odds ratios and 95% confidence intervals (CIs) for the likelihood to be discharged to either a nursing home or acute hospital care relative to being discharged to a community setting. A principal component factor analysis (PCA) was used to categorize the individual Lawton items into subsets of items that explain the greatest amount of variation in the IADL performance. Suitability of the data for factor analysis was determined using the Kaiser-Meyer-Olkin Measure of Sampling Adequacy and the Bartlett's test of sphericity. Factor extraction was performed using a standard principle component analysis with a non-rotation method applied to ease interpretation of factor loadings. The criterion for factor loading was set at 0.30 and the individual factor scores were calculated using a regression approach. Calculated factor scores were then used in a multivariate logistic regression analysis to calculate the adjusted odds ratio of discharge to an institutional setting for each of the factors. The scores on each item of the Lawton scale were then tested for univariate association with discharge destination. Factors and item scores showing a significant univariate association with discharge destination were included in a multivariate regression model in the descending order of their PCA factor loading or univariate strength of association to identify the best subset of items associated with nursing home or acute care hospital discharge relative to home discharge.

Categorical and continuous measures of initial depressive status / change in status that demonstrate a univariate association with discharge destination at $p<.15$ were considered in a multivariate regression model in order to assess the relationship between the baseline depression status and change with adjustments for demographic data, comorbidities, social support and stroke characteristics, as determined previously. Categorical and continuous measures of initial depressive status /change in status were included separately, and models were compared using likelihood statistics with chi square analysis and the coefficients of determination to identify the best subset of variables associated with discharge destination. Odds ratios with 95% confidence intervals for measures of depression favoring institutional care placement relative to home discharge were estimated, and significance were determined at $p<.05$.

4.0 THE LAWTON SCALE AS A PREDICTOR OF DISCHARGE DESTINATION IN PATIENTS WITH STROKE UNDERGOING REHABILITATION

4.1 INTRODUCTION

Stroke represents one of the leading causes of disability in the United States, with an estimated 795,000 people experiencing a new or recurrent stroke every year.[2] Approximately 25% to 74% of stroke survivors will require some assistance or are fully dependent on family members for activities of daily living.[3] Therefore, many require rehabilitation services to limit their degree of disability and improve their functional independence at home. Approximately 60% of patients with acute stroke require post-acute care rehabilitation services after acute hospital discharge.[187] The most common type of setting for post-acute stroke rehabilitation in the United States is an inpatient rehabilitation facility that provides intensive rehabilitation care.[188] Following that, many patients (about 70%) are discharged home to receive either home-based or outpatient rehabilitation services.[189] Moreover, approximately 30% are either returned to an acute care hospital or referred to a sub-acute SNF rehabilitation program.[189]

Medicare's spending on post-acute care settings is large and growing. The total payment has increased from $29.3 billion in 2001 to $59.2 billion in 2014.[190] Data from the American Heart Association's (AHA) Heart Disease and Stroke Statistics 2015 update indicated that the total direct cost of stroke is anticipated to increase from $71.55 billion to $184.13 billion by 2030.[133] Determining a patient's discharge location may facilitate optimal rehabilitation outcomes, guide appropriate functional goals, determine therapeutic interventions that can lead to a reduction in care costs associated with stroke rehabilitation, and better prepare patients and their families for post-stroke treatment.[5]

Patients' admission information such as demographic and clinical factors may be useful early in the rehabilitation process to determine which patients will require institutional care and which ones will return home independently. Several studies have looked at clinical data at admission, including patients' demographic information and functional abilities and the association between these and discharge destination after stroke rehabilitation.[5-8] Common factors that have been identified as potential predictors of discharge destination include demographic factors (e.g., age, gender, race, and marital status), clinical factors (e.g., functional status, comorbidities, and stroke characteristics), social support, prior physical function, and prior living situation.[4, 5, 138] However, the results of these particular studies yielded inconsistent findings on how these factors can be used to predict discharge destination for stroke patients.[7, 11] In addition, most of these studies were conducted in acute care hospitals; very few studies examined the impact of these factors on discharge destination in an inpatient rehabilitation setting.

Of all these factors, functional status at admission to rehabilitation has consistently been shown to be an important predictor of discharge destination.[14] The most commonly used outcome measures are the Functional Independence Measure (FIM) and the Barthel Index (BI).[14-16] Studies have shown that patients with higher FIM scores upon admission are more likely to be discharged to the community.[17, 149, 151] It has been estimated that individuals with admission or discharge FIM scores of 80 or greater are 90% more likely to return home, whereas those with scores lower than 40 are 70% more likely to be discharged to an institutional facility.[151] In addition to these well-known instruments, Tinl et al. (2014) assessed the predictive ability of the Mobility Scale for Acute Stroke (MSAS) and found that this scale could be useful and accurate in determining discharge destination after acute stroke.[152] Chang et al. (2014) examined the various domains of activity limitation using the Activity Measure for Post-Acute Care for their ability to predict discharge destination one month after hospitalization.[153] They found that basic mobility, including walking, climbing stairs, and transferring and changing position had the greatest ability to differentiate between home versus non-home settings.[153]

In addition, other studies have examined the association between specific functional areas and discharge destination using instruments such as the Motor Assessment Scale,[141, 154] the Berg Balance Scale,[147] the Cognitive Screening Test,[145] and measures of gait ability[155] and trunk control.[156] However, limitations have been found in using measures such as the FIM and BI, as they are only limited to basic activities of daily living and often lead to significant ceiling effects, in which most of the subjects show no difficulty or dependency in activities of daily living (ADL) tasks. Furthermore, other measures are specific and focus only on one particular functional area, which fails to capture a broad range of an individual's activity limitations (e.g., motor function, balance function, or cognitive function). On the other hand, instrumental ADL measures that evaluate an individual's ability to perform more complex activities that are necessary for community living have not been examined as extensively as the assessment for the basic ADL.[106] However, they could be more sensitive to changes in functional status, as they assess activities demanding more complex abilities and interaction with the surrounding environment.

Many measures have been developed to record a patient's ability to perform complex activities including the Lawton Instrumental Activities of Daily Living (Lawton's IADL) scale. Lawton and Brody's scale (1969) is among the most commonly used instruments to assess independent living skills.[19] Lawton's IADL scale is a self-reported measure that assesses complex ADL.[19] It was designed to help identify appropriate living environments for older persons.[19] It comprises the following items: use of a telephone, shopping, food preparation, housekeeping, handy-man work, laundry, mode of transportation, responsibility for one's medications, and ability to handle finances.[19] The Lawton scale may be a significant predictor of discharge destination from a rehabilitation hospital setting, but it has not been researched for that purpose. A few researchers have investigated the predictive ability of the Lawton scale in predicting dementia, and their findings range from no association to a strong correlation.[119, 120] In particular, studies have explored the predictive value of the short form of the Lawton IADL scale, including telephone use, mode of transportation, ability to take medications, and ability to handle finances, and found that these items are the best predictors of dementia for older patients.[121, 122] However, until now, no one has investigated the ability of Lawton's IADL to predict discharge destination after stroke rehabilitation. Therefore, the purpose of this study was to evaluate the predictive validity of the Lawton's IADL scale in determining the discharge destination after stroke rehabilitation and to identify whether a subset of items at admission could predict discharge destination. We hypothesized that patients with a higher total Lawton's IADL score at admission were less likely to be discharged to institutional facilities than their communities and that specific items such as telephone use, ability to take medication, and ability to handle finances would be identified as better predictors of discharge to institutional settings than the total score.

4.2 METHODS

4.2.1 Data source and study design

This study was a retrospective analysis of data obtained from the comprehensive assessment toolbox charts for stroke that were collected following stroke from patients who were admitted to the Steward Health acute care hospitals and referred to the Hillside Rehabilitation Hospital (HRH) in Youngstown, OH, between 2004 and 2010. The comprehensive assessment toolbox for stroke was implemented across the medical system as a part of their stroke center of excellence.[61] It was developed as a response to the Agency for Health Care Policy and Research (AHCPR) recommendations for post-stroke rehabilitation, which suggested using valid and reliable measures for outcome assessments and emphasized the importance of using standardized assessment tools in evaluating persons post stroke. The toolbox was designed to provide data about a patient's demographic information, stroke characteristics, functional outcome measures, and discharge destinations. Hillside Rehabilitation Hospital is a community health care provider designed to treat patients with disabling injuries or illnesses. A data set of patients' demographic and clinical information at admission was provided through a data use agreement approved by the University of Pittsburgh's Office of Research. In addition, the Institutional Review Board approved this study, and all data were handled according to HIPAA guidelines.

4.2.2 Subjects

All subjects admitted to HRH from 2004 to 2010 who were administered the comprehensive assessment toolbox at admission were potentially eligible. Subjects were included if they were 18 years of age or older and were diagnosed with a first or recurrent ischemic or hemorrhagic stroke. For subjects with multiple admissions, only the first admission was included. For the purpose of this study, subjects were excluded if they had missing data on the outcome variable (i.e., discharge destination), or if they were discharged back to the acute hospital setting.

4.2.3 Data collection

The clinical use of the toolbox across the Steward medical system was started in 2002, as a part of the development of a specilized stroke unit program at HRH. Prior to implementing the toolbox across the medical system, it was first presented and discussed with the medical staff and all professionals involved in its administration, including nurses and rehabilitation clinicians. In addition, special training on the appropriate use of assessment tools and proper documentation was provided to all staff members involved in patient assessment either through group sessions or individual meetings.[61] From January 2002 onward, the assessment toolbox was implemented and collected for all patients. Patients post stroke were routinely assessed using the stroke toolbox within 72 hours of admission and at discharge by trained health care professionals who recorded the data in paper format. Following a patient's discharge, data were entered into the hosiptal's access database. The anonymized datasets were then provided to researchers for the present study for data analysis. The dataset included information about patients' demographics data, comorbidites, stroke characteristics, prior levels of functioning, social support, cognition, depression, disabilities, functional status, and discharge destinations. Data from 2002 to 2004 have been previously analyzed and published with the purpose of decribing the implementaion of the toolbox across the medical system and discussing the clinical interpretation of the collected data.[61] In this data set, we were interested in the patient's functional status in particular instrumental ADL activities and the abilities of IADL skills to predict discharge destination following rehabilitation.

4.2.4 Outcome variable

The outcome (dependent) variable recorded was discharge destination. The comprehensive assessment toolbox includes five options for discharge setting, including home (independent), home (with assistance), acute hospital, sub-acute rehabilitation program, and long-term nursing home. For this study, discharge locations were collapsed to create a dichotomous variable. Home with assistance and home/independent were combined together to produce a variable indicating discharge to a community setting. Institutional settings included sub-acute rehab and skilled nursing facilities.

4.2.5 Predictor variables

In the toolbox dataset, several variables can be used as potential predictors of discharge destination, including sociodemographic and clinical factors. These variables were selected for analysis in order to adjust for possible confounders and to identify the most important factors affecting discharge destination after inpatient stroke rehabilitation. The selection of these variables was based on the literature and on the availability of the data in the study dataset.

The primary independent variable was the instrumental ADL, as measured by Lawton's IADL scale using the total score at admission as well as the sub-item scores. It is a self-reported measure that assesses ADL[19] and measures independent living skills in the following domains: telephone use, shopping, food preparation, housekeeping, laundry, transportation, medication and financial management.[19] Responses to each of the items range from "independence in performing the activity" to "partially able to perform the activity" to "not able to perform the activity at all." The total maximum score is 27; the higher the score, the greater the person's ability.[183] The inter-rater reliability of Lawton's scale has been established at 0.85,[184] and scores were well correlated and demonstrated concurrent validity when compared to other functional status measures.[184]

Other independent variables included: demographic information (age, sex, race, and marital status); risk factors (history of previous stroke, smoking, diabetes mellitus, high cholesterol, alcoholism, high blood pressure, and atrial fibrillation); stroke characteristics (number of days from stroke onset to rehabilitation, type of stroke [i.e. ischemic, hemorrhagic, or other], lesion site, and stroke severity as measured by the Orpington Prognostic Scale[63] [OPS]); comorbidities as measured by the Charlson Comorbidity Index[173]; social support (living with someone or alone); prior functional status as measured by the BI[78]; limitations in physical activities as measured by question 3 of the short form-36, which is a generic health survey that is often used as a measure of health-related quality of life[88]; neurological impairments as measured by the National Institute of Health Stroke Scale (NIHSS)[62]; and length of stay at the rehabilitation hospital. Additional data included the total admission scores on each of the following measures: Mini-Mental Status Examination,[82] Geriatric Depression Score,[27] Barthel Index,[78] and Rankin Scale.[174]

4.2.6 Statistical analysis

All statistical analyses were conducted using SPSS software V.19.0J (SPSS, Chicago, Illinois, USA). Descriptive statistics were calculated for all variables, to describe the sample in relation to discharge destination. For continuous variables, the means and standard deviations (SD) were reported. For categorical variables, frequencies and percentages were presented.

To identify potential predictors for discharge destination, a univariate analysis was used first in order to determine the relationships between the discharge destinations and each variable of the following domains: demographic data, clinical factors and outcome measures at admission. The independent samples t-test or nonparametric Mann-Whitney U tests were used for continuous or ordinal independent variables. The chi-square test, Fisher's exact test or likelihood ratio tests were used for categorical comparisons as appropriate. A multivariate logistic regression model was used to analyze the data from the total Lawton score at admission and to calculate odds ratios and 95% confidence intervals (CIs) for the likelihood to be discharged to institutional settings relative to being discharged to a community setting.

A principal components factor analysis (PCA) was used to categorize the individual Lawton items into subsets of items that explain the greatest amount of variation in the IADL performance. Suitability of the data for factor analysis was determined using the Kaiser-Meyer-Olkin Measure of Sampling Adequacy and the Bartlett's test of sphericity. Factor extraction was performed using a standard principal component analysis with a non-rotation method applied to ease interpretation of factor loadings. The criterion for factor loading was set at 0.30 and the individual factor scores were calculated using a regression approach. Calculated factor scores were then used in a multivariate logistic regression analysis to calculate the adjusted odds ratio of discharge to an institutional setting for each of the factors. The scores on each item of the Lawton scale were then tested for univariate association with discharge destination. Factors and item scores showing a significant univariate association with discharge destination were included in a multivariate regression model in the descending order of their PCA factor loading or univariate strength of association to identify the best subset of items associated with institutional settings discharge relative to community discharge.

4.3 RESULTS

4.3.1 Patient characteristics

In total, 364 patients who had a stroke were admitted to the Steward Health System of Ohio between 2004 and 2010. Of these patients, 210 (58%) had complete data on discharge destination and were eligible to be included in the study. One hundred fifty-four subjects were excluded from the analysis because their discharge destination had not been recorded. In addition, data from 23 subjects were excluded because they were discharged back to the acute hospital or emergency departments and our study purpose was to evaluate community discharges versus institutional discharges after inpatient rehabilitation for stroke.

Analysis based on the remaining 187 subjects showed that patients' age ranged from 67 to 84 years, with a median of 76 years. Approximately half of the subjects (54%) were women, 89% were white, 43% were married, 73% were supported by Medicare, the average length of stay for inpatient rehabilitation was 20 ± 9 days and the average time (number of days) from stroke onset to admission was 9 ±16 days. Most patients had an ischemic stroke (88%) and both hemispheres were nearly equally affected with 47% in the left hemisphere and 46% in the right hemisphere.

Of the 187 patients included, 122 (65%) were discharged from the inpatient rehabilitation facility to a community setting and 65 (35%) were discharged to institutional settings. The demographics and baseline characteristics separated by discharge destination are summarized in Table 5 and Table 6. Patients who were discharged to an institutional setting were older by a mean of 3 years (77 ± 12 vs.74 ± 13 years, p= 0.13), were more likely to be women (62% vs. 50%, p= 0.15), were less likely to be married (38% vs. 46%, p= 0.28) and had longer stays at the rehabilitation hospital (22 ± 10 vs. 19 ± 9, p= 0.01). In addition, institutionally discharged patients had worse neurological deficits (median NIHSS score, 12 vs. 6, p<0.001), worse cognitive deficits (MMSE; 19±6 vs. 22± 6, p=0.01) and a higher level of activity limitation (BI; 16±17 vs. 34±19, p<0.001) (Lawton; 11±2 vs. 12±4, p= 0.009) at admission than patients discharged to a community setting (Table 7).

The group of patients whose discharge destination had not been recorded, compared with the included sample, was characterized at admission as younger age (72 ± 12 vs. 75 ± 13 years, p= 0.043), were less likely to have had a previous stroke (14% vs. 26%, p= 0.021), were less likely to have multiple comorbidities (63% vs.76%, p<0.001), had shorter time (days) from onset to rehabilitation (4 ± 6 vs. 9 ± 15, p< 0.001), had a lower mean GDS score (3.48 ± 3 vs.4.4 ± 3, p= 0.003), had higher mean Lawton IADL scores (12.5 ± 4 vs. 11.8 ± 3, p= 0.008) and had fewer neurological deficits (NIHSS: 7±7 vs. 9±6, p= 0.018). However, these differences were relatively small and were not clinically significant.

Table 5. Demographics of study sample (n=187).

Predictor variables	Total sample N= 187		Community N=122		Institutional N=65		
Demographics	N/M (%)		N		N		*P*
Age Median (IQR) Mean ± SD	174/13 (6%)	 76 (67 - 84) 75 ± 13	114	 75 (63 - 84) 74 ± 13	60	77 (70 - 85) 77 ± 12	.136
Length of stay Median (IQR) Mean ± SD	185/2 (1%)	 20 (13 - 27) 20 ± 9	121	 18 (13 - 24) 19 ± 9	64	21 (16 - 28) 22 ± 10	**.011**
Onset date Median (IQR) Mean ± SD	163/24 (13%)	 7 (5 - 9) 9 ± 16	109	 6 (4 - 8) 9 ± 18	54	 7 (5 - 10) 10 ± 8	**.028**
Year of admission 2004 2005 2006 2007	187/0 (0%)	 5 (3%) 96 (51%) 32 (17%) 54 (29%)	122	 1 (0.8%) 67 (55%) 18 (15%) 36 (30%)	65	 4 (6%) 29 (45%) 14 (22%) 18 (28%)	.096
Sex Female Male	175/12 (6%)	 95 (54%) 80 (46%)	115	 58 (50%) 57 (50%)	60	 37 (62%) 23 (38%)	.157
Race White African American Hispanic	163/24 (13%)	 145 (89%) 16 (10%) 2 (1%)	106	 92 (87%) 12 (11%) 2 (2%)	57	 53 (93%) 4 (7%) 0 (0%)	.270
Health insurance Medicare Medicaid Private Uninsured	168/19 (10%)	 122 (73%) 9 (5%) 32 (19%) 5 (3 %)	110	 73 (66%) 7 (6%) 25 (23%) 5 (5%)	58	 49 (85%) 2 (3%) 7 (12%) 0 (0%)	**.029**
Marital status Married Divorced/separated Widowed Never married	168/19 (10%)	 72 (43%) 19 (11%) 67 (40%) 10 (6%)	110	 50 (46%) 15 (14%) 39 (36%) 6 (6%)	58	 22 (38%) 4 (7%) 28 (48%) 4 (7%)	.282
Social support Full social support Partial social support No social support unknown	159/28 (15%)	 152 (96%) 3 (2 %) 3 (2 %) 1 (0.6%)	106	 100 (94%) 3 (3%) 2 (2%) 1 (1%)	53	 52 (98%) 0 (0%) 1 (2%) 0 (0%)	.348

*Abbreviation: N/M= number of valid cases/ missing cases, (%) = percentage of missing cases, P= p-value, IQR= interquartile range, SD= standard deviation

Table 6. Clinical characteristics of study sample (n=187).

Predictor variables	Total sample N= 187		Community N=122		Institutional N=65		
Clinical factors	**N/M (%)**		**N**		**N**		***P***
Previous stroke Yes	162/25 (13%)	42(26%)	106	31 (29%)	56	11 (20%)	.185
Previous TIA Yes	162/25 (13%)	14 (9%)	105	7 (7%)	57	7 (12%)	.234
Risk factors							
Current smokers	161/26 (13%)	39 (24%)	105	28 (27%)	56	11 (20%)	.322
Former smokers	156/31 (16%)	68 (44%)	103	49 (48%)	53	19 (36%)	.162
Diabetes mellitus	164/23 (12%)	58 (35%)	108	37 (34%)	56	21 (38%)	.681
High cholesterol	156/31 (16%)	37 (24%)	102	25 (25%)	54	12 (22%)	.749
Alcoholism	162/25 (13%)	12 (7%)	107	10 (9%)	55	2 (4%)	.225
High blood pressure	163/24 (12%)	82 (50%)	106	54 (51%)	57	28 (49%)	.825
Atrial fibrillation	162/25 (13%)	28 (17%)	106	14 (13%)	56	14 (25%)	.059
Comorbidities (CCI)	173/14		114		59		.566
Low comorbidity (0-2)	(7%)	44(25%)		34 (30%)		10 (17%)	
High comorbidity (≥3)		129(75%)		80 (70%)		49 (83%)	
Median ± IQR		3 (3-4)		3 (2- 4)		3 (3 – 4)	
Mean ± SD		3.4 ± 2		3.3 ± 2		3.5 ± 2	
Stroke type	162/25		106		56		.090
Hemorrhagic	(13%)	5(3%)		1 (1%)		4 (7%)	
Ischemic		142(88%)		94 (89%)		48 (86%)	
Uncertain		15(9%)		11 (10%)		4 (7%)	
Stroke location	161/26		105		56		.860
Left hemisphere	(13%)	75(47%)		48 (46%)		27 (48%)	
Right hemisphere		74 (46%)		49 (47%)		25 (45%)	
Cerebellar		7 (4%)		4 (4%)		3 (5%)	
Uncertain		4 (3%)		3 (3%)		1 (2%)	
Bilateral		1 (.6%)		1 (1%)		0 (0%)	
Neurological deficits	137/50		91		46		**P<.001**
Mild (≤ 5)	(27%)	48 (35%)		38 (42%)		10 (22%)	
Moderate (6 - 13)		59 (43%)		43 (47%)		16 (35%)	
Severe (≥ 14)		30 (22%)		10 (11%)		20 (44%)	
Median (IQR)		7 (4-13)		6 (4 - 10)		12 (7- 16)	
Mean ± SD		9 ± 6		7 ± 5		12 ± 6	
Orpington scale level	130/57		90		40		**P<.001**
Minor (<3.2)	(30%)	34(26%)		31 (34%)		3 (7%)	
Moderate (3.2-5.2)		76(59%)		52 (58%)		24 (60%)	
Severe (>5.2)		20(15%)		7 (8%)		13 (32%)	
Median (IQR)		3.8(2.8-4.4)		3.6 (2.8- 4)		4 (3.7- 5.6)	
Mean ± SD		4 ± 1		3.5 ± 1		4.6 ± 1	

*Abbreviation: N/M= number of valid cases/ missing cases, (%) = percentage of missing cases, P= p-value set at 0.05, IQR= interquartile range, SD= standard deviation, CCI= Charlson Comorbidity Index, BI= Barthel Index

Table 7. Outcome measures variables of study sample (n=187).

Predictor variables	**Total sample N= 187**		**Community N=122**		**Institutional N=65**		
Outcome measures	**N/M**		**N/M**		**N/M**		***P***
Short Form 36 Median (IQR) Mean ± SD	133/54 (28%)	60(25 - 95) 59 ± 36	93	60 (25 - 95) 59 ± 36	40	70 (27 - 95) 60 ± 36	.970
Prior BI score Median (IQR) Mean ± SD	166/21 (11%)	100 (95-100) 95 ± 12	108	100 (95-100) 95 ± 10	58	100 (100-100) 94 ± 15	.508
Adm. GDS score Normal Mild Severe Median (IQR) Mean ± SD	140/47 25%	97 (69%) 36 (26%) 7 (5%) 4 (2 - 6) 4 ± 3	95	71 (75%) 19 (20%) 5 (5%) 4 (2 - 6) 4.2 ± 3	45	26 (58%) 17 (38%) 2 (4%) 5 (3 - 7) 5 ± 3	.071
Adm. MMSE score Median (IQR) Mean ± SD	132/55 29%	22 (18 - 26) 21 ± 6	90	23 (19 - 27) 22 ± 6	42	20 (16 -24) 19 ± 6	**.016**
Adm. BI score Median (IQR) Mean ± SD	143/44 23%	25 (10 - 45) 28 ± 20	93	35 (20 - 45) 34 ± 19	50	10 (4 - 25) 16 ± 17	**P<.001**
Adm. Lawton score Median (IQR) Mean ± SD	177/10 5%	11 (10 - 12) 12 ± 3	116	11 (10 - 12) 12 ± 4	61	11 (9 - 12) 11 ± 2	**.009**
Adm. Rankin score 1 2 3 4 5 Median (IQR) Mean ± SD	160/27 14%	1 (.6%) 1 (.6%) 4 (3%) 134 (84%) 20 (13%) 4 (4 - 4) 4 ± .4	103	1 (1%) 1 (1%) 4 (4%) 92 (89%) 5 (5%) 4 (4 - 4) 3.9 ± .46	57	0 (0%) 0 (0%) 0 (0%) 42 (74%) 15 (26%) 4 (4 - 5) 4.2 ± .44	**P<.001**

*Abbreviation: N/M= number of valid cases/ missing cases, (%) = percentage of missing cases, P= p-value set at 0.05, IQR= interquartile range, SD= standard deviation, BI= Barthel Index, Adm.= admission, Adm. GDS = admission Geriatric Depression Score, Adm. MMSE = admission Mini-Mental State Examination, Adm. BI score= admission Barthel Index score.

4.3.2 Univariate predictors of discharge destination following inpatient rehabilitation

Following the descriptive analysis, all the variables shown in Tables 5-7 were analyzed to determine which variables were associated with discharge to an institutional setting after a person's rehabilitation stay. First, unadjusted logistic regression was performed for each variable to screen the variables for significant associations with the discharge destination. Then, adjusted logistic regression was performed with adjustment for age to obtain the corresponding odds ratio (OR) adjusted for the possible confounding factor for each predictor. We adjusted for age because of an association detected in the univariate analysis with significance set at a p-value of ≤ 0.15. Based on the results of the adjusted logistic regression analyses, variables with a p-value of ≤ 0.15 were included in the multivariate regression model.

A number of variables were found to be significantly related to the likelihood of being discharged to the institutional setting, as detailed below and demonstrated in Table 8. The results indicated that for every 1 day increase in the rehabilitation stay, the odds of being discharged to an institutional setting increased by 4%. Patients who experienced a moderate stroke, as measured by the Orpington Prognostic scale (OPS), had a lower odds of discharge to institutional care compared to those who had a severe stroke (OR: 0.24, 95%CI 0.08 – 0.70, $p = .009$). Higher neurological deficits, as measured by the NIHSS, increased the odds of an institutional discharge destination compared with mild neurological deficits (OR: 1.1, 95%CI: 1.06 – 1.2, $p < .001$) (Table 9).

Patients with a better score on the Mini-Mental State Examination (MMSE) were less likely to be discharged to an institutional setting (OR: 0.94, 95%CI: 0.88 – 0.99, $p = .038$). A better functional status on admission in both basic and instrumental activities of daily living also showed that these patients were less likely to be discharged for further care (BI: OR: 0.94, 95%CI: 0.92 –

0.97, $p < .001$; Lawton IADL: OR: 0.86, 95%CI 0.76 – 0.97, $p = .021$). Moreover, patients with a possible depressive symptom (GDS > 5) were discharged to an institutional setting more often (OR: 2.2, 95%CI: 1.0 – 4.6, p =.044). Moderate disability as measured by the Rankin scale was associated with a lower likelihood of discharge to an institutional care setting (OR: 0.15, 95%CI: 0.05 - .44, p = .001) (Table 10).

Table 8. Unadjusted and adjusted odds ratio of demographic variables associated with discharge destination.

Variable	Unadjusted				Adjusted for Age		
Demographics	**N**	**β**	**OR (95% CI)**	***P***	**N**	**OR (95% CI)**	***P***
Age (years)	174	.019	1.01 (.99 - 1.04)	**.137**	-	-	-
Gender	175				174		
Male vs. female		- .458	0.63 (.33 - 1.19)	.158		0.68 (.35 - 1.30)	.251
Race	163				162		
Other vs. White		-.701	0.49 (.15 -1.58)	.237		0.55 (.17 - 1.78)	.319
Health Insurance	168			.232	167		.341
Medicaid vs. Medicare		-.854	0.42 (.08 - 2.13)	.299		0.43 (.07 - 2.39)	.338
Privet vs. Medicare		-.874	0.41 (.16 - 1.03)	.061		0.42 (.15 - 1.12)	.085
Marital Status	168			.303	167		.540
Divorced vs. Married		-.501	0.60 (.18 - 2.03)	.418		0.65 (.19 - 2.23)	.497
Widowed vs. Married		.490	1.63 (.81 - 3.27)	.169		1.42 (.67 - 3.00)	.347
Single vs. Married		.416	1.51 (.38 - 5.90)	.550		1.64 (.41 - 6.57)	.482
Social support	159				147		
Presence vs. absence		.415	1.51 (.15 - 14.9)	.722		1.30 (.12 - 13.1)	.823
Length of stay (days)	185	.043	1.04 (1.0 - 1.07)	**.013**	173	1.03 (1.0 - 1.07)	**.042**
Onset days (days)	163	.001	1.00 (.98 - 1.02)	.948	162	1.00 (.97 - 1.02)	.984
Year of admission	187				174		
2004/05 vs. 2006/07		.200	1.22 (.66 - 2.23)	.516		1.46 (.77 - 2.77)	.241

*Abbreviation: N= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, *P*= *P*-values. Note: other race includes African American and Hispanic, onset days = number of days from stroke onset to admission of inpatient rehabilitation. Variables with p-values in bold were considered as significant for inclusion in the multivariate analyses, with a p-value of ≤ 0.15.

Table 9. Unadjusted and adjusted odds ratio of clinical factors associated with discharge destination.

Variable	Unadjusted				Adjusted for Age		
Clinical factors	**N**	**β**	**OR (95%CI)**	**P**	**N**	**OR (95%CI)**	**P**
Previous stroke	162	- .525	.59 (.27 - 1.29)	.187	161	.54 (.24 - 1.20)	**.136**
Previous TIA	162	.673	1.9 (.65 - 5.89)	.231	161	1.9 (.64 - 5.91)	.238
Prior Barthel score	166	-.010	.99 (.96 - 1.01)	.450	162	.99 (.96 - 1.04)	.569
Short Form-36	133	.001	1.0 (.99 - 1.01)	.809	122	1.0 (.99 - 1.05)	.592
Comorbidities/ CCI	173				161		
Low vs. high		-.734	.48 (.21 - 1.05)	**.069**		.43 (.19 - 1.0)	**.052**
Risk factors					167		
Current smokers	161	-.397	.67 (.30 - 1.47)	.324		.80 (.33 - 1.92)	.626
Former smokers	156	-.485	.61 (.31 - 1.21)	.163		.67 (.33 - 1.35)	.266
Diabetes mellitus	164	.141	1.1 (.58 - 2.25)	.681		1.2 (.63 - 2.50)	.518
High cholesterol	156	-.128	.88 (.40 - 1.92)	.749		.87 (.39 - 1.92)	.736
Alcoholism	162	-1.00	.36 (.07 - 1.73)	.205		.37 (.79 - 1.79)	.220
High blood pressure	163	-.073	.93 (.48 - 1.77)	.825		.97 (.50 - 1.85)	.927
Atrial fibrillation	162	.784	2.2 (.95 - 5.00)	**.063**		1.9 (.84 - 4.57)	**.117**
Stroke type	162				161		
Ischemic vs. others		-.267	1.5 (.15 - 14.9)	.722		.74 (.28 - 1.96)	.554
Stroke location	161			.995	160		.927
Left hemi vs. others		.118	1.1 (.31 - 4.08)	.858		1.17 (.32 - 4.3)	.805
Right hemi vs. others		.020	1.0 (.28 - 3.71)	.976		1.04 (.28 - 3.8)	.951
Neurological deficits	137			**<.001**	129		**<.001**
Moderate vs. mild		.346	1.4 (.57 - 3.48)	.452		1.6 (.65 - 4.35)	1.69
Severe vs. mild		2.02	7.6 (2.7 - 21.2)	**<.001**		9.2 (3.0 - 28.3)	**<.001**
Baseline NIHSS score		.130	1.1 (1.06 - 1.2)	**<.001**		1.1(1.07 - 1.2)	**<.001**
Orpington scale level	130			**<.001**	121		**.002**
Minor vs. severe		-2.95	.05 (.01 - 0.23)	<.001		.06 (.01 - 0.29)	<.001
Moderate vs. severe		-1.39	.24 (.08 - 0.70)	.009		.29 (.10 - 0.86)	.026
Total score		.836	2.3 (1.6 - 3.37)	<.001		2.2 (1.5 - 3.21)	<.001

*Abbreviation: N= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, *P*= *P*-values, TIA= Transient Ischemic Attack, CCI= Charlson Comorbidity Index, hemi= hemisphere, NIHSS=NIH Stroke Scale. Note: other stroke type includes hemorrhagic and uncertain, “others”, stroke location included cerebellar, bilateral and uncertain. Variables with p-values in bold were considered as significant for inclusion in the multivariate analyses, with a p-value of ≤ 0.15.

Table 10. Unadjusted and adjusted odds ratio of outcome measures associated with discharge destination.

Variable	Unadjusted				Adjusted for Age		
Outcome Measures	N	β	OR (95% CI)	P	N	OR (95% CI)	P
Cognitive status	132				122		
Baseline MMSE score		-.061	.94 (.88 -.99)	**.038**		.94 (.89-1.00)	**.077**
Depressive symptoms	140				130		
Baseline GDS score		.078	1.1 (.96 - 1.2)	.183		1.1 (.96 -1.2)	**.149**
Depressed vs. normal		.771	2.2 (1.0 - 4.6)	**.044**		2.7 (1.2 - 6.1)	**.017**
Basic ADL	143				134		
Baseline BI score		-.053	.94 (.92 - .97)	**<.001**		.94 (.92 - .97)	**<.001**
Instrumental ADL	177				165		
Baseline Lawton score		-.143	.86 (.76 - .97)	**.021**		.87 (.77 - .99)	**.037**
Baseline Rankin score	160			**.003**	150		**.005**
Mild vs. Severe		-22.30	.000	.999		.000	.999
Moderate vs. Severe		-1.883	.15 (.052 - .44)	.001		.16 (.05 - .48)	.001
Total score		1.970	7.2 (2.5 – 20.3)	<.001		6.6 (2.3-19.1)	<.001

*Abbreviation: N= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, *P*= *P*-values, MMSE=Mini-Mental State Examination, GDS= Geriatric Depression Score, BI=Barthel Index. Note: Variables with p-values in bold were considered as significant for inclusion in the multivariate analyses, with a p-value of ≤ 0.15.

4.3.3 Multivariate model predictive of discharge destination

Multicollinearity among predictor variables was evaluated by the Pearson Product Moment Correlation analysis. The results of the correlation analysis are presented in Table 11, which shows that there are moderate correlations among some of the predictor variables. The NIHSS score and OPS correlated significantly (r =0.790; P< 0.01). In addition to the NIHSS and BI score were correlated (r = -0.717; P< 0.01). Literature has suggested that multicollinearity exists if the correlation coefficient is greater than 0.70.[191] Therefore, we excluded the NIHSS variable from the multivariate analysis.

Table 11. Pearson Correlations among predictor variables.

Variables	Age	LOS	NIHSS	OPS	MMSE	GDS	BI	Lawton
Age	1.00							
LOS	-.042	1.00						
NIHSS	-.057	.546**	1.00					
OPS	-.092	.610**	.790**	1.00				
MMSE	-.138	-.007	-.347**	-.268**	1.00			
GDS	-.142	.242**	.213*	.136	.090	1.00		
BI	-.075	-.547**	-.717**	-.698**	.330**	-.219*	1.00	
Lawton	-.048	-.148	-.291**	-.241**	.200*	-.061	.345**	1.00

*Abbreviations: LOS: length of stay at rehabilitation, NIHSS: National Institutes of Health Stroke Scale, OPS: Orpington Prognostic Scale, MMSE: Mini-Mental State Examination, GDS: Geriatric Depression Scale, BI: Barthel Index; ** Correlation is significant at the 0.01 level; * Correlation is significant at the 0.05 level.

Only variables that were significant from the univariate analysis were included in the multivariate regression analysis using the backward elimination stepwise method; the significance level criterion for variable entry was $p < 0.05$ and $p > 0.10$ for removal. We examined three multivariate logistic models for each of the following domains separately: patient characteristics, disease-specific factors and outcome measure variables. Model 1 included age and length of stay at inpatient rehabilitation (Table 12). Model 2 included history of previous stroke, comorbidities, atrial fibrillation and the OPS score (Table 13). Model 3 included the total admission MMSE score, total admission BI score, total admission Lawton IADL score and the admission Rankin score coded as categorical variables (Table 14).

Table 12. Results from the multivariate logistic regression analysis of discharge destination (Model 1).

Step no.	***Predictor variables (n=173)***	***Multivariate analysis (Backward elimination method)***			
		β	OR	95% CI	*P*
Step 1	Age	.020	1.02	.99 – 1.04	.123
	Length of stay	.038	1.03	1.00 – 1.07	.042
Step 2	Length of stay	.035	1.03	1.00 – 1.07	**.051**

* Abbreviation: n= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, P= p-value.

Table 13. Results from the multivariate logistic regression analysis of discharge destination (Model 2).

Step no.	***Predictor variables (n=110)***	***Multivariate analysis (Backward elimination method)***			
		β	OR	95% CI	P
Step 1	OPS levels				.010
	Minor vs. severe	-2.588	.075	.014 – .400	.002
	Moderate vs. severe	-1.055	.348	.10 – 1.17	.089
	Previous stroke	-.523	.593	.20 – 1.75	.344
	Atrial fibrillation	1.04	2.84	.95 – 8.48	.060
	Comorbidities/ CCI				
	Low vs. high	-.116	.891	.28 – 2.75	.841
Step 2	OPS levels				.005
	Minor vs. severe	-2.639	.071	.014 – .353	.001
	Moderate vs. severe	-1.081	.339	.104 – 1.11	.074
	Previous stroke	-.525	.592	.200 – 1.74	.342
	Atrial fibrillation	1.045	2.84	.95 – 8.46	.061
Step 3	OPS levels				**.004**
	Minor vs. severe	-2.720	.066	.013 – .324	.001
	Moderate vs. severe	-1.197	.302	.095 – .965	.043
	Atrial fibrillation	1.042	2.83	.96 – 8.63	**.059**

* Abbreviation: n= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, P= p-value, OPS= Orpington Prognostic Score, CCI= Charlson Comorbidity Index.

Table 14. Results from the multivariate logistic regression analysis of discharge destination (Model 3).

Step no.	***Predictor variables (n=101)***	***Multivariate analysis (Backward elimination method)***			
		β	OR	95% CI	P
	Admission MMSE score	.011	1.01	.94 – 1.08	.770
	Admission BI score	-.043	.958	.92 – .98	.006
Step 1	Admission Lawton score	-.081	.922	.77 – 1.09	.356
	Admission Rankin score	-19.39	.000		.992
	Mild vs. severe	-.131	.877	.000	.999
	Moderate vs. severe			.12 – 6.36	.897
	Admission BI score	-.042	.959	.93 – .98	.006
Step 2	Admission Lawton score	-.076	.927	.78 – 1.09	.375
	Admission Rankin score				.992
	Mild vs. severe	-19.43	.000	.000	.999
	Moderate vs. severe	-.130	.878	.12 – 6.37	.898
Step 3	Admission BI score	-.045	.956	.93 – .98	.002
	Admission Lawton score	-.074	.929	.78 – 1.09	.376
Step 4	Admission BI score	-.048	.954	.92 – .98	**.001**

*Abbreviation: N= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, *P*= *P*-values, MMSE=Mini-Mental State Examination, BI=Barthel Index.

Only variables remaining in the last step at each model were included in the final multivariate model. The backward elimination multivariate logistic regression analysis identified four predictors of discharge destination following inpatient rehabilitation. These predictors were length of stay, stroke severity as measured by the OPS score, atrial fibrillation and the total admission BI score. Then, a multivariable logistic regression analysis was run with the length of rehabilitation stay (days), stroke severity as measured by the OPS score coded as a categorical variable, atrial fibrillation and total admission BI score coded as a continuous variable. All variables were entered in a single step.

The results of the multivariable logistic regression analysis were significant, $\chi 2$ (5, N = 93) = 25.436, $p < .001$ (see Table 15 for the results of the multivariable model). The model as a whole explained 33% (Nagelkerke's R^2) of the variance in discharge destination and correctly classified 77% of the cases. Two of the four predictor variables (total BI score at admission and stroke severity as measured by the OPS) made a statistically significant contribution to the model, indicating that patients with a better functional status at admission and those who had a minor stroke, as measured by the OPS, were less likely to be discharged to further care.

Adding the total Lawton score as a predictor variable to the model resulted in a little improvement of the overall model fit ($\chi 2$ (6, N = 91) = 24.154, $p < .001$). The model explained 32% of the variance. The total BI score remained significant, whereas stroke severity became a non-significant predictor of discharge destination. According to the Hosmer and Lemeshow test, the model showed a better fit for the data ($\chi 2$ (8) = 5.598, p=.692), when compared with the previous model (see Table 15). However, the independent effect of the total Lawton score on discharge destination was not significant in the model (β = -.029; P=.745).

Table 15. Results from multivariate logistic regression, including admission total Lawton score, on patients discharge destination to an institutional setting.

Predictor variables	Model A (n=93)			Model B (n=91)		
Model A	β	OR	*P*	β	OR	*P*
Total BI score	-.042	.95	**.028**	-.039	.962	**.048**
OPS levels			.094			.125
Minor vs. severe	-2.43	.088	**.042**	-2.30	.100	.057
Moderate vs. severe	-1.52	.217	.053	-1.47	.230	.067
LOS	-.012	.989	.759	-.007	.993	.861
Atrial fibrillation	.139	1.14	.854	.176	1.19	.818
Model B						
Total Lawton score				-.029	.971	.745
Model Characteristics						
Nagelkerke's R^2	.332			.323		
-2 log likelihood	92.955			92.594		
Hosmer & Lemeshow test	$\chi 2$ (8)= 12.928, p=.114			$\chi 2$ (8)= 5.598, p=.692		

* Abbreviation: n= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, P= P-value, BI= Barthel Index, OPS= Orpington Prognostic Score, LOS: length of stay.

4.3.4 Principal factor analysis of the Lawton IADL scale

Factor analysis with principal components extraction was run to extract factors from the admission scores of the 9-items of the Lawton scale that measured the instrumental activities of daily living on 176 subjects following a stroke. Prior to analysis, the correlation matrix was examined to ensure the suitability of factor analysis, and it was observed that all variables had at least one correlation coefficient greater than 0.3. In addition, the overall Kaiser-Meyer-Olkin (KMO) measure for sample adequacy was 0.89, and the individual KMO measures were all greater than 0.7, above the commonly recommended value of .5. Also, the Bartlett's test of sphericity was statistically significant ($p < 0.05$), indicating that the data were suitable for factor analysis.

The results of the PCA revealed two components that had eigenvalues greater than one and which explained 66% and 12.5% of the total variance, respectively. Factor 1 included items that involve some aspect of physical health and motor functions; thus, Factor 1 was defined as the "physical factor." Factor 2 included items that were mainly related to cognitive function; thus, Factor 2 was defined as a "cognitive factor." The two components extracted accounted for 78% of the total variance. All items loaded strongly on the first principal component (i.e., above 0.4). The variables' loading of > 0.3 on any factor are shown in Table 16, along with the percentage of variance explained by each factor.

Table 16. Factor loadings and communalities based on a principle components analysis for 9 items from the Lawton IADL scale (N=176).

Variable	Factor 1 (physical)	Factor 2 (cognitive)	Communalities (initial)
Item 5. Housework activities	.948		.931
Item 4. Preparing meals	.939		.908
Item 3. Shopping	.902		.826
Item 6. Handyman work	.899		.865
Item 7. Laundry	.897		.833
Item 2. Transportation	.772		.631
Item 8. Handling medications	.718	.357	.643
Item 1. Telephone use	.627	.522	.666
Item 9. Handling finances	.476	.728	.757
Total variance %	66%	12%	
Cumulative %	66%	78%	

Extraction method: Principle Component Analysis; Rotation method: Non- Rotation
All loading on factors <0.3 are not shown.

4.3.5 Prediction of discharge destination using factor scores identified in factor analysis and the 9 sub-items of the admission Lawton

To examine how the Lawton scores are related to discharge destination, univariate logistic regression analyses were conducted first with each of the two identified factors from factor analysis and the scores from each sub-item of the Lawton IADL scale. Results from the unadjusted logistic regression models are presented in Table 17. None of the factors were significantly associated ($p < 0.05$) with the outcome of being discharged to an institutional setting. For individual items, only item 1 (telephone use) demonstrated statically significant association with the discharge destination. The unadjusted OR indicated that subjects with higher scores on item 1 (ability to use telephone) were 2.22 times less likely to go to an institutional setting (OR: 0.45; 95%CI: .26 – .78; P= .005).

Second, to assess the independent associations between these variables and the outcome of being discharged to an institutional setting, all variables with a p-value ≤ 0.15 in the univariate analysis were selected to fit the multivariate logistic model. Three separate models were conducted. In the first model, the total admission Lawton score was analyzed. As shown before, adding the total Lawton score as a predictor variable to the model did not significantly contribute to the prediction of discharge destination. In the second model, the two identified factors resulting from the principal component analysis of the Lawton scale were entered and the total Lawton score was removed from the final model.

Table 17. Results from the unadjusted logistic regression analysis.

Variable	***Unadjusted***			
Admission Lawton score	**N**	**β**	**OR (95% CI)**	**P**
Factor scores				
Factor 1 (Physical/ cognitive)	175	-.380	.68 (.45 – 1.02)	**.063**
Factor 2 (Cognitive)	175	-.301	.74 (.53 – 1.02)	**.070**
Individual scores				
Item 1 Telephone use	175	-.778	.45 (.26 – .78)	**.005**
Item 2 Transportation	175	-.738	.47 (.16 – 1.35)	.164
Item 3 Shopping	175	-1.036	.35 (.12 – 1.04)	**.060**
Item 4 Preparing meals	175	-.819	.44 (.16 – 1.15)	**.095**
Item 5 Housework activities	175	-.582	.55 (.22 – 1.39)	.212
Item 6 Handyman work	175	-.523	.59 (.22 – 1.58)	.296
Item 7 Laundry	175	-.398	.67 (.30 – 1.46)	.317
Item 8 Handling medications	175	-.507	.60 (.32 – 1.10)	**.104**
Item 9 Handling finances	175	-.522	.59 (.34 – 1.02)	**.063**

Results indicated that the overall model fit was statically significant, $\chi 2$ (7, N = 89) = 22.981, p= .002, and accounted for 31% of the variance in discharge destination. The Hosmer and Lemeshow test was $\chi 2$ (8) = 10.291, p=.245, suggesting that adding the total Lawton score did not improve the model. According to the Wald statistic, none of the Lawton IADL factors contribute significantly when added to the regression model (factor1; β = -.086; P=.766) and (factor2; β = .186; P=.583). In the third model, all individual items with a p-value of < 0.15 in the univariate analysis were added to the final model one at a time based on the level of significance, beginning with the most significant item to the least significant one. The overall model was found to be statically significant, χ2 (10, N = 89) = 24.282, p= .007, and accounted for 33% of the variance in discharge destination. However, none of the individual items of the Lawton scale contributed significantly to predicting discharge destination following inpatient rehabilitation (Table 18).

Table 18. Results from multivariate logistic regression, including admission total Lawton score, factor scores, and sub-items scores of the Lawton scale on patients discharge destination to institutional setting.

	Model A (n=91)			Model B (n=89)			Model C (n=89)		
Predictor variables	β	OR	*P*	β	OR	*P*	β	OR	*P*
Total BI score	-.039	.962	**.048**	-.035	.966	.101	-.041	.960	.071
OPS levels			.125			.093			103
Minor vs. severe	-2.30	.100	.057	-2.454	.086	**.047**	-2.587	.075	**.044**
Moderate vs. severe	-1.47	.230	.067	-1.652	.192	**.043**	-1.727	.178	.060
LOS	-.007	.993	.861	.008	1.00	.849	.001	1.00	.972
Atrial fibrillation	.176	1.19	.818	.074	1.07	.929	.077	1.08	.927
Admission Lawton score									
Total score	-.029	.971	.745						
Factor1 (physical/cognitive)				-.086	.917	.766			
Factor2 (cognitive)				.186	1.20	.583			
Item.1 telephone use							.436	1.54	.514
Item.3 shopping							-1.485	.227	.473
Item.9 handling finances							.340	1.40	.562
Item.4 preparing meals							.529	1.69	.772
Item.8 handling medication							-.112	.894	.881
Nagelkerke's R²	.323			.317			.333		
-2 log likelihood	92.594			89.371			88.070		
Hosmer & Lemeshow test	χ2 (8)= 5.598, p=.692			χ2 (8)= 10.291, p=.245			χ2 (8)= 10.578, p=.227		

* Abbreviation: n= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, P= P-value, BI= Barthel Index, OPS= Orpington Prognostic Score, LOS=Length of Stay.

4.3.6 Reexamination of the OPS and Rankin as continuous variables

At first, we examined the OPS and Rankin scale as categorical variables to assess the association of each category with the probability of being discharged to an institutional setting. For the OPS, stroke severity was grouped into three categories (minor, moderate, severe), but there were only 20 subjects in the severe category. Similarly, for the Rankin Scale, there were only five subjects in the mild group. Therefore, we reexamined the OPS and Rankin scales as continuous variables to determine which method was the best way to deal with these variables. The multivariate model containing disease-specific variables, including the OPS, showed that both OPS and atrial fibrillation were significant at p <0.15 and were selected to fit the final multivariate model (Table 19). However, in the model containing outcome measure variables, only the admission score of the BI was significant and included in the final multivariate model (Table 20).

Table 19. Re-examining the effect of OPS as a continuous measure on discharge destination.

Step no.	***Predictor variables (n=110)***	***Multivariate analysis (Backward elimination method)***			
		β	OR	95% CI	P
Step 1	OPS scale	.765	2.14	1.38 – 3.33	.001
	Previous stroke	-.250	.778	.26 – 2.31	.653
	Atrial fibrillation	.973	2.64	.95 – 8.48	.084
	Comorbidities/ CCI Low vs. high	-.070	.932	.30 – 2.89	.904
Step 2	OPS scale	.773	2.16	1.42 – 3.28	<.001
	Previous stroke	-.250	.779	.26 – 2.31	.653
	Atrial fibrillation	.970	2.63	.87 – 7.94	.085
Step 3	OPS levels	.795	2.21	1.47 – 3.33	**<.001**
	Atrial fibrillation	.968	2.63	.87 – 7.90	**.084**

* Abbreviation: n= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, P= p-value, OPS= Orpington Prognostic Score, CCI= Charlson Comorbidity Index.

Table 20. Re-examining the effect of Rankin scale as a continuous measure on discharge destination.

Step no.	***Predictor variables (n=101)***	***Multivariate analysis (Backward elimination method)***			
		β	OR	95% CI	P
Step 1	Admission MMSE score	.012	1.01	.94 – 1.08	.738
	Admission BI score	-.043	.958	.92 – .98	.007
	Admission Lawton score	-.084	.920	.77 – 1.09	.336
	Admission Rankin score	.516	1.67	.31 – 8.90	.545
Step 2	Admission BI score	-.041	.959	.93 – .98	.006
	Admission Lawton score	-.078	.925	.78 – 1.09	.375
	Admission Rankin score	.524	1.68	.31 – 8.96	.539
Step 3	Admission BI score	-.045	.956	.93 – .98	.002
	Admission Lawton score	-.074	.929	.78 – 1.09	.376
Step 4	Admission BI score	-.048	.954	.92 – .98	**.001**

*Abbreviation: N= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, *P*= *P*-values, MMSE=Mini-Mental State Examination, BI=Barthel Index.

The results of the final multivariate analysis shown in Table 21 indicated that of all the independent variables, only stroke severity as measured by the OPS was a significant predictor of discharge destination, indicating that patients who experienced a severe stroke as measured by the OPS were more likely to be discharged for further care. For every 1 point increase in the OPS, patients were 2.08 times more likely to be discharged to a destination other than a community setting. Adding the total Lawton score as a predictor variable to the model resulted in a non-significant improvement of the coefficient and odds ratio of each variable in the model (see Table 21).

To examine the differences between models with the OPS, included as a categorical measure versus a continuous one, a model discrimination with ROC (Receiver Operating Characteristics) curves was assessed by determining the area under the curve (AUC) for each model, and a larger AUC indicates better predictability of the model. The AUC of the final model with the OPS coded as a categorical variable was .78 (95%CI= .68-.88). When the OPS was included as a continuous measure, the AUC was .79 (95% CI= .69- .89) (Figure 2).

Table 21. Results from multivariate logistic analysis, including the effect of OPS as a continuous measure on discharge destination.

Predictor variables	***Model A***			***Model B***		
Model A (n=93)	β	OR	*P*	β	OR	*P*
Total BI score	-.034	.96	.084	-.033	.968	.111
LOS	-.013	.987	.731	-.010	.990	.800
Atrial fibrillation	.061	1.06	.935	.078	1.08	.918
OPS scale	.734	2.08	**.030**	.713	2.04	**.040**
Model B (n=91)						
Total Lawton score				-.014	.986	.877
Model characteristics						
Nagelkerke's R^2	.331			.322		
-2 log likelihood	93.057			92.652		
Hosmer & Lemeshow test	$\chi2$ (8) = 5.779, p=.672			$\chi2$ (8) = 9.800, p=.279		

* Abbreviation: n= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, P= p-value, BI= Barthel Index, OPS= Orpington Prognostic Score.

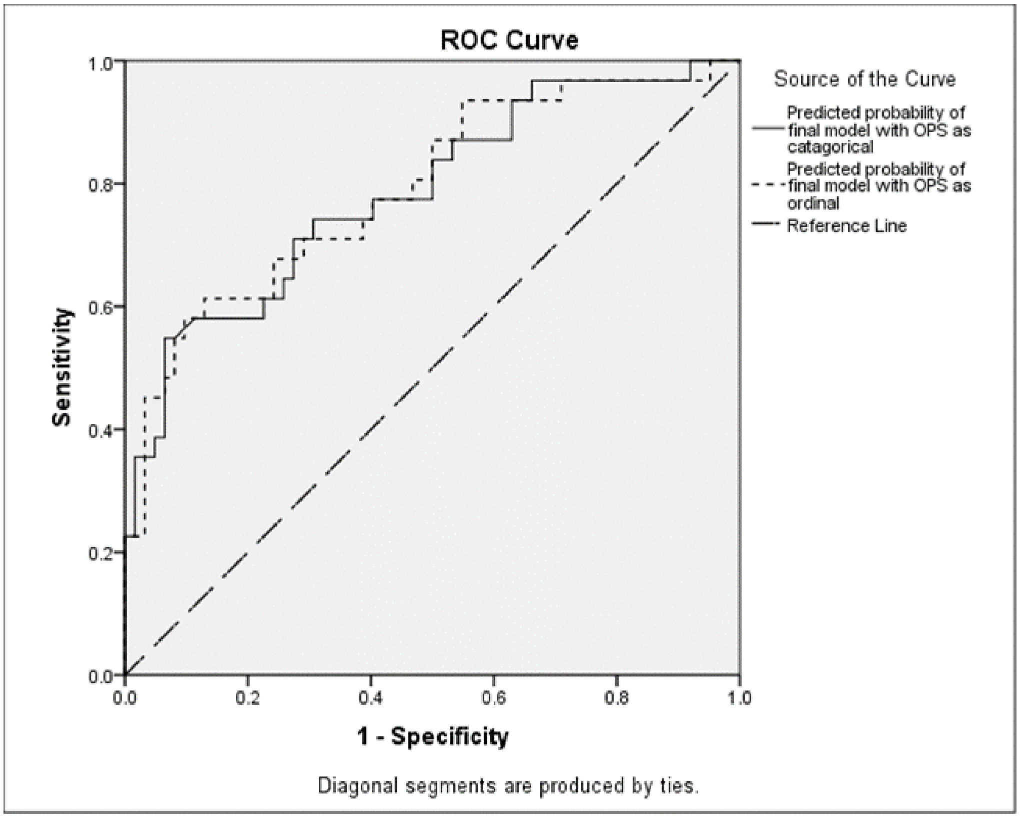

Figure 2. Receiver Operating Characteristics curves comparing the probability of the final model with Orpington Prognostic Score as categorical versus as a continuous measure.

4.4 DISCUSSION

Our purpose was to explore the predictive ability of Lawton's IADL scores upon admission to predict discharge destination, as well as to explore factors associated with community versus institutional discharges in patients receiving inpatient rehabilitation after stroke. Our univariate analyses of the comprehensive assessment toolbox data showed that the total Lawton's IADL score upon admission, as well as the individual score for item 1 (telephone use) emerged as significant predictors of discharge destination. However, in a multivariate regression analysis neither the total scale score nor the individual items were associated with increased odds of discharge to institutional care. The other main finding in our study is that dependence in basic ADL at admission as measured by the BI was the main independent predictor of discharge destination, although it did not largely contribute to this prediction. Stroke severity as measured by the OPS, however, showed a good utility in discriminating community and institutional discharges after inpatient rehabilitation.

4.4.1 Univariate predictors of discharge destination following inpatient rehabilitation

Age, gender, race, marital status, and health insurance showed no association with discharge destination. Of all demographic variables, only length of stay (LOS) contributed to the prediction of discharge destination. Consistent with previous research, longer LOS increases the probability of institutional discharge and lowers the chance of community discharge.[192, 193] O'Brien et al. (2013) reported that each additional day at an inpatient rehabilitation facility was associated with 0.3% reduced odds of community discharge for Medicare beneficiaries with stroke.[193] In another study, Camicia and colleagues stratified a sample into three impairment groups and demonstrated that longer length stay for severely impaired patients was associated with higher likelihood of discharge to community.[192] However, patients in the mildly and moderately impaired groups with longer LOS at the inpatient rehabilitation hospital were less likely to be discharged to community.[192] Our data subgroup analysis found no different association between LOS and discharge destination by stroke impairment severity.

Age has been reported in several studies as a significant predictor of outcomes following stroke rehabilitation.[5, 7, 8, 135, 137, 141] Advanced age is usually associated with adverse outcomes such as a decreased likelihood of community discharge.[5, 194] However, younger age is more likely associated with favorable outcomes and increased likelihood of returning home.[14, 195, 196] Yet, studies have found the inclusion of age minimally added to the predictive power of other variables in predicting discharge destination.[4, 138] Wee et al. (2003) reported a similar result, finding that age was not a good predictor of LOS and discharge destination in a stroke rehabilitation population.[147] In this study sample, we also found that age was not a significant predictor of discharge destination following inpatient rehabilitation. Previous researchers who have evaluated the effect of age on discharge destination have studied different age ranges. Some studies were limited by restricted age ranges such as those 75 or 65 years of age and above[5, 143] and others included a wide age range of individuals.[138, 195] In this study, we included a broad age range of patients above the age of 18 years old. However, the median age of our entire studied sample was 76 years and the interquartile range was 67–84.

Marital status may be an important factor in predicting outcomes following stroke rehabilitation.[5, 137, 139] Nguyen et al. (2007) found that among patients with an admission FIM score of 75 or lower, those who were married were significantly more likely to be discharged home.[197] Other authors have found a significant association between the presence of a family member or partner at home and returning home after stroke rehabilitation.[136, 138, 198] In this sample, however, no significant difference was found in marital status between those who were discharged to the community and those who were discharged to institutional settings. Various other studies also found no association between marital status or living with family and discharge destination.[199, 200] Social factors may play an important role in determining discharge destination; however, a clear distinction should be made between measurements of structural support such as marital status or living with others and functional support measures, which are about individual beliefs or perceptions of caregiving support availability if needed.[201] The use of marital status as a measure of home support may not adequately address the need for information about social support. In our study, we did not have data that indicated the presence of a spouse would provide the necessary caregiving support or if support came from others such as family or friends. However, this study reported that 96% of our subjects perceived that they would receive full social support at home if needed and found that perceived social support was not associated with odds of institutional discharge. However, this finding should be interpreted with caution as this measurement was carried out at the inpatient rehabilitation unit shortly after stroke and subjects may not have been totally aware of their new and constantly changing functional capabilities. In addition, the method in which the social support was measured using only one or two questions based on self-reported data may not always be accurate and may only cover one element of social support. Future studies should consider including a more detailed and directed measure of an individual's social support.

Results from previous studies conflict regarding the effects of sex, race, and insurance status on discharge destination after inpatient stroke rehabilitation. For example, several studies have found that women are more likely to be discharged to institutional settings rather than home after stroke rehabilitation.[138, 139] However, consistent with our results, some other authors have found that sex was not significantly associated with discharge destination.[5, 136, 137, 147] Similar to studies of associations between race and discharge destination that concluded race/ethnicity was not a significant factor,[153, 202] in our study no significant difference was seen in racial/ethnic group status between those who were discharged to a community and those who were discharged to an institutional setting. This interpretation, however**,** may not be accurate since we did not have a very diverse sample and subjects were only from one inpatient rehabilitation facility. However, some studies reported that blacks were more likely to be discharged home compared to whites after inpatient rehabilitation.[137, 203] Regarding health insurance, Onukwugha et al. (2007)[204] and Freburger et al. (2011)[142] found that lack of insurance was associated with lower probability of being discharged to an institutional setting. Furthermore, patients with Medicare insurance were less likely to be discharged home.[205] However, these studies were conducted only among patients who were admitted to acute care hospitals. Nguyen et al. (2015) studied populations who received inpatient rehabilitation and found that patients with Medicare health insurance compared with private insurance had lower odds of returning home (OR = .69; 95% CI [0.55 - 0.88]).[137] Our data analysis suggests that health insurance is not associated with discharge destination following inpatient rehabilitation. However, if we compared Medicare versus other insurance, the unadjusted univariate analysis showed that patients with Medicare insurance were more likely to be discharged to institutional settings (OR = 2.76; 95% CI = [1.22 - 6.22]), but it was found not significant in the multivariate analysis after adjusting for other variables.

Several studies have highlighted the importance of stroke severity in predicting outcomes and discharge destination in patients receiving rehabilitation after stroke.[15, 144, 206] Consistent with previous research,[207, 208] this study also found that the odds of being discharged to an institutional setting increase with the severity of stroke. Patients discharged from the inpatient rehabilitation hospital were 7 times more likely to go to institutional settings than to be discharged to the community if they had severe stroke (NIHSS $\geq$ 14). This finding is in agreement with previous studies that assessed the relationship between stroke severity, measured by the NIHSS, and discharge destination.[207, 209] Others have examined the use of the OPS as a measure of stroke severity in predicting outcomes after stroke inpatient rehabilitation,[210, 211] and some have suggested that compared to the NIHSS, the OPS had a stronger predictive value in predicting outcomes such as functional status[176] and discharge destination.[212] Patients with a high score on the OPS are more likely to be discharged to institutional settings.[212] In our study, for every one-point increase in the OPS, the odds of being discharged to an institutional setting was increased by 2.3 (95% CI [1.6 – 3.3]; $P < .001$). Other clinical and stroke-related variables such as stroke type and lesion site did not differ between the discharge groups and were not significantly associated with discharge destination. Most studies agreed with our results[137, 147, 195] and indicated that these variables may not have a strong influence on discharge destination.[7]

To our knowledge, this study was the first to examine the predictive ability of the Lawton IADL scale for predicting destination after discharge from an inpatient rehabilitation hospital. Our current findings suggest that in the univariate analysis a high score on the total Lawton IADL scale at admission was significantly associated with a lower risk of being institutionalized. However, in a multivariate analysis, this finding was no longer significant when LOS, admission BI score, atrial fibrillation, and OPS score were adjusted. Several researchers have evaluated the role of functional status, specifically activity limitations at admission to rehabilitation in predicting discharge destination.[4, 5, 14, 135, 137, 148, 150, 153] They have noted that lower functional status was associated with discharge to an institution.[5, 138, 197] Most researchers who have observed this association used common outcome measures of activity limitation including the BI and the FIM, which assess only basic activities and fail to capture a wider range of activity limitations that are more complex and necessary for community function.

Activity limitations in terms of IADL and their role in predicting outcomes after rehabilitation have not been studied extensively. Studies have supported the association of IADL limitations and discharge destination in different populations.[213, 214] A study of 109 patients admitted to a rehabilitation hospital after a hip fracture found that low Lawton scores on admission was associated with discharge to an institution.[213] In a prospective cohort study of older patients in an acute care setting, Zureik et al. (1995) found a significant association between IADL status at admission and discharge destination after hospitalization.[214] Compared with other studies, this study further confirmed the effect of IADL in determining a patient's discharge destination following inpatient rehabilitation after stroke. The finding indicates that those who had better IADL status at admission were less likely to go to institutional settings after rehabilitation.

This study also was the first to report that of the 9 items of the Lawton IADL scale, only one item (telephone use) was identified as a significant predictor of patients being discharged to an institution from an inpatient rehabilitation hospital. We hypothesized that certain items on the Lawton scale including telephone use, handling medications, and handling finances would be better than other items at predicting discharge destination. Although no similar studies of individual Lawton items relative to discharge destination were found, dependence on these items was shown to be associated with cognitive function and highly predictive of dementia in community-dwelling older people.[109, 121] In this study, however, we only found item 1, which tests the ability to use a telephone, to be a significant predictor of discharge destination. Subjects with a high score on item 1 (telephone use) of the Lawton scale were 2.22 times less likely to be discharged to an institutional setting. Each of the above-mentioned items involves multifaceted abilities required for community living. Each item requires higher levels of cognitive processing such as conceptual abilities, orientation, memory, and physical functioning to perform these tasks. Accordingly, cognitive impairment—particularly executive dysfunction—may play an important role in determining the best destination following rehabilitation. However, neither the sub-item scores nor the total score were significant in the multivariate model. A possible explanation for this finding could be that the Lawton IADL scale (total and sub-item scores) was associated with one or more of the variables in the model. As shown in the correlation analysis, the strongest correlation of the Lawton scale was seen with the BI (Pearson $r = 0.345$), which may indicate that the significance result seen in the univariate analysis was influenced by BI or by the information this scale captured. Another possible reason might be due to the small sample size in the multivariate model and that most of our patients in this study had high instrumental ADL impairment (mean ± SD; 12 ± 3). Accordingly, low variability in the Lawton scale will make it less likely to explain more variance in discharge destination. Further investigation may be needed with a larger sample size and wider range of IADL functional status to clarify the effect of instrumental ADL in predicting discharge destination after inpatient rehabilitation.

4.4.2 Multivariate analysis of variables affecting discharge destination

Our model gave an overall accuracy of 78% in predicting discharge destination after inpatient rehabilitation. Admission BI score and stroke severity as measured by the OPS were associated with a higher risk of institutionalization. A higher score on the BI on admission, which indicates less functional dependence, decreases the odds of being discharged to an institutional setting by a factor of 0.95. Previous studies have also reported the significant relationship between functional status, as measured by the BI and discharge destination.[16, 145] However, these studies included only patients who received acute care rehabilitation. Pinedo et al. (2014) addressed the inpatient rehabilitation population and found that patients who were totally dependent on admission, as measured by the BI, had 2.95 times higher risk of going into an institutional setting on discharge.[139] In our study, even though BI was a significant variable, it did not appear to be a strong predictor of discharge destination as we can notice from the OR value, which was close to 1 point (OR = 0.95).

Regarding stroke severity, previous research also evaluated the association between stroke severity, measured by the OPS, and discharge destination. Our data analysis found that stroke severity was significantly associated with discharge to an institutional setting. Our finding are supported by Kalra et al. (1994), who reported also that the predictive value of the OPS in the intermediate group (OPS, 3.2-5.2) was not strong compared to the mild and severe group for predicting dependence and discharge destination in older stroke patients.[215] The result of multivariate analysis showed that the strongest predictor of discharge to an institutional setting was stroke severity as measured by the OPS. This information could be used to facilitate an early discharge planning process. Using the OPS to provide an early indicator of where a patient's most likely discharge location will be may allow for more successful clinical pathways that best meet a patient’s needs, shorten length of stay, and minimize costs associated with inappropriate use of rehabilitation resources. It may be useful to stratify patients based on their levels of stroke severity and enable patients who require additional rehabilitation treatment to enter such facilities sooner and minimize additional services that add costs without meaningful benefit to the individual experience of care.

The main finding of this study is that instrumental IADL as measured by the Lawton scale was not an independent predictor of discharge destination. Even though IADL functional status alone was a significant predicting factor for discharging a patient to an institutional setting, it was not significant in a multivariate model. This may be in part because of the correlation between the Lawton scale and the other variables. Moreover, although others have found a significant association between instrumental ADL and discharge destination in different populations, this relationship may not be detectable in the early stage after stroke, given that other factors such as dependence in basic ADL activities may be more important at this stage than complex ADL activities. In addition, the predictive value of instrumental ADL could be more important among patients from a community-based sample to identify patients who are at high risk of being institutionalized or re-hospitalized. As in this stage, instrumental activities could be the main concern for these patients and may influence their living locations. Our multivariate analysis suggests that a patient’s basic functional abilities and stroke severity should be evaluated and recorded during the first days in an inpatient rehabilitation facility, being the most important aspect in determining a discharge location.

4.5 LIMITATIONS

This study has several limitations that need to be considered. A major limitation was the use of retrospective data collected from the comprehensive assessment toolbox charts that were originally used for clinical purposes and practice improvement, but not for our specific research purposes. As a result, missing and inaccurate data or failure to meet our inclusion criteria may have a major impact on the generalizability and the findings of this study. Approximately half of the individuals (42%) were excluded due to missing data on the outcome variable. Moreover, the data used in the present study were obtained from a single inpatient rehabilitation facility; it is unknown how the Lawton scale would perform in other facilities. Future studies may need to evaluate the predictive utility of the Lawton scale at predicting discharge destination in larger and diverse communities, which would improve the generalizability of study findings. Another limitation is that discharge destination could be influenced by many other factors such as premorbid living status, presence of family or caregiver support, availability of services, and patient preferences, but they were not available in this dataset. However, in this study we included most of the variables that have previously been shown to be important predictors of discharge destination; unmeasured variables may have affected our findings. Furthermore, our model only explained a small proportion (33%) of the variation in discharge destination, which indicates that a larger proportion of the variation was apparently influenced by other factors. All these potential important factors for predicting discharge destination should be taken into account in future studies.

4.6 CONCLUSION

In conclusion, our data analysis indicates that instrumental ADL status, as measured by the Lawton scale, was a significant variable of discharge destination in patients receiving inpatient rehabilitation after stroke, but not independent of basic ADL functional status. The findings of this study confirm the fact that activity limitation, in particular basic ADL function at admission, is significantly associated with post-rehabilitation discharge destination. Stroke severity as measured by the OPS was the main determinant in differentiating community and institutional discharges following inpatient rehabilitation. Other important factors previously reported to have strong influence on discharge destination in patients after stroke (such as age, marital status, and insurance coverage) did not contribute to the prediction of discharge destination. Further investigation is needed to understand the predictive value of instrumental ADL status in predicting discharge destination among stroke population.

5.0 EFFECT OF DEPRESSIVE SYMPTOMS ON DISCHARGE DESTINATION IN A STROKE POPULATION AFTER UNDERGOING INPATIENT REHABILITATION

5.1 INTRODUCTION

In the United States, strokes are the most common cause of disability, affecting nearly 800,000 people annually[2], and place a huge physical and socioeconomic burden on patients, their families, and society.[216] In 2010, the estimated direct and indirect costs associated with stroke care was about $36.5 billion,[2] with the vast majority of the direct costs coming from longer hospital stays and admissions to institutions or long-term care facilities.[217, 218] Therefore, careful planning is necessary in terms of optimizing health care services and minimizing costs associated with the inappropriate use of services and financial resources.[4] Ideally, after a stroke, individuals would receive rehabilitation services to enhance the recovery process and minimize functional disability. Stroke rehabilitation starts early during the acute hospitalization once the diagnosis of a stroke is identified and medical stability has been achieved. Following discharge from acute care hospitals, post-acute rehabilitation services are required and necessary for returning patients post-stroke to their prior status. Selecting the most appropriate setting at discharge is important to ensure optimal, efficient and effective health care. Therefore, accurately predicting discharge destination early in the rehabilitation process is important in the determination of further care. Various clinical and nonclinical factors such as the patients' functional and emotional status, family support, and patient or relatives' preferences may have an influence on the discharge selection.[219]

Depression after a stroke is one of the most common emotional disorders,[220] affecting approximately one-third of all stroke survivors at some point after the onset of a stroke,[23] with the period of highest occurrence being the first 3 to 6 months following a stroke.[221] Longitudinal studies after a stroke have shown that the prevalence rates of depression after a stroke varies widely depending on the setting of the study and the time of the assessment after a stroke.[222, 223] Higher rates of depressive symptoms after a stroke have been reported among individuals in acute and rehabilitation hospitals,[159] and is more likely to develop in the third month or subsequent months after a stroke and remain high up to two years after the onset of a stroke.[221, 224]

The presence of depressive symptoms after a stroke is likely caused by either biological factors that originate from the brain injury and vascular lesions underlying the stroke,[225, 226] or from a psychological reaction toward the functional and cognitive impairments resulting from the stroke.[162, 227] Several studies have found a positive association between post-stroke depression and physical disability,[228, 229] stroke severity[230] and cognitive impairment,[231, 232] thus, depressive symptoms may arise as a response to this disability and subsequent loss. Conversely, there is strong evidence suggesting that lesion location, which primarily affects the left frontal lobe and basal ganglia is significantly associated with depressive disorders,[225, 233, 234] suggesting that biological factors may be involved in the mechanism of post-stroke depression. However, other authors have considered both mechanisms as possible causes of depressive symptoms following a stroke,[221, 235] with the biological factors contributing during the first months after stroke[225] and the psychological reaction occurring during the later stages.[236] Other reported risk factors such as age, gender, past medical or psychiatric history, and presence of social support have shown no consistent relationship with the development of depression after stroke.[237] Ultimately, the existence of depressive symptoms after a stroke may depend on the complex interactions of the biological and psychosocial factors.[238]

Diagnosing and examining depressive symptoms in patients after a stroke can be challenging given that some symptoms such as sleep, appetite disturbance, and lack of concentration could result from the stroke itself. In addition, an evaluation may be complicated by the onset of serious aphasia or dementia that may accompany a stroke. Therefore, many studies have defined depression post-stroke by using structured interviews to identify certain criteria based on the Diagnostic and Statistical Manual of Mental Disorders, (DSM-IV), which has been recommended in the literature as the accepted definition for the diagnosis of post-stroke depression. However, the clinical application of the DSM-IV criteria in stroke patients may be hampered due to serious cognitive and communicative deficits. In addition, clinicians have used a variety of screening tools to identify depressive symptoms and monitor the patients' progress. The most commonly used scales are the Beck Depression Inventory (BDI),[239] the Hamilton Depression Rating Scale (HDRS),[240] the Geriatric Depression Scale (GDS),[27] the Zung Self-Rating Depression Scale (ZSDS) and the Hospital Anxiety and Depression Scale (HADS).[241] Although these tools were not specifically developed for persons post-stroke, validation studies have supported the use of these measures in the stroke population.[242, 243] Agrell and Dehlin (1989) compared the GDS to other depression rating scales and found that both the GDS and the ZSDS[244] were the best self-rating scales when used in stroke patients.[245]

Studies have shown that post-stroke depression has a negative impact on the patients' recovery and their ability to participate in rehabilitation,[24, 246] which might complicate or delay stroke recovery. The literature on the impact of depressive symptoms on recovery and stroke outcomes has resulted in inconsistent findings,[247] which may be in part due to methodological issues and differences in the time of post-stroke assessment.[247] The overall trend shows that depression after a stroke negatively influences functional outcomes[22, 248] with respect to both increased dependency in ADL[249], reduced participation in rehabilitation,[24] reduced quality of life[250], and increased mortality.[251] Considering these negative outcomes associated with post-stroke depression, one might expect that persons with depression after a stroke would have higher rates of health care utilization compared to non-depressed patients. However, limited information is available on the effect of post-stroke depression on inpatient and total health care use.[26] Most studies have examined the impact of depression on length of stay in rehabilitation settings.[24, 25] Those studies have found that patients with higher levels of depressive symptoms in the acute phase had a longer stay in rehabilitation hospitals[25, 166, 252] and had higher subsequent health use in the 12 months after a stroke.[25] Moreover, depressive symptoms upon hospital admission were associated with an increased risk of hospital readmission and institutional placements during follow-up.[248, 253] Little is known about the impact of depression on other stroke outcomes such as discharge destination and quality of life.

Given that depression at the time of admission has been associated with physical functional limitations, cognitive impairments, and increased health care utilization, depression may have a negative impact on the rehabilitation process, which may, in turn, require additional services and the institutionalization of stroke survivors. Thus, depression may contribute to the patients' discharge planning decision. One study examined the impact of prior depression at the time of hospital admission on length of hospital stay and discharge destination.[26] They found that patients who were depressed at the time of admission were more likely to be discharged to institutional care rather than to their home after an acute stroke hospitalization.[26] However, no studies have examined the impact of post-stroke depression at the time of rehabilitation admission on discharge destination after rehabilitation. Therefore, the purpose of this study was to examine the impact of depressive symptoms on discharge destination among persons post-stroke in rehabilitation settings and to identify whether changes in depressive symptoms during rehabilitation have an impact on discharge destination. We anticipated that patients with a high level of depressive symptoms at the time of admission (GDS>5) were more likely to be discharged to an institution than the community. We also hypothesized that patients who were depressed at the time of admission and showed improvements in depressive symptoms at the time of discharge from the rehabilitation hospital were more likely to be discharged to the community, while patients with persistent or worsening depressive symptoms at the time discharge from the rehabilitation hospital were more likely to be discharged to an institution.

5.2 METHODS

5.2.1 Data source and study design

The retrospective analysis in this study was based on data collected from the comprehensive assessment toolbox charts that were administrated to patients after a stroke who were admitted to the Steward Health acute care hospitals and referred to the Hillside Rehabilitation Hospital (HRH) in Youngstown, OH, between 2004 and 2010. The toolbox was implemented across the medical system as a part of their stroke center of excellence.[61] It was designed to provide data about a patient's demographic information, stroke characteristics, functional outcome measures, and discharge destinations. A data set of the patients' characteristics and demographic data at the time of admission was provided through a data use agreement that was approved by the University of Pittsburgh's Office of Research. In addition, the Institutional Review Board approved this study, and all data were handled according to HIPAA guidelines.

5.2.2 Subjects

The subjects were eligible for this study if they were admitted to the HRH from 2004 to 2010 and completed the comprehensive assessment toolbox at the time of admission. Subjects over 18 years of age who were diagnosed with a first or recurrent ischemic or hemorrhagic stroke were included in the analysis. For the subjects with multiple admissions, only the first admission was included. The subjects who had missing data on their discharge destination or if they were discharged back to the acute hospital setting were excluded from the analysis.

5.2.3 Data collection

In 2002, the medical system started implemnting the toolbox across all patients with a stroke as a part of the development of a specialized stroke unit program. Prior to 2002, all the staff members and professionals involved in patient assessment were trained on the appropriate use of assessment tools and proper documentation through group sessions or individual meetings.[61] From January 2002 onward, the assessment toolbox was used. Patients were assessed using the stroke toolbox within 72 hours of admission and at the time of discharge by trained health care professionals. The dataset included information about patients' demographics, comorbidities, stroke characteristics, prior levels of functioning, presence of social support, cognition, depression, disabilities, functional status, and discharge destinations. Data from 2002 to 2004 were previously analyzed and published.[61] In this dataset, we were interested in the patients' emotional status, particularly depressive symtpoms, and the impact of these symtpoms in predicting discharge destination following rehabilition.

5.2.4 Outcome variable

The outcome variable of interest was discharge destination. In this study, discharge destinations were collapsed to create a dichotomous variable. Home with assistance and home/independent were combined together to produce a variable that indicated a discharge to a community setting. Institutional settings included subacute rehab and skilled nursing facilities.

5.2.5 Predictor variables

The primary independent variable was depressive symptoms, and change in depressive symptoms was measured by the Geriatric Depression Score (GDS) using both the total score at the time of admission as well as the dichotomous variable at a cutoff score of five. The GDS is a self-reported screening measure that assesses depressive symptoms in older adults.[27] The original 30 items were reduced to 15 for older adults who had short attention spans and were easily fatigued.[178] Scores ranged from 0 to 15, with a score of >5 is **suggestive of depression** and a score of >10 indicate highly likely depression. .[254] The reliability of the GDS has been established in subjects from a variety of populations and has been shown to demonstrate adequate internal consistency (Cronbach alpha ranging from 0.74–0.86)[179] and excellent test-retest reliability (r = .75).[180] In addition, high correlations ranging from 0.58 to 0.89 have been found between the GDS and other depression measures.[181]

Other independent variables included demographic information (age, sex, race, and marital status); risk factors (history of previous stroke, smoking, diabetes mellitus, high cholesterol, alcoholism, high blood pressure, and atrial fibrillation); stroke characteristics [number of days from a stroke onset to rehabilitation, type of stroke (i.e. ischemic, hemorrhagic, or other), lesion site, and stroke severity as measured by the Orpington Prognostic Scale[63] (OPS)]; comorbidities as measured by the Charlson Comorbidity Index[173]; social support (living with someone or alone); prior functional status as measured by the BI[78]; limitations in physical activities as measured by question three on the short form-36, which is a generic health survey that is often used as a measure of health-related quality of life[88]; neurological impairments as measured by the National Institute of Health Stroke Scale (NIHSS)[62]; and length of stay at the rehabilitation hospital. Additional data included the total admission scores on each of the following measures: the Mini-Mental Status Examination,[82] the Geriatric Depression Scale,[27] the Barthel Index,[78] and the Rankin Scale.[174]

5.2.6 Statistical analysis

All the statistical analyses were conducted using SPSS software V.19.0J (SPSS, Chicago, Illinois, USA). Descriptive statistics were calculated for all variables to describe the sample in relation to the discharge destination. For continuous variables, the means and standard deviations (SD) were reported. For categorical variables, frequencies and percentages were presented.

The univariate analysis was used to examine the association between the depressive symptoms at the time of admission and/or changes in depressive symptoms and discharge destinations (community vs. institutional settings). The relationship between the categorical measures of initial depression status/change in status and discharge destination was evaluated using a contingency table with a chi-square analysis. The mean differences in the GDS scores and changes in the GDS scores between the discharge groups were determined using the nonparametric Kruskal-Wallis test.

The categorical and continuous measures of the initial depressive status/change in status that demonstrated a univariate association with the discharge destination at $p<0.15$ were considered in a multivariate regression model in order to assess the relationship between the baseline depression status and the change, with adjustments for demographic data, comorbidities, social support, and stroke characteristics, as determined previously. The categorical and continuous measures of the initial depressive status/change in status were included separately, and models were compared using likelihood statistics with chi-square analysis and the coefficients of determination to identify the best subset of variables associated with discharge destination. Odds ratios with 95% confidence intervals for measures of depression favoring institutional care placement relative to home discharge were estimated, and the significance were determined at $p<0.05$.

5.3 RESULTS

5.3.1 Patient characteristics

The demographic and clinical characteristics of 187 patients included in the study and the univariate analysis results are listed in Tables 22-24. Of the 187 patients included, 122 (65%) were discharged from the inpatient rehabilitation facility to a community setting and 65 (35%) were discharged to institutional settings. There was a large amount of missing data for depressive symptoms, with 47 cases (25%) having missing values at their admission GDS score and 60 cases (32%) having missing values at discharge. The average GDS score of the sample at admission was 4 (SD = 3), higher scores indicate greater symptoms of depression. At discharge, 54% of the stroke survivors showed an improvement in the total GDS score, 17% had worsened, and 29% had no change in their total GDS score (Table 25).

Table 22. Demographics of the entire sample, those discharged to the community versus an institution.

Predictor variables	Total sample N= 187		Community N=122		Institutional N=65		
Demographics	**N/M (%)**		**N**		**N**		***P***
Age Median (IQR) Mean ± SD	174/13 (6%)	76 (67 - 84) 75 ± 13	114	75 (63 - 84) 74 ± 13	60	77 (70 - 85) 77 ± 12	.136
Length of stay Median (IQR) Mean ± SD	185/2 (1%)	20 (13 - 27) 20 ± 9	121	18 (13 - 24) 19 ± 9	64	21 (16 - 28) 22 ± 10	.011
Onset date Median (IQR) Mean ± SD	163/24 (13%)	7 (5 - 9) 9 ± 16	109	6 (4 - 8) 9 ± 18	54	7 (5 - 10) 10 ± 8	.028
Year of admission 2004 2005 2006 2007	187/0 (0%)	5 (3%) 96 (51%) 32 (17%) 54 (29%)	122	1 (0.8%) 67 (55%) 18 (15%) 36 (30%)	65	4 (6%) 29 (45%) 14 (22%) 18 (28%)	.096
Sex Female Male	175/12 (6%)	95 (54%) 80 (46%)	115	58 (50%) 57 (50%)	60	37 (62%) 23 (38%)	.157
Race White African American Hispanic	163/24 (13%)	145 (89%) 16 (10%) 2 (1%)	106	92 (87%) 12 (11%) 2 (2%)	57	53 (93%) 4 (7%) 0 (0%)	.270
Health insurance Medicare Medicaid Private Uninsured	168/19 (10%)	122 (73%) 9 (5%) 32 (19%) 5 (3 %)	110	73 (66%) 7 (6%) 25 (23%) 5 (5%)	58	49 (85%) 2 (3%) 7 (12%) 0 (0%)	.029
Marital status Married Divorced/separated Widowed Never married	168/19 (10%)	72 (43%) 19 (11%) 67 (40%) 10 (6%)	110	50 (46%) 15 (14%) 39 (36%) 6 (6%)	58	22 (38%) 4 (7%) 28 (48%) 4 (7%)	.282
Social support Full social support Partial social support No social support Unknown	159/28 (15%)	152 (96%) 3 (2 %) 3 (2 %) 1 (0.6%)	106	100 (94%) 3 (3%) 2 (2%) 1 (1%)	53	52 (98%) 0 (0%) 1 (2%) 0 (0%)	.348

*Abbreviation: N/M= number of valid cases/ missing cases, (%) = percentage of missing cases, P= p-value set at 0.05, IQR= interquartile range, SD= standard deviation, Full social support= having someone who is able to help the patient as long as needed, Partial social support= having someone who is able to help the patient for only a short period of time.

Table 23. Clinical characteristics of the total sample, those discharged to community versus an institution.

Predictor variables	Total sample N= 187		Community N=122		Institutional N=65		
Clinical factors	**N/M (%)**		**N**		**N**		***P***
Previous stroke Yes	162/25 (13%)	42(26%)	106	31 (29%)	56	11 (20%)	.185
Previous TIA Yes	162/25 (13%)	14 (9%)	105	7 (7%)	57	7 (12%)	.234
Risk factors							
Current smokers	161/26 (13%)	39 (24%)	105	28 (27%)	56	11 (20%)	.322
Former smokers	156/31 (16%)	68 (44%)	103	49 (48%)	53	19 (36%)	.162
Diabetes mellitus	164/23 (12%)	58 (35%)	108	37 (34%)	56	21 (38%)	.681
High cholesterol	156/31 (16%)	37 (24%)	102	25 (25%)	54	12 (22%)	.749
Alcoholism	162/25 (13%)	12 (7%)	107	10 (9%)	55	2 (4%)	.225
High blood pressure	163/24 (12%)	82 (50%)	106	54 (51%)	57	28 (49%)	.825
Atrial fibrillation	162/25 (13%)	28 (17%)	106	14 (13%)	56	14 (25%	.059
Comorbidities (CCI)	173/14 (7%)		114		59		.566
Low comorbidity (0-2)		44(25%)		34 (30%)		10 (17%)	
High comorbidity (≥3)		129(75%)		80 (70%)		49 (83%)	
Median ± IQR		3 (3-4)		3 (2- 4)		3 (3 – 4)	
Mean ± SD		3.4 ± 2		3.3 ± 2		3.5 ± 2	
Stroke type	162/25 (13%)		106		56		.090
Hemorrhagic		5(3%)		1 (1%)		4 (7%)	
Ischemic		142(88%)		94 (89%)		48 (86%)	
Uncertain		15(9%)		11 (10%)		4 (7%)	
Stroke location	161/26 (13%)		105		56		.860
Left hemisphere		75(47%)		48 (46%)		27 (48%)	
Right hemisphere		74 (46%)		49 (47%)		25 (45%)	
Cerebellar		7 (4%)		4 (4%)		3 (5%)	
Uncertain		4 (3%)		3 (3%)		1 (2%)	
Bilateral		1 (.6%)		1 (1%)		0 (0%)	
Neurological deficits	137/50 (27%)		91		46		**P<.001**
Mild (≤ 5)		48 (35%)		38 (42%)		10 (22%)	
Moderate (6 - 13)		59 (43%)		43 (47%)		16 (35%)	
Severe (≥ 14)		30 (22%)		10 (11%)		20 (44%)	
Median (IQR)		7 (4-13)		6 (4 - 10)		12 (7- 16)	
Mean ± SD		9 ± 6		7 ± 5		12 ± 6	
Orpington scale level	130/57 (30%)		90		40		**P<.001**
Minor (<3.2)		34(26%)		31 (34%)		3 (7%)	
Moderate (3.2-5.2)		76(59%)		52 (58%)		24 (60%)	
Severe (>5.2)		20(15%)		7 (8%)		13 (32%)	
Median (IQR)		3.8(2.8-4.4)		3.6 (2.8- 4)		4 (3.7- 5.6)	
Mean ± SD		4 ± 1		3.5 ± 1		4.6 ± 1	

*Abbreviation: N/M= number of valid cases/ missing cases, (%) = percentage of missing cases, P= p-value set at 0.05, IQR= interquartile range, SD= standard deviation, CCI= Charlson Comorbidity Index, BI= Barthel Index

Table 24. Outcome measures scores for the total sample, those discharged to the community versus an institution.

Predictor variables	**Total sample N= 187**		**Community N=122**		**Institutional N=65**		
Outcome measures	**N/M**		**N/M**		**N/M**		***P***
Short Form 36	133/54		93		40		.970
Median (IQR)	(28%)	60(25 - 95)		60 (25 - 95)		70 (27 - 95)	
Mean ± SD		59 ± 36		59 ± 36		60 ± 36	
Prior BI score	166/21		108		58		.508
Median (IQR)	(11%)	100 (95-100)		100 (95-100)		100 (100-100)	
Mean ± SD		95 ± 12		95 ± 10		94 ± 15	
Adm. MMSE score	132/55		90		42		**.016**
Median (IQR)	29%	22 (18 - 26)		23 (19 - 27)		20 (16 -24)	
Mean ± SD		21 ± 6		22 ± 6		19 ± 6	
Adm. BI score	143/44		93		50		**P<.001**
Median (IQR)	23%	25 (10 - 45)		35 (20 - 45)		10 (4 - 25)	
Mean ± SD		28 ± 20		34 ± 19		16 ± 17	
Adm. Lawton score	177/10		116		61		**.009**
Median (IQR)	5%	11 (10 - 12)		11 (10 - 12)		11 (9 - 12)	
Mean ± SD		12 ± 3		12 ± 4		11 ± 2	
Adm. Rankin score	160/27		103		57		**P<.001**
1	14%	1 (.6%)		1 (1%)		0 (0%)	
2		1 (.6%)		1 (1%)		0 (0%)	
3		4 (3%)		4 (4%)		0 (0%)	
4		134 (84%)		92 (89%)		42 (74%)	
5		20 (13%)		5 (5%)		15 (26%)	
Median (IQR)		4 (4 - 4)		4 (4 - 4)		4 (4 - 5)	
Mean ± SD		4 ± .4		3.9 ± .46		4.2 ± .44	

*Abbreviation: N/M= number of valid cases/ missing cases, (%) = percentage of missing cases, P= p-value set at 0.05, IQR= interquartile range, SD= standard deviation, BI= Barthel Index, Adm.= admission, Adm. MMSE = admission Mini-Mental State Examination, Adm. BI score= admission Barthel Index score.

Table 25. Association between depressive symptoms and discharge destination (as a continuous measure).

	Total sample N= 187		Community N=122		Institutional N=65		
Variable	**N/M**		**N/M**		**N/M**		***P***
Admission GDS score	140/47		95		45		.071
Median (IQR)	25%	4 (2 - 6)		4 (2 - 6)		5 (3 - 7)	
Mean ± SD		4 ± 3		4.2 ± 3		5 ± 3	
GDS change scores	115/72		80		35		.194
(GDS $_{baseline}$ - GDS $_{discharge}$)	38%						
No change		33 (29%)		22 (27%)		11 (31%)	
Improved		62 (54%)		47 (59%)		15 (43%)	
Worsened		20 (17%)		11 (14%)		9 (26%)	
Mean ± SD		1.31 ± 2.77		1.44 ± .312		1.03 ±.463	

*Abbreviation: N/M= number of valid cases/ missing cases, (%) = percentage of missing cases, P= p-value set at 0.05, IQR= interquartile range, SD= standard deviation, GDS = Geriatric Depression Score.

In addition, the total GDS scores were grouped into three categories: score ≤ 5, score > 5 and score > 10, where a higher score reflects more symptoms of depression. Approximately 69% of the sample had no depressive symptoms and only 31% had mild to severe depressive symptoms. Among patients who were depressed at admission, 54% were no longer depressed at discharge, and 46% remained depressed (but improved, 20%; worsened, 13%; no change, 13%). Patients who were discharged to institutional settings had a higher level of depressive symptoms (GDS score; 5 ± 3 vs. 4.2 ± 3) than patients discharged to community settings (Table 26).

Table 26. Association between depressive symptoms and discharge destination (as a categorical measure).

	Total sample N= 187		Community N=122		Institutional N=65		
Variable	N/M		N/M		N/M		*P*
Depressive symptoms	140/47		95		45		.071
Normal (≤5)	25%	97 (69%)		71 (75%)		26 (58%)	
Mild (>5)		36 (26%)		19 (20%)		17 (38%)	
Severe (>10)		8 (5%)		5 (5%)		2 (4%)	
Change in depressive symptoms	46/141		28		18		.158
No longer depressed	75%	25 (54%)		18 (64%)		7 (40%)	
Remained depressed but improved		9 (20%)		6 (21%)		3 (17%)	
Remained depressed and worsened		6 (13%)		2 (7%)		4 (22%)	
Remained depressed, no change		6 (13%)		2 (7%)		4 (22%)	

*Abbreviation: N/M= number of valid cases/ missing cases, (%) = percentage of missing cases, P= p-value set at 0.05.

5.3.2 Univariate analysis of association between depressive symptoms and discharge destination

Univariate logistic regression analysis results for depressive symptoms at admission to inpatient rehabilitation and change in depressive symptoms with discharge destination are shown in Table 27 as continuous variables and categorical variables in Table 28. As a continuous measure, the relationship between the independent variables and discharge destination were found to be not significant (GDS score; OR=1.1, 95%CI= .96-1.2, P= .149). As a categorical measure, results indicated that depressive status at admission was significantly associated with discharge destination from inpatient rehabilitation. Compared with patients who were not depressed at admission, patients with possible depressive symptoms at admission (GDS >5) were discharged to an institution more often after inpatient rehabilitation (n=143, OR= 2.7, 95%CI= 1.2-6.1, P= .017). Changes in depressive status measured either as a continuous or categorical variable were not significantly associated with the discharge destination following inpatient rehabilitation.

Table 27. Univariate analysis of baseline GDS score as a continuous measure.

Variable	Unadjusted				Adjusted for Age		
Outcome Measures	**N**	**β**	**OR (95% CI)**	**P**	**N**	**OR (95% CI)**	**P**
Baseline GDS score	140	.078	1.1 (.96 - 1.2)	.183	130	1.1 (.96 -1.2)	**.149**
GDS change scores Changed vs. no change	115	-.056 .189	.94 (.81 – 1.1) 1.2 (.50 – 2.8)	.466 .668	107	1.0 (.85 - 1.2) 1.0 (.99 - 1.06)	.986 .995

* Abbreviation: N= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, P= p-value, GDS= Geriatric Depression Score.

Table 28. Univariate analysis of baseline GDS score as a categorical measure.

Variable	Unadjusted				Adjusted		
Outcome Measures	**N**	**β**	**OR (95% CI)**	**P**	**N**	**OR (95% CI)**	**P**
Depressive symptoms Depressed vs. normal	140	.771	2.2 (1.0 - 4.6)	**.044**	130	2.7 (1.2 - 6.1)	**.017**
Depressive symptoms No change vs. no longer depressed	46	1.638	5.1 (.76 - 34.6)	.093	43	2.69 (.30 - 23.9)	.373
Remained depressed but improved vs. no longer depressed		.251	1.3 (.25 - 6.6)	.764		1.1 (.20 - 6.08)	.894
Remained depressed and worsened vs. no longer depressed		1.638	5.1 (.76 - 34.6)	.093		6.3 (.54 - 75.1)	.140

* Abbreviation: N= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, P= p-value.

5.3.3 Multivariate analysis of the association between depressive symptoms and discharge destination

Multivariate logistic regression analyses were analyzed to assess the independent association between demographic, clinical and functional characteristics with discharge to an institutional setting. Only significant variables from univariate analysis were included into the multivariate regression analyses, and significance was set at a p-value of ≤ 0.15. Variables were grouped into three categories, and each category was examined separately using the backward elimination stepwise method; the significance level criterion for variable entry was $p < 0.05$ and $p > 0.10$ for removal. Three models were examined: model 1, including age and length of stay at inpatient rehabilitation (see Table 29); model 2, including history of previous stroke, comorbidities, atrial fibrillation and OPS score (see Table 30); and model 3, including total admission MMSE score, total admission BI score, total admission GDS score coded as a continuous variable and admission Rankin score coded as a categorical variable (Table 31).

Table 29. Results from the multivariate logistic regression analysis of discharge destination (Model 1).

Step no.	***Predictor variables (n=173)***	***Multivariate analysis (Backward elimination method)***			
		β	OR	95% CI	*P*
Step 1	Age	.020	1.02	.99 – 1.04	.123
	Length of stay	.038	1.03	1.00 – 1.07	.042
Step 2	Length of stay	.035	1.03	1.00 – 1.07	**.051**

* Abbreviation: n= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, P= p-value.

Table 30. Results from the multivariate logistic regression analysis of discharge destination (Model 2).

Step no.	***Predictor variables (n=110)***	***Multivariate analysis (Backward elimination method)***			
		β	OR	95% CI	P
Step 1	OPS levels				.010
	Minor vs. severe	-2.588	.075	.014 – .400	.002
	Moderate vs. severe	-1.055	.348	.10 – 1.17	.089
	Previous stroke	-.523	.593	.20 – 1.75	.344
	Atrial fibrillation	1.04	2.84	.95 – 8.48	.060
	Comorbidities/ CCI				
	Low vs. high	-.116	.891	.28 – 2.75	.841
Step 2	OPS levels				.005
	Minor vs. severe	-2.639	.071	.014 – .353	.001
	Moderate vs. severe	-1.081	.339	.104 – 1.11	.074
	Previous stroke	-.525	.592	.200 – 1.74	.342
	Atrial fibrillation	1.045	2.84	.95 – 8.46	.061
Step 3	OPS levels				**.004**
	Minor vs. severe	-2.720	.066	.013 – .324	.001
	Moderate vs. severe	-1.197	.302	.095 – .965	.043
	Atrial fibrillation	1.042	2.83	.96 – 8.63	**.059**

* Abbreviation: n= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, P= p-value, OPS= Orpington Prognostic Score, CCI= Charlson Comorbidity Index.

Table 31. Results from the multivariate logistic regression analysis of discharge destination.

Step no.	***Predictor variables (n=92)***	***Multivariate analysis (Backward elimination method)***			
		β	OR	95% CI	P
Step 1	Admission MMSE score	.011	1.01	.93 – 1.09	.786
	Admission BI score	-.051	.951	.91 – .98	.003
	Admission Rankin score				.984
	Mild vs. severe	-18.901	.000	.000	.999
	Moderate vs. severe	.187	1.20	.15 – 9.24	.857
	Admission GDS score	.116	1.12	.95 – 1.32	.164
Step 2	Admission BI score	-.049	.952	.92 – .98	.003
	Admission Rankin score				.982
	Mild vs. severe	-18.92	.000	.000	.999
	Moderate vs. severe	.197	1.21	.15 – 9.37	.850
	Admission GDS score	.120	1.12	.96 – 1.32	.144
Step 3	Admission BI score	-.051	.950	.92 – .98	.001
	Admission GDS score	.125	1.13	.96 – 1.33	.132
Step 4	Admission BI score	-.052	.949	.92 – .97	**.001**

*Abbreviation: N= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, *P*= *P*-values, MMSE=Mini-Mental State Examination, BI=Barthel Index, GDS= Geriatric Depression Score.

In the final model, only variables that were significant from each category were entered in a single step with significance set at $p < 0.05$. In the final model containing length of stay at rehabilitation, stroke severity measured by the OPS score, atrial fibrillation and total admission BI score, only the total BI score and stroke severity made a statistically significant contribution to the model (Table 32). To examine the effect of the GDS score on discharge destination, two rounds of analyses were conducted for the final model. In the first round, the total GDS admission score variable was added to the model.

Results indicated that the overall model fit was statically significant, $\chi2$ (6, N = 78) = 25.552, p < .001, and the model explained 38% of the variance in discharge destination. However, the independent effect of the total GDS score was not significant (β=.091; P= .396). In the second round, the variable of change in depressive status was added to the previous model. In this round, the stroke severity variable was no longer statistically significant; however, the BI admission score remained significant in all rounds (β= -.055; P=.033). Change in depressive status was not significant (β=.112; P=.494), although the overall model was statically significant, $\chi2$ (7, N = 65) = 24.465, p = .001, and explained 43% of the variance in discharge destination.

Table 32. Results from multivariate logistic regression, including admission total GDS score and change in depressive symptom on patients discharge destination to institutional setting.

Predictor variables	Model A			Model B			Model C		
Model A (n=93)	β	OR	*P*	β	OR	*P*	β	OR	*P*
Total BI score	-.042	.95	.028	-.052	.949	.017	-.055	.947	.033
OPS levels			.094			.130			.600
Minor vs. severe	-2.43	.088	.042	-3.04	.047	.046	-20.7	.000	.998
Moderate vs. severe	-1.52	.217	.053	-1.48	.227	.129	-1.06	.343	.312
LOS	-.012	.989	.759	-.030	.970	.470	-.006	.994	.898
Atrial fibrillation	.139	1.14	.854	.471	1.60	.600	.064	1.06	.951
Model B (n=78)									
Admission GDS score				.091	1.09	.396	-.035	.966	.829
Model C (N=65)									
GDS change scores							.112	1.11	.494
Model Characteristics									
Nagelkerke's R^2	.332			.385			.438		
-2 log likelihood	92.955			75.074			57.327		
Hosmer & Lemeshow test	$\chi2$ (8)= 12.928, p=.114			$\chi2$ (8)= 10.326, p=.243			$\chi2$ (7)= 2.310, p=.941		

* Abbreviation: n= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, P= P-value, BI= Barthel Index, OPS= Orpington Prognostic Score, LOS=Length of Stay, GDS= Geriatric Depression Score.

The relationships between the independent variables (depressive status at admission and changes of depressive status) and discharge destination were also examined by a categorical measure of depressive status based on the GDS score cut-off value at 5. Table 33 presents the adjusted odds ratio and 95% confidence interval results of the backward stepwise logistic regression for all the functional variables that were found to be significantly related to the likelihood of being discharged to an institutional setting. Of all the variables, only the basic daily activity function measured by the BI was significantly correlated with the discharge destination. The individuals with a higher score on the BI were less likely to be discharged to an institutional facility. Variables with a significance level of < 0.10 were used in the multivariate regression analyses; both BI and depressive status were included in the final model. Results of the multivariate logistic regression, including the independent effect of initial depressive status and changes in depressive status, are presented in Table 34. Both the initial depressive status (OR= 3.29; P= .166) and changes in depressive status (OR= 4.07; P=.140) did not significantly contribute to the prediction of discharge destination, $\chi 2$ (7, N = 65) = 26.749, $p < .001$.

Table 33. Results from the multivariate logistic regression analysis of discharge destination.

Step no.	***Predictor variables (n=92)***	***Multivariate analysis (Backward elimination method)***			
		β	OR	95% CI	P
Step 1	Admission MMSE score	.011	1.01	.93 – 1.09	.777
	Admission BI score	-.052	.950	.91 – .98	.003
	Admission Rankin score				.995
	Mild vs. severe	-18.855	.000	.000	.999
	Moderate vs. severe	.103	1.10	.14 – 8.52	.921
	Depressive symptoms				
	Depressed vs. normal	.892	2.43	.89 – 6.66	.082
Step 2	Admission BI score	-.050	.951	.92 – .98	.003
	Admission Rankin score				.994
	Mild vs. severe	-18.87	.000	.000	.999
	Moderate vs. severe	.113	1.11	.14 – 8.62	.914
	Depressive symptoms				
	Depressed vs. normal	.912	2.49	.91 – 6.74	.073
Step 3	Admission BI score	-.052	.949	.92 – .97	.001
	Depressive symptoms				
	Depressed vs. normal	.954	2.59	.95 – 7.04	.061

*Abbreviation: N= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, *P*= *P*-values, MMSE=Mini-Mental State Examination, BI=Barthel Index.

Table 34. Results from multivariate logistic regression, including the presence of depressive symptoms on admission and change in depressive symptom on patients discharge destination to institutional setting.

Predictor variables	Model A			Model B			Model C		
Model A (n=93)	β	OR	*P*	β	OR	*P*	β	OR	*P*
Total BI score	-.042	.95	.028	-.054	.948	.016	-.062	.940	.018
OPS levels			.094			.162			.680
Minor vs. severe	-2.43	.088	.042	-2.91	.054	.060	-20.1	.000	.998
Moderate vs. severe	-1.52	.217	.053	-1.44	.237	.143	-.959	.383	.379
LOS	-.012	.989	.759	-.033	.968	.441	.014	1.01	.784
Atrial fibrillation	.139	1.14	.854	.553	1.73	.538	.017	1.01	.989
Model B (n=78)									
Depressive symptoms									
Depressed vs. normal				.808	2.24	.203	1.191	3.29	.166
Model C (N=65)									
GDS change scores									
Changed vs. no change							1.40	4.07	.140
Model characteristics									
Nagelkerke's R^2	.332			.397			.471		
-2 log likelihood	92.955			74.128			55.043		
Hosmer & Lemeshow test	χ^2 (8)= 12.928, p=.114			χ^2 (8)= 11.098, p=.196			χ^2 (7)= 7.077, p=.421		

* Abbreviation: n= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, P= P-value, BI= Barthel Index, OPS= Orpington Prognostic Score, LOS=Length of Stay, GDS= Geriatric Depression Score.

5.4 DISCUSSION

In examining this database of patients following a stroke who were admitted to an inpatient rehabilitation hospital, we were interested in the effects of having depressive symptoms at the time of admission and changes in depressive symptoms during rehabilitation in predicting discharge destination. In addition, we were interested in to identifying which variables could be predictors for institutional discharge after inpatient rehabilitation post stroke. Findings suggest that the presence of depressive symptoms, when considered alone as a categorical variable, was predictive of discharge to institutional care. When treated as a continuous-level variable, it was not found to be a significant predictor of discharge destination. Change in depressive symptoms was not significantly associated with discharge destination regardless of whether it was entered as a continuous- or a categorical-level variable. Furthermore, in the multivariate regression analysis, neither the depressive symptoms nor the changes in the symptoms were associated with increased odds of discharge to an institutional care. Of all the variables that have been shown to have predictive values for the outcome of discharge destination, admission total BI scores was the main independent predictor of discharge to an institutional setting. The strongest predictor of the discharge destination after an inpatient rehabilitation was "stroke severity," as measured by the OPS.

In this study, we found that 44/140 (31%) of our sample had depressive symptoms (GDS score > 5); 24/95 (25%) of the patients were discharged to a community setting and 19/65 (42%) were discharged to an institutional setting. The number of patients with probable symptoms of depression in our study was inconsistent with previous research that found that the prevalence of post-stroke depression in rehabilitation hospitals ranged from 33% to 55%.[227, 255] A recent meta-analysis by Hackett and Pickles[256] found that during the acute period (< 1 month after a stroke) the prevalence of depressive symptoms among patients from rehabilitation settings was 33% (95% CI 23%-43%). However, the reported prevalence estimates of post-stroke depression appear to differ widely across studies depending on the assessment method, diagnostic criteria, study setting, and time of assessment after a stroke.[23, 159] In general, studies from hospital-based settings (e.g. acute settings and rehabilitation facilities) have reported a higher prevalence rate of depressive symptoms than community-based studies.[221, 257] This may be explained by the fact that patients recruited from hospital settings usually have greater disability than patients from the community who have a wider range of stroke severity.[221] In addition, several longitudinal studies that reviewed the natural history of depression after stroke found that the peak prevalence of depression occurs around 3 to 6 months after a stroke, then it declines to about 50% after 1 year from the stroke onset, but remains significant even two years after a stroke.[221-223]

Although most patients showed improvement in their symptoms (54%), a considerable minority remained depressed at discharge from inpatient rehabilitation (33%) and approximately 13% of the sample reported no change of depressive symptoms over the period of rehabilitation. A change in depressive symptoms could possibly result from an improvement in functional status after intensive rehabilitation. Several studies have demonstrated an association between depressive symptoms and severity of impairments in ADL and functional status after a stroke.[24, 249] Hadidi et al. (2011) described patterns of changes in depressive symptoms and functional status in 25 subjects following a stroke over a 3-month period. Depressive symptoms improved from baseline to 2 weeks and then remained stable up to 3 months after follow-up, and that change in depressive symptoms was associated with improvement in functional abilities. However, in our study we could not evaluate change in functional status because of missing data from the BI at discharge.

5.4.1 Univariate logistic regression analysis for discharge to institutional setting

Among the demographic factors, a longer length of stay at an inpatient rehabilitation facility was associated with an increased odds of being discharged to an institutional setting. Previous studies have also evaluated the number of days in an inpatient rehabilitation hospital as a predictor of rehabilitation outcomes.[192, 193] Granger et al. (2009) reported that between 2000 and 2007 the rate of discharge to the community following an inpatient rehabilitation stay decreased from 75.8% to 69%.[258] In a recent study among Medicare beneficiaries with a stroke, a one-day increase in length of stay at an inpatient rehabilitation hospital was associated with less likelihood to be discharged to the community.[193] None of the other factors such as age, sex, race, health insurance, and marital status were associated with the discharge destination after stroke rehabilitation. These results were consistent with many previous studies,[5, 153, 202] though there is conflicting evidence in the literature regarding demographic variables. Several studies reported that they do not have a strong influence on discharge destination after an inpatient stroke rehabilitation.

Of the patients' clinical factors examined for possible association with discharge destination, stroke severity was the only factor that influenced post rehabilitation discharge destination for patients with a stroke. For every 1-point increase in the NIHSS, the likelihood of being discharged to an institutional setting was increased. The results of this study support those of previous studies, which reported that a higher score on the NIHSS was associated with discharge to institutional settings compared to a home discharge.[206, 207, 209, 259] Other scales have also been examined in this context; such as the OPS, which has been shown to be a good tool for predicting outcomes after a stroke.[210, 211]In addition, several studies have suggested that the predictive ability of the OPS is better than the NIHSS at predicting outcomes, such as functional status[176, 260] and discharge destination from an acute hospital.[212] In previous studies, patients with a low score (OPS

<3.2) showed better outcomes than patients with a high score (OPS >3.2).[212, 260] In this study sample, we also found that there was a greater proportion of patients with a mild stroke severity (OPS <3.2) discharged to the community (34%), while those discharged to an institutional setting (92%) had moderate to severe stroke severity (OPS ≥ 3.2). Similar to previously published results, this study also found that factors regarding stroke characteristics including stroke type (ischemic vs. hemorrhagic) and stroke location were not helpful in differentiating between community settings versus institutionalization. Nguen et al. (2015) asserted that neither stroke type nor location was predictive of a discharge disposition after an inpatient rehabilitation for a stroke.[137]

Among the outcome measure variables, patients with depressive symptoms on admission were twice more likely to be discharged to institutional settings from inpatient rehabilitation after stroke than return to community. This finding corresponds to a previous study by Saxena et al. (2006) that found depressive symptoms on admission was a significant factor for predicting discharge to institutions from rehabilitation hospitals.[261] Moreover, this result is consistent with previous research that has examined the association between depressive symptoms and rehabilitation outcomes[25, 252] and suggested that patients with symptoms of depression in the acute stage used rehabilitation services less efficiently compared with those without depressive symptoms.[24] As a result, these subjects may have progressed slowly in regaining ADL function. Lower functional independence has been known to be strong predictor of discharge destination post stroke.[137, 150] However, when we performed the analysis using a continuous variable for the GDS, we found that the total GDS score at the time of admission was not associated with the discharge to an institution. This may be because of the fact that the GDS scale was based on the old DSM criteria for depression, which conceptualized mental illness categorically and separates people into two categories as opposed to placing people along a continuum of disease and health.[262]

Our study also showed that change in depressive symptoms was not associated with the discharge destination after an inpatient rehabilitation. A possible explanation for this could be due to the high number of missing values for the GDS at discharge. Hadidi et al. (2011) also evaluated change in depressive symptoms in an acute rehabilitation setting by using two instruments: the GDS and the Center for Epidemiologic Studies Depression Scale (CES-D)[263] at the time of admission to 3 months post-stroke.[264] They found that the GDS did not capture the change in depressive symptoms as compared to the CES-D that demonstrated change in depressive symptoms over time.[264] In addition, a recent meta-analysis by Meader et al. (2013) investigated the screening proprieties of the GDS in a stroke population and the results showed that the GDS lack specificity and has high false-positive rate, indicating that in clinical practice clinicians should not rely only on this measure to identify depressed patients after a stroke.[265]

5.4.1 Multivariate logistic regression analysis for discharge to institutional setting

From the multivariate analysis, neither the continuous GDS score nor the categorical variable of the GDS with a cutoff score of 5 or greater predicted discharge to an institutional setting from an inpatient rehabilitation after accounting for the BI score at the time of admission. In addition, a change in depressive symptoms was not predictive of discharge to an institutional setting. One possible factor contributing to this could be that the GDS score at the time of admission was correlated with one of the other variables in the model. Using the correlation analysis, we found a significant inverse relationship between the GDS and the BI at the time of admission (Pearson r = -0.219), which has been reported previously in the literature that post-stroke depression is associated with the degree of functional impairment.[22, 249] Another explanation is that most of the patients in our sample had no depressive symptoms, with only 31% of them classified as having mild to severe depressive symptoms. Further research with a larger and more diverse sample may be needed to understand the impact of depressive symptoms on discharge destination after an inpatient rehabilitation. Consistent with the previous literature,[16, 145] the model in this study found that better functional performance at the time of admission as measured by the BI reduced the odds of being discharged to an institutional setting. However, the strength of the predictive power of this variable in our study was very weak, with an odds ratio close to one (OR = 0.94). In this study sample, we also found that stroke severity, as measured by the OPS, was a strong predictor of discharge destination. These findings provide important information to initiate early discharge planning process. Our study emphasizes the importance of basic functional abilities and stroke severity that may be used to assist clinicians with treatment planning and to prepare patients and their caregivers regarding likely outcomes post rehabilitation.

5.5 LIMITATIONS

Our study has several potential limitations. One of the limitations is that patients in our sample were not diagnosed as having major or minor depression using the DSM diagnostic criteria, instead our patients were classified as having depressive symptoms based only on one measure: the GDS, which was part of the comprehensive assessment toolbox. Although the GDS has been widely used and has been validated as a screening tool in stroke populations, this measure is not a diagnostic tool for depression. An additional limitation was the use of retrospective data collected from a single inpatient rehabilitation facility, which limits the generalizability of the findings. Future studies with larger samples from multicenter facilities are needed to determine the impact of depressive symptoms on predicting outcomes from poststroke rehabilitation. Furthermore, other potentially important factors were not included in this dataset such as their premorbid living status, the presence of family or caregiver support, the prior history of depressive symptoms, and the list of medications. The absence of these factors may have influenced our results.

5.6 CONCLUSION

Depressive symptoms, when measured by the GDS as a categorical variable, was predictive of the discharge destination in patients receiving inpatient rehabilitation after a stroke, but not after accounting for the BI at the time of admission. When treated as a continuous variable, a higher GDS score at the time of admission was not predictive of the discharge destination. Similarly, change in depressive symptoms during rehabilitation was not associated with discharge to an institutional setting. In this study, the main independent predictor of the discharge destination following inpatient rehabilitation was functional dependence as measured by the BI at the time of admission. Furthermore, our analysis indicated the strongest predictor of discharge to an institutional setting was stroke severity, as measured by the OPS. Future studies should investigate the impact of depressive symptoms on stroke outcomes using a tool that is better designed to diagnose and screen for depression in the stroke population.

6.0 GENERAL DISCUSSION

Post-acute rehabilitation services are essential and the primary mechanism for returning patients post-stroke to their pre-event status. These services are provided in a variety of different settings, including inpatient rehabilitation facilities, skilled nursing facilities, home health agencies, and long-term care hospitals.[266] Many patients receive rehabilitation care from multiple providers in several different settings during a single episode of illness. Post-acute care services are covered mainly by the US Centers for Medicare and Medicaid Services (CMS). Generally, the CMS makes separate payments for all the services provided in each setting using different types of payment systems in which each has different rates of payment, rules for coverage, and assessment tools.[267] In the last two decades, there has been a significant change in the use of acute and post-acute stroke rehabilitation in the United States.[266] Medicare's spending on post-acute care settings has increased from $29.3 billion in 2001 to $59.2 billion in 2014.[190] The number of patients discharged to post-acute care settings in 2010 was 50% higher than it was in 1996.[268] This is possibly due to the repeated changes to the federal reimbursement payment structure, in particular, to the Medicare post-acute care payment policies.[266]

Therefore, the CMS has developed a number of national reform initiatives to promote efficient and coordinated use of post-acute care services and reduce care spending. One example is the bundled payments and accountable care organizations (ACOs) under which hospitals, post-acute care providers, and physician services are paid for a set of services with a single payment during a clinical episode of care within a defined time period.[269, 270] Under the bundled payment, care providers are paid a single bundled payment for all services including hospitalization, post-acute care facilities, outpatient care, home healthcare, physician services, and readmissions.[271] As such, providers are offered financial incentives to manage post-acute care utilization and care spending by facilitating patient care in the right sitting at the right time and minimizing any additional services that add costs without meaningful benefit to the individual experience of care.[272] Under these cost constraints and limited rehabilitation recourses, it is important to help providers and rehabilitation teams in predicting the best discharge destination early after hospital admission and thereby identify patients in need of further care. An improved prediction of discharge destination may ensure the most efficient use of rehabilitation resources, improve patients' outcomes, and reduce costs associated with an overall rehabilitation care.

Determining discharge destination after stroke rehabilitation is influenced by a variety of factors such as stroke severity, type and degree of impairments, functional limitations, social and economic status, and environmental factors. Of these factors, functional status in terms of physical activity limitations has been reported as the main factor in determining where patients with stroke are discharged following rehabilitation. However, studies examining the predictive ability of various domains of activity limitations in predicting discharge destination are limited. No previous studies have specifically described the influence of instrumental ADL functioning and examined the predictive value of the admission Lawton score on predicting discharge destination. This is in part because most studies that have examined the impact of activity limitation on discharge destination have used instruments that generally focus on basic ADL functioning such as the BI and FIM and did not include measures of complex ADL functioning that is necessary for community living.

The purpose of this analysis, therefore, was to evaluate instrumental ADL functioning as measured by the Lawton IADL scale, administrated on admission to rehabilitation, to predict discharge destination after inpatient rehabilitation for stroke. Approximately 65% of the sample returned to the community after inpatient rehabilitation. Our data analysis shows that instrumental ADL functioning on admission to rehabilitation was not predictive of discharge destination. Even though higher total Lawton score alone at admission was significantly associated with decreased odds of discharge to an institutional setting, it was not significant in the multivariate regression model. This may be due to the fact that most of the patients in this sample had minimum scores on the Lawton scale (12±3), and given the small sample size of our cohort, the predictive value of the instrumental ADL functioning in predicting discharge destination after inpatient rehabilitation was not revealed. Further investigations are needed to confirm the effect of instrumental ADL in predicting discharge destination in a larger sample size and wider range of IADL functional status.

In addition, a number of studies have reported that depression in the acute phase has a negative impact on the outcome of rehabilitation and has been associated with longer stay in rehabilitation hospitals, poor functional outcomes, and poor participation in rehabilitation therapy. Most studies have reported an association between depression and length of stay in rehabilitation settings, and very few have studied the relationship between depressive symptoms and discharge destination after stroke rehabilitation. Therefore, another component of this investigation was to explore the impact of the presence of depressive symptoms on rehabilitation hospital admission and changes in depressive symptoms in predicting destination after discharge from inpatient rehabilitation hospital. We found that patients who were depressed at admission defined as GDS score > 5 were twice as likely to be discharged to institutional settings as those who were not depressed. However, multivariate analysis has not confirmed this finding, possibly because of the relatively low proportion (31%) of patients with depressive symptoms in our cohort. Accordingly, the main concern for these patients is more likely to be their ability to perform basic activities of daily living, and that may influence their place of discharge after inpatient rehabilitation. Neither the presence of depressive symptoms nor change in depressive symptoms was independently associated with discharge to an institutional setting after inpatient rehabilitation for stroke. Further investigation may be needed to understand the impact of depressive symptoms on discharge destination in patients with various levels of depressive symptoms. Our data analysis suggests that the presence of depressive symptoms may greatly influence outcome after inpatient rehabilitation; thus, depression should be carefully evaluated and monitored in rehabilitation setting. However, in this analysis, we also identified potential predictors of institutional discharge in patients undergoing inpatient rehabilitation after stroke. Similar to previously published studies, the results of our data analysis demonstrated that basic ADL functioning and stroke severity at the time of rehabilitation admission were significant predictors of discharge destination. The findings emphasize the importance of these variables in influencing discharge outcomes after inpatient rehabilitation. This information could be easily used as an assessment tool at the time of admission to rehabilitation and has the potential to assist rehabilitation clinicians in identifying patients who are in need of further care.

6.1 LIMITATIONS AND FUTURE CONSIDERATIONS

Given the retrospective nature of our study and the fact that data were obtained from a clinical database that was initially created for clinical reasons, and not for our specific purposes, missing data was a significant issue in this study. Complete data were obtained from only 187 subjects, and nearly half (42%) of the subjects were excluded due to missing data on discharge destination. To address this, we performed further analyses to see if there were any differences in baseline data between the included and excluded subjects. The group of patients whose discharge destination had not been recorded, compared with the included sample, were younger, had a lower proportion of high comorbidities, had a lower prevalence of previous stroke, and had a shorter time from onset to rehabilitation. Compared with the included patients, those who were excluded were less impaired as measured by the NIHSS, more independent in IADL functioning, and less depressed at admission. However, these differences were relatively small and were not clinically significant (see Appendix A). In addition, we had a high rate of missing values among several predictors and covariates. Additional analyses were conducted to evaluate the extent of missing values and to assess for patterns of missing values. Results showed that data were not missing completely at random. Therefore, multiple imputation and sensitivity analyses were performed to handle missing data and to examine any potential impact of missing data on the findings. Further details are provided in Appendix C. Our main conclusions about the main factors associated with discharge destination in patients undergoing inpatient rehabilitation remained unchanged.

Due to the small sample size and the fact that patients were included from a single inpatient rehabilitation facility, the results of this study may not be generalizable to all patients with stroke undergoing inpatient rehabilitation. Future studies should examine the value of these potential factors for discharge prediction in larger samples from various locations and use prospective study design in future research that would allow for the generalization of results to other settings. Further, while clinical factors have been clearly shown to be an important factor when deciding on discharge destination, there are other potentially important factors that may have influenced the outcome but were not available in this dataset, for example, prior living status, presence and availability of the caregivers, previous medical and mood disorders, availability of services, and patient preferences. Further research should consider all these factors when determining patients' discharge destinations. Although in this study sample we included a broad range of most of the factors that may influence discharge destination after inpatient rehabilitation, our model only explained 33% of the variation in discharge destination, suggesting that there might be other factors contributing to prediction of discharge destination.

6.2 CONCLUSION

In conclusion, we found that instrumental activity of daily living limitations and presence of depressive symptoms on admission to rehabilitation significantly contributed to the prediction of discharge destination after stroke, but not after accounting for basic ADL functioning at the time of admission. Stroke severity and level of basic ADL at rehabilitation hospital admission are the main independent predictors of discharge to institutional setting after inpatient rehabilitation for stroke. Particularly, stroke severity demonstrated the strongest factor in differentiating community and institutional discharges after inpatient rehabilitation for stroke. Previously identified factors that have been reported to be significant predictors of discharge destination after stroke (e.g., age, gender, marital status, health insurance, and comorbidities) did not contribute to this prediction and may be considered less important when determining the best discharge location after inpatient rehabilitation. As payment policy moves from the current fee-for-service payment structure toward an episode-based payment and the continuum of care across post-acute care settings[267], heath care providers and researchers are seeking ways to improve the quality of overall episode of care and reduce healthcare spending by focusing on improving care transitions and selecting the most appropriate care setting for a given patient.[273] The findings of this research provide important information for clinical decision-making in discharge planning from rehabilitation. Knowledge about the importance of these factors would allow the initiation of early discharge planning that best meets the patient's needs and reduces healthcare costs.

APPENDIX A.

Table 35. A comparison between subjects included and excluded in the analysis (demographics).

Variable *based on the D/C	Total sample (n=364)		Included sample (n=210)*		Excluded sample (n= 154)*		p
Demographic data	N/M		N/M		N/M		
Age	338/26		193/17		145/9		.043
Median (IQR)		75 (66-82)		77 (67 - 85)		75 (61-79)	
Mean ± SD		74 ± 12		75 ± 13		72 ± 12	
Length of stay	228/136		206/4		22/132		.377
Median (IQR)		18 (12 - 25)		18 (13-25)		15 (11-31)	
Mean ± SD		20 ± 15		20 ± 16		18 ± 11	
Onset days	272/92		179/31		93/61		<.001
Median (IQR)		6 (3 – 9)		7 (5 – 9)		7 (4 – 15)	
Mean ± SD		7 ± 13		9 ± 15		4 ± 6	
Sex	347/17		195/15		152/2		.304
Female		197(57 %)		106(54.4%)		91(60 %)	
Male		150(43 %)		89(46%)		61(40%)	
Race	270/94		178/32		92/62		.996
White		243 (90%)		160 (90%)		83 (90%)	
African American		24 (9%)		16 (9%)		8 (9 %)	
Hispanic		3 (1%)		2 (1%)		1 (1%)	
Health insurance	280/84		185/25		95/59		.090
Medicare		210 (75%)		134(72.4%)		76 (79%)	
Medicaid		12 (4%)		10 (5.4%)		2 (2%)	
Privet Insurance		53 (19%)		36(19.5%)		17 (18%)	
None		5 (2%)		5 (2.7%)		0	
Marital status	279/85		185/25		94/60		.518
Married		127(45.5%)		79(43%)		48(51%)	
Divorced/separated		31(11%)		20(11%)		11(12%)	
Widowed		106(38%)		75(40.5%)		31(33%)	
Never married		15(5.4%)		11(6%)		4(4%)	
Previous stroke	270/94	60(22%)	178/32	47(26.4%)	92/62	13(14%)	.021
TIA	267/97	24 (9%)	178/32	17 (10%)	89/65	7 (8%)	.650
Comorbidities	328/36		194/16		134/20		< .001
Low comorbidity (0-2)		96(29.3%)		47(24.2%)		49(36.6%)	
High comorbidity (≥3)		232(70.7%)		147(75.8%)		85(63.4%)	
Median ± IQR		3 (2-4)		3 (3-4)		3 (1-3)	
Mean ± SD		3 ± 2		3.48 ± 2		2.63 ± 1.3	
Social support	307/57		177/33		130/24		.022
Full social support		280(91.2%)		168(95%)		112(86.2%)	
Partial social support		9 (3%)		4(2.3%)		5(3.8%)	
No social support		10(3.3%)		4(2.3%)		6(4.6%)	
unknown		8 (2.6%)		1(0.6%)		7(5.4%)	

APPENDIX B.

Table 36. A comparison between subjects included and excluded in the analysis (clinical characteristics).

Variable		Total sample (n=364)		Included sample (n=210)		Excluded sample (n= 154)	p
Clinical data	**N/M**		**N/M**		**N/M**		
Stroke type	**270/94**		**180/30**		**90/64**		**.586**
Hemorrhagic		13 (5%)		7(4%)		6(6.7%)	
Ischemic		234(68.7%)		157(87%)		77(85.6%)	
uncertain		23(8.5%)		16(9%)		7 (7.8%	
Stroke location	280/84		179/31		101/53		.749
Left hemisphere		131(47%)		83(46.4%)		48(47.5%)	
Right hemisphere		127(45.4%)		81(45.3%)		46(45.5%)	
Cerebellar		10 (3.6%)		7(4%)		3(3%)	
Uncertain		8 (3%)		6(3.4%)		2(2%)	
Bilateral		3 (1%)		2(1%)		1(1%	
Brainstem		1(.4%)		0 (0.0%)		1(1%)	
Neurological deficits	221/143		150/60		71/83		.018
Mild (0-13)		178(80.5%)		116(77.3%)		62(87.3%)	
Moderate (14-21)		35(15.8%)		29(19.3%)		6(8.5%)	
Severe (22-42)		8(3.6%)		5(3.3%)		3(4.2%)	
Median (IQR)		7 (4 – 12)		8 (4 – 13)		5 (3 – 10)	
Mean ± SD		8 ± 6		9 ± 6		7 ± 7	
Orpington scale level	203/161		143/67		60/94		.228
Minor (<3.2)		54(26.6%)		36(25.2%)		18(30%)	
Moderate (3.2-5.2)		120(59%)		83(58%)		37(61.7%)	
Severe (>5.2)		29(14.3%)		24(16.8%)		5 (8.3%)	
Median (IQR)		3.6 (3 - 4.4)		4 (3 - 4.8)		3.6 (3 - 4)	
Mean ± SD		4 ± 2		4 ± 1		4 ± 2	
Adm. GDS score	275/89		155/55		120/34		.003
Normal		197(71.6%)		109(70.3%)		88 (73%)	
Mild		66 (24%)		38(24.5%)		28 (23%)	
Severe		12 (4.4%)		8(5.2%)		4 (3.3%)	
Median (IQR)		3 (1- 6)		4 (2 – 6)		3 (1 – 6)	
Mean ± SD		4 ± 3		4.4 ± 3		3.48 ± 3	
Adm. MMSE score	251/113		146/64		105/49		.408
Median (IQR)		22 (16 - 26)		22 (17 - 26)		22 (13- 28)	
Mean ± SD		19.84 ± 7.8		20.7±6.3		18.5 ±9.4	
Adm. Barthel score	227/137		156/54		71/83		.406
Median (IQR)		25 (10 - 40)		25 (10 - 45)		25 (5 - 40)	
Mean ± SD		26.6 ±19.8		27.3 ±19.9		25 ± 19.6	
Adm. Lawton score	325/39		197/13		128/26		.008
Median (IQR)		11 (10 - 12)		11 (10 - 12)		11 (10 -13)	
Mean ± SD		12.1 ±3.3		11.8 ±3.2		12.5 ±3.6	
Adm. Rankin score	257/89		177/33		98/56		.641
1		1 (.4%)		1 (.6%)		0	
2		1 (.4%)		1 (.6%)		0	
3		8 (2.9 %)		4 (2.3%)		4 (4%)	
4		228 (83%)		149 (84%)		79 (80.6%)	
5		37 (13.5%)		22 (12.4%)		15 (15.3%)	
Median (IQR)		4 (4 – 4)		4 (4 – 4)		4 (4 – 4)	
Mean ± SD		4 ± .45		4 ± .46		4 ± .42	

*D/C = discharge destination, N/M = number of valid cases/ number of missing cases, Adm. GDS = admission Geriatric Depression Score, Adm. MMSE = admission Mini-Mental State Examination

APPENDIX C.

Missing value analysis and multiple imputation

A missing value analysis was performed to evaluate the extent of missing values and examine the patterns of missing data on each variable. Variables that were selected for missing value analysis are only variables that were significantly associated with the outcome from the available data analysis. Results showed that 67% of all individuals had at least one missing value over all variables, and of all possible values, about 16% were missing. The variable “stroke severity” as measured by the Orpington prognostic score had the highest number of missing values with 30% missing, and the variable “length of stay” had the lowest missing value with 1.1%. Table 37 shows the frequency and percentage of missing values for all variables that were selected for missing value analysis.

Table 37. Frequency and percentage of missing values for variables included in missing value analysis.

Variable (n= 187)	Frequency (n)	Percentage %
Orpington Prognostic score	57	30.5%
Mini-Mental State Examination	55	29.4%
Geriatric Depression Scale	47	25%
Barthel Index	44	23.5%
Rankin Scale	27	14.4%
Atrial Fibrillation	25	13.4%
History of Previous stroke	25	13.4%
Charlson Comorbidity Index	14	7.5%
Age	13	.7%
Lawton Scale	10	5.3%
Length of stay	2	1.1%

Figure 3 displays the missing value patterns that were evident in the dataset. Each pattern represents a group of cases with the same pattern of missing values. For example, the first pattern from the top corresponds to those cases with no missing values. However, pattern 43 represents cases having missing values on more than one variable. The figure showed a tendency of having a monotone characteristic pattern by looking at the concentration of missing cells in the lower left portion of the figure, which suggests the presence of a monotonicity pattern. A missing data pattern is said to be monotone if the variables can be re-arranged such that if one variable is missing then the subsequent variables are missing as well.[274]

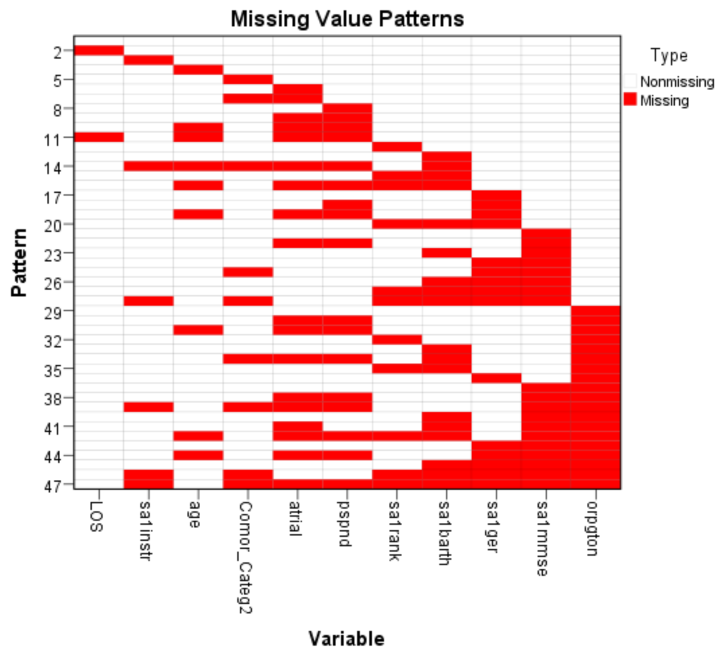

Figure 3. Missing Value Patterns of the predictor variables

Little's chi-square test indicated that the data are not missing completely at random, $\chi2$ (72) = 99.455, p=.018. Thus, a multiple imputation was conducted to address the issue of missing values. This method replaces each missing value with a set of plausible values. Five complete imputed datasets were then analyzed, and results were averaged to get a pooled estimate of the regression coefficient. We imputed the following variables: age, length of stay, history of previous stroke, atrial fibrillation, Charlson Comorbidity Index, Orpington Prognostic score, Mini-Mental State Examination, Geriatric Depression Scale, Barthel Index, Rankin Scale and Lawton IADL Scale. The specifications of the imputation process are shown in Table 38. Results from the univariate and multivariate analyses of each domain from five imputed datasets are presented in Table 39. The multivariate analysis identified several predictors of discharge destination following inpatient rehabilitation, which were similar to the complete cases analysis except that the atrial fibrillation was not significant after imputation (β = .618; P=.156). These predictors were: length of stay at rehabilitation, stroke severity as measured by the OPS score and total admission BI score. Then, a final multivariable logistic regression analysis was run with the length of stay at rehabilitation (days), stroke severity as measured by the OPS score coded as a categorical variable, atrial fibrillation and total admission BI score coded as a continuous variable. All variables were entered in a single step. Results of the multivariate logistic regression indicated that individuals with a higher score on the BI were less likely to be discharged to an institutional facility. The same results were obtained with the complete cases analysis. Among all predictors, only the total admission Barthel index score was important and made a statistically significant contribution to the model. Both the initial Instrumental IADL (OR= -.051; P= .429; Table 40) and initial depressive status (OR= .036; P=.473; Table 41) did not significantly contribute to the prediction of discharge destination.

Table 38. Multiple Imputation Specifications.

Imputation Method	**Automatic**
Number of Imputations	5
Model for Scale Variables	Linear Regression
Model for Categorical Variables	Logistic Regression
Interactions Included in Models	None
Maximum Percentage of Missing Values	100%
Maximum Number of Parameters in Imputation model	100

Table 39. Univariate and multivariate logistic regression analysis from five imputed datasets.

Variable	**Univariate (n=187)**			**Multivariate (n=187)**		
Demographics	**β**	**OR (95% CI)**	***P***	**β**	**OR (95% CI)**	***P***
Age (years)	.018	1.01(.99 -1.04)	.154	.019	1.02(.99 - 1.04)	.124
Length of stay (days)	.041	1.04 (1.00 -1.07)	.016	.043	1.04 (1.0 -1.08)	**.013**
Clinical factors	**β**	**OR (95%CI)**	**P**	**β**	**OR (95%CI)**	**P**
Previous stroke	- .461	.63 (.29 -1.33)	.227	-.462	.63 (.27-1.46)	.282
Comorbidities/ CCI Low vs. high	-.703	.49 (.22 - 1.11)	.088	-.642	.52 (.20 - 1.36)	.181
Risk factors Atrial fibrillation	.656	1.9 (.86- 4.28)	.107	.618	1.8 (.79 - 4.35)	.156
Orpington scale level Minor vs. severe Moderate vs. severe	 -1.48 -.798	 .22 (.04 - 1.16) .45 (.18- 1.11)	 .071 .085	 -1.38 -.716	 .25 (.04 -1.36) .49 (.20 -1.19)	 **.099** .114
Outcome Measures	β	OR (95% CI)	P	**β**	OR (95% CI)	P
Cognitive status Baseline MMSE score	-.049	.95 (.90 -1.00)	.049	-.014	.98 (.92-1.05)	.659
Depressive symptoms Baseline GDS score	.080	1.08 (.98 - 1.2)	.093	.043	1.04 (.93 -1.2)	.446
Basic ADL Baseline BI score	-.040	.95 (.93 - .97)	<.001	-.037	.96 (.94 - .98)	**<.001**
Instrumental ADL Baseline Lawton score	-.126	.88 (.77 - .99)	.045	-.043	.95 (.84 – 1.08)	.503
Disability level Baseline Rankin score	.821	2.3 (.97- 5.3)	.056	.349	1.41 (.69 -2.88)	.335

*Abbreviation: N= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, *P*= *P*-values, CCI= Charlson Comorbidity Index, MMSE=Mini-Mental State Examination, GDS= Geriatric Depression Score, BI=Barthel Index. Note: Variables with p-values in bold were considered as significant for inclusion in the multivariate analyses, with a p-value of ≤ 0.15.

Table 40. Results of multivariate analysis from five imputed datasets.

Predictor variables	Model A			Model B		
Model A (n=187)	β	OR	*P*	β	OR	*P*
Total BI score	-.044	.957	.001	-.041	.960	.003
OPS levels						
Minor vs. severe	-.726	.484	.318	-.718	.488	.343
Moderate vs. severe	-.341	.711	.465	-.311	.733	.527
LOS	-.015	.985	.534	-.013	.987	.573
Atrial fibrillation	.657	1.93	.150	.672	1.95	.144
Model B (n=187)						
Total Lawton score				-.051	.950	.429

* Abbreviation: n= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, P= P-value, BI= Barthel Index, OPS= Orpington Prognostic Score, LOS=Length of Stay.

Table 41. Results of multivariate analysis from five imputed datasets.

Predictor variables	Model A			Model B		
Model A (n=187)	β	OR	*P*	β	OR	*P*
Total BI score	-.044	.957	**.001**	-.043	.958	**.001**
OPS levels						
Minor vs. severe	-.726	.484	.318	-.690	.502	.328
Moderate vs. severe	-.341	.711	.465	-.308	.735	.514
LOS	-.015	.985	.534	-.016	.984	.507
Atrial fibrillation	.657	1.93	.150	.644	1.90	.154
Model B (n=187)						
Admission GDS score				.036	1.03	.473

* Abbreviation: n= sample size, β= regression coefficient, OR= odds ratio, CI= confidence interval, P= P-value, BI= Barthel Index, OPS= Orpington Prognostic Score, LOS=Length of Stay, GDS= Geriatric Depression Score.

Sensitivity analysis

A sensitivity analysis was performed to examine how sensitive are the results to changes in the data analysis, regarding the effects of imputed data on pooled effect estimates. First, all analyses were performed using available data. Then, a multiple imputation was used as a chosen method for handling missing data. Then, a sensitivity analysis on the final models was performed by repeating the analysis and re-examining the association between all the significant predictors and discharge destination. Results obtained from the analysis based on imputation data were then compared to the results of complete case analysis based on the original data. We compared the area under the ROC curve of different models on five imputed datasets, all of which were around 0.78 and showed consistent overlapping of the confidence intervals, as shown in Table 42.

Table 42. The AUC (95% confidence interval) of the final model from the five imputed datasets.

Area Under the Curve

Imputation Number	Test Result Variable(s)	Area	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval	
					Lower Bound	Upper Bound
1	Predicted probability of final model	.786	.052	.000	.684	.887
	Predicted probability of final imputed model	.757	.056	.000	.646	.868
2	Predicted probability of final model	.786	.052	.000	.684	.887
	Predicted probability of final imputed model	.784	.053	.000	.681	.887
3	Predicted probability of final model	.786	.052	.000	.684	.887
	Predicted probability of final imputed model	.778	.053	.000	.675	.882
4	Predicted probability of final model	.786	.052	.000	.684	.887
	Predicted probability of final imputed model	.765	.055	.000	.657	.873
5	Predicted probability of final model	.786	.052	.000	.684	.887
	Predicted probability of final imputed model	.776	.054	.000	.669	.882

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