# PREDICTORS OF PERFORMANCE OF ACTIVITIES OF DAILY LIVING (ADL) AND GAIT SPEED FOR SPECIFIC DIAGNOSTIC GROUPS OF PEOPLE RECEIVING HOME-BASED REHABILITATION (HBR)

by

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Submitted to the Graduate Faculty of

The School of Health and Rehabilitation Sciences in partial fulfillment

of the requirements for the degree of

Doctor of Philosophy

University of Pittsburgh

2013

UNIVERSITY OF PITTSBURGH

SCHOOL OF HEALTH AND REHABILITATION SCIENCES

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**PREDICTORS OF PERFORMANCE OF ACTIVITIES OF DAILY LIVING (ADL) AND GAIT SPEED FOR SPECIFIC DIAGNOSTIC GROUPS OF PEOPLE RECEIVING HOME-BASED REHABILITATION (HBR)**

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University of Pittsburgh, 2013

The literature on the impact of home-based rehabilitation (HBR) on activities of daily living (ADL) and gait performance for individuals with stroke, heart failure, and Parkinson's disease are limited. The purpose of this dissertation was to explore the effects of home-based rehabilitation on function (ADL) and gait performance and to identify the optimal combination of predictive factors that affect ADL and gait outcomes at the end of care.

We reviewed patients' records (8,437 persons over 65 years of age) who were admitted to GENTIVA Health Services in 2010. The clinical data were collected from patients with various diagnoses from multiple settings across the United States. The dataset includes patients' information from the OASIS-C and gait speed performance at the start of care and at discharge. The dependent t-tests and General Linear Model (GLM) procedure were used for the analysis of the data.

There were overall significant improvements in ADL function and gait performance in all three groups. Among all three diagnostic groups, the strongest predictors of improvement in ADL and gait change scores were gait speed and ADL composite scores at the start of care. Greater ADL improvement was associated with faster gait speed and higher level of impairment in ADL at the start of care. Also, greater improvement in gait speed was associated with, slower gait speed less impairment of ADL composite scores at the start of care. Several factors have effects on ADL and gait on the various diagnostic groups. For stroke survivors, type of discharge facility and living arrangement had effects on HBR outcomes. Cognitive-behavioral status and living arrangement had effects on HBR outcomes for patients with heart failure. Memory deficits and anxiety (constant) were associated with less change in ADL and gait speed respectively in patients with Parkinson's disease. In addition, greater change in ADL was associated with cognitively intact patients with Parkinson's disease. Considering which factors affect outcome in patients undergoing HBR could affect clinician judgment, goal setting, the length of the episode of care, and future payment models.

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# PREFACE

I would like to acknowledge the support of many people who made this work possible. A special gratitude I give to my advisor Dr. Susan L. Whitney PhD, PT, DPT, NCS, ATC, FAPTA for her guidance and insight throughout the process of my graduate studies and research. Many thanks to Dr. Gregory F. Marchetti PhD, PT for his support throughout the process of research development and statistical analysis. I would like to thank Dr. Patrick J. Sparto PhD, PT and Dr. Valerie Watzlaf, PhD, RHIA, FAHIMA for their valuable advice and feedback. I also want to acknowledge the contributions of clinicians and researchers in the GENTIVA Inc. especially Jennifer Ellis, PT, DPT, MS, GCS and Laurie Otis PT, MBA, MHA, GCS for their effort and support in the dataset.

Furthermore, I would also like to thank the support of my friends in the Eye and Ear center: Mohammad Almohiza, James, Saud, Abdulaziz, Bader, Sahar, Kefah, Ala’a, Abdullfatah, Mohammed Shehri, and Dr. Jing. Finally, I would like to take this opportunity to extend my appreciation to my parents, Ebtisam (wife), and Muhnnad (son) for their continuing support throughout my graduate studies.

(وَمَا تَوْفِيقِي إِلَّا بِاللَّهِ عَلَيْهِ تَوَكَّلْتُ وَإِلَيْهِ أُنِيبُ)

# 1.0 INTRODUCTION

Home health care (HHC) is one of the major health services delivered to the elderly in the United States (US) within the community.[1] According to projections of the US census bureau, the population of older adults who are above 65 years of age will double from 40.2 million people in 2010 to 88.5 million people by 2050.[2] Older Americans are projected to have chronic conditions or severe illness that may require health services in order to promote or restore health functioning and prevent re-hospitalization.[3,4]

Several factors make home-based rehabilitation (HBR) a better choice, than other rehabilitation settings such as in-patient and out-patients services, for countries around the world. Home-based rehabilitation includes rehabilitation disciplines such as physical therapy, occupational therapy, and speech pathology. These factors include projections of more older adults, increasing chronic diseases among older people, increasing cost of care in hospitals, technology development for home settings,[5,6] and individual's preferences such as patient satisfaction, dignity and independence.[6]

Regarding the cost effectiveness and clinical outcomes, use of HHC services has resulted in improvements in functional outcomes, instrumental activities of daily living, and significant reductions in cost when compared with long term hospital care for chronically ill elderly persons.[7] The total cost of inpatient hospital care was three times higher than HHC.[7] Patients discharged after total hip and knee replacement who received HHC were less likely to be institutionalized or re-hospitalized than persons treated in a skilled nursing facility (SNF) or inpatient rehabilitation facility (IRF).[8] Whitney et al. demonstrated that there was a significant change in balance and gait after an episode of HHC.[9] Home health care also has an impact on lowering mortality rates and delaying functional decline, and has decreased mortality by two years after home care intervention.[9,10]

Recently, the Outcome and Assessment Information set (OASIS-C functional items) has been used as an outcome measure for home health research.[2,11,12] Madigan et al. concluded that the HHC intervention improved functional capacity for patients with heart failure.[2,12]

However, previous studies on HHC have been conducted with a heterogeneous population,[2,5,9,10] and there are a limited number of studies that examined the effect of home-based rehabilitation on functional status and gait speed performance for a specific-diagnostic category, e.g. individuals with stroke, heart failure, and individuals with Parkinson's disease. Studies on specific-diagnostic conditions and associated factors that contribute to performance of activities of daily living (ADL) and gait speed gains during rehabilitation in the home do not exist.

The purpose of this study was to describe patients' outcome after receiving HHC, by using OASIS-C functional items and gait improvement after the episode of home health care. Also, the associated factors (e.g. demographic, psychological, ADL, and gait factors) that positively and negatively affect outcome on functional (ADL) scores and gait performance will be examined. Our studies with different diagnostic groups (e.g. individuals with stroke, heart failure, and individuals with Parkinson's disease) will identify the optimal combination of potential predictors (e.g. demographic, psychological, clinical, and social variables) at the start of care that predict the probability of functional and gait improvement after rehabilitation in the home. Knowledge of which factors affect outcome in patients undergoing home-based rehabilitation could affect goal setting, the length of the episode of care, and future payment models.

## 1.1 SPECIFIC AIMS

### 1.1.1 Specific aim 1

The literature on the impact of home-based rehabilitation on functional outcomes for individuals after stroke is limited. The purpose of this study is to describe the outcomes of home-based rehabilitation on functional performance (activities of daily living ADL) and gait speed for individuals after stroke and associated factors that contribute to better or worse outcomes after an episode of care.

### 1.1.2 Specific aim 2

Home-based rehabilitation (HBR) outcomes after hospitalization have not been studied in depth for persons with heart failure. Therefore, the aim is to describe improvements in activities of daily living (ADL) and associated factors in patients undergoing home-based rehabilitation after hospital admission for heart failure.

### 1.1.3 Specific aim 3

The impact of HBR on persons with Parkinson’s disease does not exist in the literature. Thus, we are interested in exploring the effects of HBR on persons with Parkinson’s disease, and associated factors that positively and negatively affect outcome on functional scores and gait performance after rehabilitation in the home.

# 2.0 BACKGROUND

## 2.1 AGING AND HOME HEALTH CARE (HHC)

Home health care (HHC) is one of the major health services delivered to the elderly in the US within the community.[1] Older people in the US represent 12% of the total population in 2006 and the percentage has been estimated to increase to 20% of the US population in 2030. [3,4] In terms of health care delivery, the Department of Health and Human Services (DHHS) in the US reported that 7.6 million people received community based services in 2011, such as home health and hospice care. By 2050, the estimation for those who will need long term care will be approximately 27 million people. Therefore, having various rehabilitation care options is important since many older adults will have chronic health conditions and may need to receive health services either in their homes or communities for quality and cost purposes.[3,4] Other countries now are considering the dignity and independence of older people by supporting home care services.[6]

## 2.2 DEVELOPMENT OF GLOBAL HOME HEALTH CARE

There are several definitions for home care in the United States (US). In 1980, the public health services defined HHC as " *that component of comprehensive healthcare whereby health services* *are provided to individuals and families in their places of residence for the purpose of promoting, maintaining, or restoring health, or maximizing the level of independence, while minimizing the effects of disability and illness, including terminal illness. Services appropriate to the needs of the individual patient and family are planned, coordinated, and made available by providers organized for the delivery of home care*."[1,13] Based on this definition, health services at home consider preventive aspects of care. Promoting or restoring function for older adults is a health service related to preventing further decline and promotion toward better health.[1] Home health care has different terms around the world. In the United Kingdom, it known as 'hospital at home' and 'healthcare at home', as an 'extra mural hospital' in Canada and New Zealand, and 'hospital in the home' in Australia, which includes acute care services.[14,15]

The definition of HHC in the literature, as defined by Hurworth, is more comprehensive and very broad definition, that is *"those services that provide active treatment by health care professionals in the patient's home for a condition that would otherwise require acute hospital care, always for a limited period"*.[14,16,17] The vision of the Canadian Home Care Association for 2020 is that "home care services will be accessible to all Canadians and play a key role in chronic disease management".[6] The development of the Canadian Home Care Association vision was due to several factors, such as an increase in the aging population projections, increasing number of chronic diseases, and the increasing cost of care in hospitals.[6] The overall benefits of HHC are to improve quality of care, reduce health care expenditures, and increase care efficiency.[6]

### 2.3 DEVELOPMENT OF HHC IN THE UNITED STATES

In the United States, the home care industry began in the 1880's. The number of home health care agencies increased rapidly in the last four decades, especially after the enactment of Medicare in 1965 that enabled agencies to be paid to provide home health services for the elderly. [2,8,18] According to the DHHS, the number of health care agencies participating in Medicare programs was estimated to be approximately 7,000 in 1995 and increased to over 10,000 home health care agencies in 2010 in the US.[8] The rapid rise in the number of home health agencies were due to several reasons: home health care is cost effective,[3,4,9] it increases patient's satisfaction by providing health services in homes,[1] it enhances the dignity and independence of older adults,[6] and the increased projections of older adults with increased numbers of chronic diseases and comorbidities.[19]

Comprehensive home health care involves health professionals (a multidisciplinary team) such as a physician, physician assistant, nurse practitioner, physical therapist, occupational therapist, speech pathologist, and other supportive services such as social worker and home health aides. Home health care provided to the older adults can also be diagnostic, therapeutic, preventive, or even palliative services.[20] There are only six services that are covered by the Medicare home health benefit, which require a physician's order for skilled services. The covered services include nursing, physical therapy, occupational therapy, speech and language pathology, social work services, and home health aide.[1,11]

According to the Centers for Medicare and Medicaid Services (CMS), the national average number of home visits per patient was 36 visits, the average payment for each visit was approximately $147.99, while the payment for each patient during their episode of care was a mean of $5,216.44 across all the United States in 2007.[11]

### 2.3.1 Medicare and Medicaid programs

In the 1965, the US Congress established the Medicare and Medicaid programs; these governmental programs are the largest governmental payers for home health services.[8,21] The Medicare and Medicaid programs were initially administered by the Department of Health, Education, and Welfare then the responsibilities for managing and administering the Medicare and Medicaid programs were moved to the DHHS, Centers for Medicare and Medicaid Services (CMS).[21] Medicare benefits were initially established for post acute care, then, after several legislative revisions, the Medicare benefits expanded to home health services in 1980.[21-23] The Medicare program is a governmental insurance program, directed to those who are 65 years of age or older, people with certain disabilities, and people at the end-stage of renal disease.[24]

The Medicare and Medicaid programs are the main sources of payment for home health; Medicare paid 41% and Medicaid 24% of the total payment for home health care in the 2009.[8] The figure below shows the sources of payment for HHC in 2009.[8]

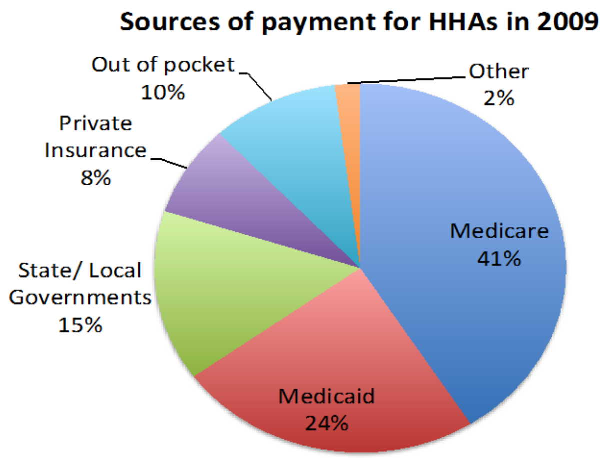


**Figure 1. Sources of payment for home health agencies in 2009**

Adapted from Basic Statistic about Home Care, prepared by the National Association for Home Care & Hospice.[8]

The CMS are the largest institutional payers for HHC services,[8] followed by State governments and private insurance companies.[8] Total payment for home health agencies in 2004 was approximately 4% (11 billion dollars) of the total Medicare benefits for the health care system in the US.[1,8] The estimation of the total HHC spending in 2006 was approximately 52.7 billion dollars with CMS the dominant payer for HHC services.[1]

In 1999, the CMS implemented that the Outcome Assessment Information Set (OASIS) was to be mandatory for all Home Health Agencies (HHA) for receiving payment through the Prospective Payment System (PPS). The OASIS had been revised several times until it became the source of payment for home health agencies and the payment became based on the episode of care (60 days) and diagnostic severity, not based on the number of visits. The Centers for

Medicare and Medicaid Services established the PPS in order to estimate payment rates for group of patients undergoing HHC, and assigned the Home Health Resource Group (HHRG) which is a score based on the OASIS information, and classify patients into groups, for payment purposes, based on their condition and severity for each domain (clinical, functional, and service utilization).[1,11]

The payment rate for HHC is standardized among all HHAs in the US. The payment rate "bundle" for HHC in 2011 was $2,192.07 for one episode of care (60-day period) regardless of the number of visits or actual costs of care.[1,11,24] The bundle payment covers all service disciplines (e.g. physical therapists, registered nursing, occupational therapists, speech language and pathologist, social workers, and home health aides), and nonroutine medical supplies.[1] The standardized payment then goes under several adjustments based on the geographical locations and patient's conditions from the OASIS documentation through a case-mix classification system, which classifies patients into categories based on the diagnostic severity, functional status at the onset of care and at the completion of the episode of care, and also services utilized during that episode of care.[1,24] In addition, admission to home care services and pathway of care processing are also standardized, for optimal care delivery,[1,11] across all home health agencies in the US (Figure 2).

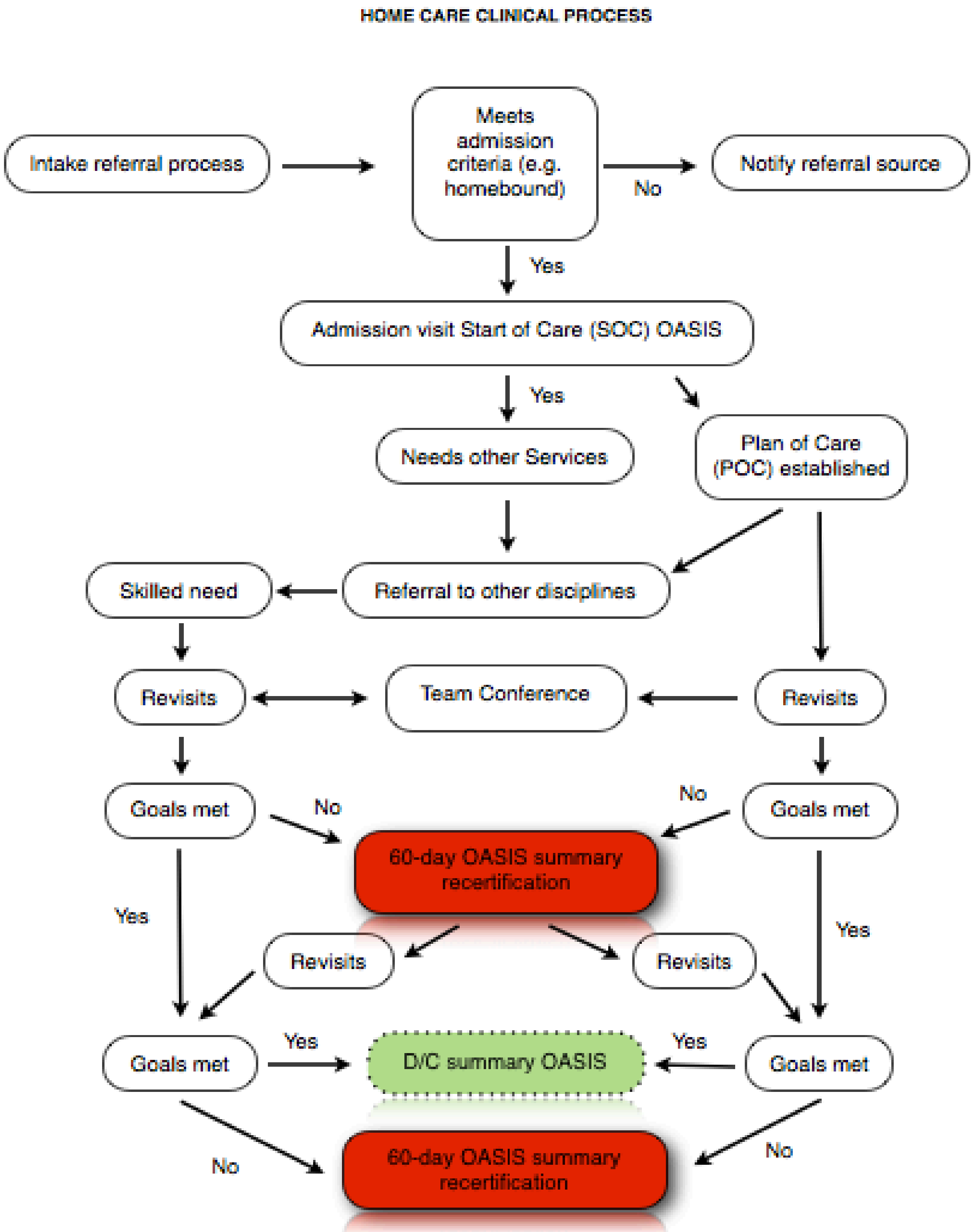


**Figure 2. Home care clinical pathway among home health agencies (HHAs) in the US**

(Adapted from CMS and waiting for permission)[1,11]

### 2.3.2 The Outcome and Assessment Information set (OASIS)

The Outcome and Assessment Information set (OASIS) is a comprehensive assessment tool for assessing patient characteristics and measuring patient outcomes in HHC between admission and discharge from the episode of care.[1,11] Historically, the OASIS was established initially in 1973 by the Center for Health Services at the University of Colorado. The research program at the University of Colorado analyzed health care policies and regulations of the health care system in the US in terms of cost and quality assurance. Around 200 agencies across the US contributed to refine and review the OASIS until the Research Center at the University of Colorado released the original report in 1994, which was followed up by five years of a national review program.[25]

In the 1999, the CMS implemented the OASIS to be mandatory for all home health agencies for receiving payment through the prospective payment system (PPS).[22,26] A multidisciplinary team developed the OASIS in order to improve the quality of HHC services delivered to Medicare and Medicaid beneficiaries; those patients who are eligible for Medicare or Medicaid benefits.[27]

The OASIS is used for several purposes: reimbursement, as a mean to certify home health care agencies, to determine quality outcomes for the agency, and to compare services between agencies for greater patient's choice.[26] There are six domains that the OASIS can assess, sociodemographic, environment, support system, health status, functional status, and behavioral status.[11,28]

The original OASIS (OASIS-B) was revised by CMS and they updated the new version (OASIS-C) to make it effective starting in January 1, 2010. These modifications include some issues related to clarifying items for greater accuracy, expanding some items to include additional scale levels (e.g. bathing and transferring), and some modifications including adding a new item to increase the clarity in measurement (e.g. toilet hygiene).[11]

### 2.3.2.1 The OASIS-C items

The OASIS-C is collected at different time points, e.g. start of care (SOC), resumption of care following inpatient facility stay (ROC), recertification within the last five days of each 60-day recertification period, other follow-up, transfer to an inpatient facility, discharge from home care, and death at home. The number of collected items of the OASIS-C depends on the time point collection, for example: there are 79 items at the start of care and 61 items have to be collected at discharge from home care. The OASIS-C consists of 16 categories that include several items under each category, with a total number of 114 items and questions. For example, the category of activities of daily living and instrumental activities of daily living (ADLs/IADLs) includes thirteen items that capture the level of ADLs/IADLs at certain time points, e.g. at baseline and at discharge (Table 1).[11]

**Table 1. OASIS-C items categories and their numbering system**
(Adapted from the CMS)[11]

| OASIS-C item categories | Number of items | OASIS-C Numbering system |
|---|---|---|
| Patient Tracking Items | 17 | M0010 – M0069; M0140 –M0150 |
| Clinical Record Items | 6 | M0080 – M0110 |
| Patient History and Diagnoses | 17 | M1000s |
| Living Arrangements | 1 | M1100 |
| Sensory Status | 6 | M1200s |
| Integumentary Status | 17 | M1300s |
| Respiratory Status | 2 | M1400s |
| Cardiac Status | 2 | M1500s |
| Elimination Status | 5 | M1600s |
| Neuro/Emotional/Behavioral Status | 7 | M1700s |
| ADLs/IADLs | 13 | M1800s + M1900s |
| Medications | 8 | M2000s |
| Care Management | 2 | M2100s |
| Therapy Need and Plan of Care | 2 | M2200s |
| Emergent Care | 2 | M2300s |
| Data Collected at Transfer/Discharge | 7 | M2400s, M0903+M0906 |
| Total number of Items and questions in the OASIS-C: 114 items | | |

#### 2.3.2.2 Functional composite score within the OASIS-C

The functional status items in the OASIS-C (under the ADLs/IADLs category) consist of nine activities of daily living (ADL) items that assess functional performance. The functional ADL items are: grooming, dressing upper body, dressing lower body, bathing, toilet transferring, toileting hygiene, transferring, ambulation/ locomotion, and feeding or eating. Each item has different levels of scoring. In all items, 0 indicates totally independent and the highest score suggests total assistance is needed (totally dependent).[1,11,25] (see the appendix 1).

In terms of reliability and validity of the OASIS-C, Landis et al. (1977) found that the inter-rater reliability was adequate or better with kappa's of 0.60 or higher.[26,29-32] The internal consistency was 0.88 and higher by using Cronbach's coefficient alpha for baseline and discharge ADL scores.[26] The OASIS functional scores (ADLs items) were compared with the Older American Resources and Services (OARS) instrument to measure it's concurrent validity with an overall correlation of r = 0.71.[28] The OASIS functional scores are also highly correlated with the Katz Index of Activities of Daily Living.[26,28] The ability of the functional items within the OASIS-C to detect functional change over period of time compared with validated outcome measures has not examined.

To compute overall functional status, a composite score is the appropriate choice to use since the OASIS functional items were not developed for scale scoring.[33] Scharpf et al. proposed the corrected Likert approach, in which an individual's score for each ADL item is divided by the highest score. The advantage of the corrected Likert approach is that all the ADL items are scaled similarly. For example, ambulation/ locomotion item ranges from 0 (independent) to 6 (totally dependent). If the score for an individual patient was a “2”, then the value would be (2/6= 0.33) and range from 0 to 1. Therefore, the total functional performance score in the OASIS can be calculated by adding all nine ADL items scores. The total summed ADL score ranges from 0 to 9. The value (0) indicates totally independent whereas (9) indicates totally dependent. The change score between admission and discharge is calculated by subtracting the discharge ADL score from the admission score. The ADLs change score ranges from -9 to 9. The score of (9) indicates a better performance or functional improvement, (0) indicates no change between admission and discharge, and (-9) indicates that the individual's ADL score got worse after the episode of care.

## 2.4 HHC: STATISTICS, COST ASSOCIATED, WITH CARE COMPARISON WITH IN-PATIENT HOSPITALS

Private insurance companies and governmental health programs, such as Medicare and Medicaid, acknowledge the importance of home-based care and it's benefits in reducing the cost of care. According to the U.S. DHHS, the cost of a HHC visit in 1993 was approximately $66, whereas the Medicare charges for an average day in the hospital was around $1500.[18,34] In 2009, the Medicare charges for HHC per visit compared with a hospital per day charges were around $135 versus $6,200 respectively.[8] The hospital at home, or HHC, showed significant improvements in functional outcomes, instrumental activities daily living, and significant reduction in cost when compared with long term hospital care for chronically ill Swedish older adults.[7] The total cost of inpatient hospital care was three times higher than those treated at home.[7] Also in New Zealand, older women over the age of 80 performing a preventive home exercise program in the home showed that the approach is more cost effective than the cost of a fall.[9,35]

The home health care industry in the US has increased significantly during the past four decades due to different challenges in the US public health sector. These challenges were the increasing cost of care within in-patient hospitals, the aging of the population, technology development that can be utilized in home settings, and the popularity and advantages of care in the home.[5] Hughes et al. studied the impact of home care utilization on hospital days. There was a small to moderate positive impact of HHC on re-hospitalization days, which might be helpful in decreasing cost of health expenditures with a statistically significant relationship between decreased inpatient hospital care days and HHC.[5,8]

The Research and Development corporation (RAND), one of the biggest nonprofit institutions that improve policy and decision making through research and analysis, studied the home health benefits for patients discharged with total hip and knee replacement. The result was that patients who received HHC were less likely to be institutionalized or re-hospitalized than patients who received care in skilled nursing facility (SNF) and in in-patient rehabilitation facilities (IRF).[8] In terms of the effectiveness of an early hospital discharge, a community rehabilitation team (PT, OT, SP, social workers, and rehabilitation nurses) demonstrated similar clinical outcomes at home when compared with usual care (in-patient hospital) at 6 months follow up for patients with stroke.[8] Home-based rehabilitation reduces the use of hospital beds without affecting clinical outcomes.[16]

Rehabilitation programs provided in the home improved functional outcomes for patient with heart failure (HF).[12] Hadley et al. compared functional capacity improvement for those who received home care rehabilitation versus a control group. The home care rehabilitation users had improved in terms of functional outcomes.[12,36] The Australian guidelines for stroke rehabilitation and recovery suggested that rehabilitation in community, including home visits, for people with stroke is equally effective if they received care in the hospital including either inpatient or outpatient settings.[37-41]

## 2.5 IMPACT OF HHC ON BALANCE, GAIT, AND FUNCTIONAL PERFORMANCE BASED ON SPECIFIC DIAGNOSTIC CATEGORIES

### 2.5.1 Stroke population

Home-based rehabilitation is effective in enhancing function for persons post stroke according to the Canadian study.[42] Mayo et al. (2000) assigned stroke survivors into either a home care or usual care group. Home care consisted of immediate services by an interdisciplinary team (nursing, PT, OT, and speech therapy). The home intervention program showed significant improvements compared to usual care (inpatients and outpatients rehabilitation settings) in the physical health component of the Measuring Outcomes Study Short-Form-36 (SF-36), the Older Americans Resource Scale for instrumental activities of daily living (OARS-IADL), and in Reintegration to Normal Living (RNL) scales. Meanwhile, there were similar improvements between two groups in terms of the Barthel Index (BI) and the Timed Up & GO (TUG) at one and three months after stroke.[42] Home care intervention by a physical or occupational therapist in addition to a falls reduction program have an impact on delaying mortality rates and functional decline, and have shown decreases in mortality two years after intervention.[9,10]

In a recent systematic review for stroke rehabilitation at home, the authors stressed the importance of home-based rehabilitation after stroke events.[43] They concluded that there was a significant effect for home-based rehabilitation versus center-based rehabilitation at 6 months. The benefits of rehabilitation at home include cost reductions, enhanced patient satisfaction,[43,44] improvements in physical health,[42,43] and enhanced functional outcomes.[43,44] Home-based rehabilitation compared with usual or standard care is more effective for stroke survivors in improving their independence in activities daily living.[38,43] Home-based rehabilitation has an influence on positive functional outcomes for community dwelling older people in Italy.[45] Fusco et al. demonstrated that one third of the patients improved.[45] Factors associated with functional decline in dwelling older adults were cognitive impairment, hearing or visual impairment, depression, and urinary or bowel incontinence.[12,45] There are several factors were suggested to be associated with stroke recovery in the literature. These factors are: age,[46-51] severity of stroke,[52] stroke type,[47,53] were stated to be the predictors for walking recovery in post stroke individuals within 30 days of stroke onset.[46] Cognitive impairment,[47,54,55] gender,[47,56,57] continence,[50,58] were also negatively associated with functional recovery at discharge from in-patients rehabilitation settings.[47] Severity of stoke symptoms, such as moderate to severe hemiparesis, was suggested in the literature as a predictor factor for re-hospitalization, disability, and increasing the mortality rate after 5 years after stroke.[52,59] However, the predicted factors for improvement in functional and gait in the rehabilitation in the home care setting were not described yet in the literature for individuals with stroke.

### 2.5.2 Heart failure population

Exercise training on individuals with heart failure was shown to be effective after short period of time of rehabilitation,[60,61] and showed a positive impact on physical performance, endurance capacity such as exercise duration,[62-64] 17% increasing in peak oxygen consumption,[62-64] quality of life,[60-62,64,65] and decreases the hospitalization and mortality rate.[60-62,64,65] Several studies were conducted in person's home and suggested that home-based exercise showed improvement on quality of life of individuals with heart failure,[62,66] self-efficacy enhancement,[62,67] increased maximum exercise period,[62,68] and significant reductions in hospitalization rate after six months of walking exercise at home,[62,69,70] improvement in the blood flow in the lower extremities,[62,71] fatigue improvement,[67] and enhanced emotional function in individuals with heart failure.[67] Based on the literature, age and other comorbidities, such as diabetics, chronic obstructive pulmonary diseases associated with heart diseases have impact on physical activities and functional recovery, and associated with high rate of re-hospitalization.[72,73]

In terms of comparing between hospital-based training exercises and home-based exercises program for individuals with heart failure, several studies found that both intervention groups were shown similar improvement on six-minute walk test, quality of life (measured by short form survey SF-36), psychological symptoms (beck depression inventory),[74] and functional capacity (obtained by maximal oxygen uptake pVO2).[74,75] Home-based exercises program was equally as effective as hospital or center-based exercise program on physical activity for individuals with heart failure after eight weeks and six months of follow up.[76] Although both groups did not show any positive effects significantly on upright duration or step taken, which was measured by noninvasive monitoring devise, both groups maintained their physical activity level after long period of time (after eight weeks of discharge) and there was no significant difference between groups in term of upright duration, steps taken per day, and walking pattern at long period of time.[76]

In a recent meta-analysis study, Hwang et al (2009) examined 19 randomized clinical trials in order to investigate the benefits of home-based exercise for individuals with heart failure compared with standard care or center-based exercise. They concluded that home-based exercise showed a significant improvement on peak oxygen consumption, exercise duration, and walking capacity, by using the six-minute walk test, the mean improvement was increased by 2.86 ml/kg per min (95% CI: 1.43-4.29), 1.94 minute (95% CI: 0.89-2.98) and 30.41 meters (95% CI: 6.13-54.68) respectively.[62]

However, rehabilitation programs provided in the previous studies were either center-based programs followed by home instructions in patient's home, or home-based exercise alone without clinician's supervision. The studies of HBR programs (supervised) for individuals with heart failure are limited in the literature, such as those provided by a certified home health care agency, specialized on home health services including rehabilitation interdisciplinary team (e.g. PT, OT, SP). Wall et al. was one of the limited studies that examined the impact of home-based exercise on individuals with heart failure under supervision of cardiac rehabilitation specialist, and the findings were compared with conventional intervention.[60] Home-based program compromised of three home visits per week by cardiac rehabilitation specialists and treadmill utilization for at least fifteen minutes, while the conventional therapy included outpatient, home visits, and education sessions related to nutrition and intake medication. Although there was no significant difference between groups after discharge, there was a greater improvement for the home-based program group on the Yale Physical Activity Survey (YPAS), that measure activity dimensions, and that improvement was four times greater than conventional group.[60]

Home-based rehabilitation is critical and important for heart failure population because it maintained exercise benefits after discharge from outpatient or center-based rehabilitation,[62] and has impact in enhancing and restoring functional capacity.

### 2.5.3 Parkinson's disease population

Parkinson's disease is a progressive neurological disorder, characterized by rigidity, tremor, gait and balance disorders,[77,78] which have impact on activities daily living (ADL), gait performance, and others manifestations could be seen, such as psychological changes, cognitive involvement, and sensory changes.[78] The prevalence of the disease in older adults over 65 years of age is above 2%,[78] and 4% in elderly over 80 years of age.[79,80] The incidence is positively correlated with increasing age,[77,78] and the estimated projected number of people with Parkinson's disease in 2030 will be around 8 to 9 million around the world.[79,81]

The cost of care for individuals' with Parkinson's disease was estimated to be around $25,000 per patient each year, and the overall expenditures in the United States was approximately $34 billion in 2004.[77] The individuals with Parkinson's disease had higher rate in health care utilization among elderly beneficiaries, and they were more likely to use home health care services (OR= 2.08; 95% CI = 1.76- 2.46),[77] and the annual health care expenditures in 2002 was significantly higher than others Medicare beneficiaries (without Parkinson's disease) which was approximately $18,528, and $10,818 respectively.[77] There are several factors were suggested in the literature to be associated with functional improvements or recovery for individuals with Parkinson's disease, these were age, baseline gait speed (as a motor domain), and cognitive impairment (as a cognitive domain) and emotional factors (anxiety and depression) are negatively associated with rehabilitation outcomes.[82]

Exercise training program (resistive exercises and balance training) is effective in enhancing quality of life,[78,83,84] and motor performance for individual' with Parkinson's disease at mild and moderate stage.[78,83,85] Previous studies suggested also that flexibility and functional training had impact in improving spinal flexibility and balance in individual with Parkinson's disease,[79,86] in addition, endurance exercises such as aerobic training enhanced the functional activities.[79,87] In a recent meta-analysis,[88] the exercise program designed for individual with Parkinson's disease is beneficial in various aspects, such as functional level, gait speed, balance, and lower extremities strength. Also, exercise benefits were associated with improvements with gait performance and physical functioning.[88,89]

In terms of home-based interventions, training programs designed in person's home were stressed in the literature to be significantly beneficial especially for those at the early stages when compared with usual care.[90] A home-based exercise is essential part of rehabilitation for individuals with Parkinson's disease, due to the progressive nature of disease. The daily or regular exercise is required to prevent of prolonged inactivity for patients,[78] also, ongoing exercise is important for this type of population to maintain and restore functional level and gait abnormalities.[78,79]

Ashburn et al. examined the effectiveness of home-based exercises, which were exercises and some strategies related to movement initiation and compensation. The home-based group was monitored initially by PT visits and then followed by phone calls. They compared the outcomes with a usual care group, in which no exercises were provided in the usual care group, just nursing recommendations and instructions. Their findings showed that there were significantly lower numbers in falling events at eight weeks and six months of follow up for the exercise group, and also improvements were seen in the exercise group on functional reach scores and quality of life performance after six months.[90] Schenkman et al. (2012) also compared the benefits of a supervised training group, in an outpatient setting, with a home-based exercise group. The supervised training consisted of flexibility, balance, and function exercises for four months, 3 times per week, while the home-based exercise group were instructed to perform the exercises described in the fitness counts, that was developed by the national Parkinson foundation. Although the supervised group did better and there was a significant difference between groups on overall function and ADL scores after 4 months, the home-based exercise group (unsupervised) was equally effective on balance (by using the Functional Reach Test

FRT). The evidence stressed on the importance of exercise's supervision, and the exercise's benefits will be affected when there is no supervision.[79,88]

The rationale for decreased exercise benefits when there is no professional supervision is that due to adherence to home exercise program for individuals with Parkinson's. The recent study on individuals' with Parkinson’s disease suggested that older people with anxiety, depression, and with mental or cognitive abnormalities were shown to have less adherence to the home exercises program.[91] Some studies suggested conflict results, Lun et al showed that there was no difference between supervised PT and self-supervised home-based exercises in improving motor function in individuals with Parkinson's disease, and both interventions were equally effective.[78,92]

### 2.6 REHABILITATION AND PHYSICAL THERAPY IN HHC

In terms of physical therapy utilization in homes, there are a limited numbers of studies that have been conducted in home health. Whitney et al. recently examined changes in balance and gait performance in older adults, over 65 years of age, receiving home care services.[9] Whitney et al. demonstrated that there is a significant change in balance and gait after an episode of HHC.[9] They examined the mean and standard deviation (SD) change in improvement, which exceeded the minimum detectable change (MDC)[9] on the Berg Balance Scale (BBS),[93] the Performance Oriented Measurement Assessment (POMA),[94] and the Dynamic Gait Index (DGI).[95,96] The value of the mean and SD changes were 12, 8, and 7 points respectively. The findings stressed the importance of HHC in improving balance and gait outcomes, which decreases the risk of falling for older adults.[9]

Physical therapy utilization in HHC is limited in the literature. The only study that discussed the utilization of physical therapy in HHC, and used the OASIS as an outcome measure, was investigated by Kim et al.[2] They analyzed the utilization of physical therapy in HHC by using OASIS functional measures. From eight functional measures in the OASIS-C, they analyzed only three functional items from the OASIS, which included ambulation, transferring, and toileting. Their findings suggested that there is a significant functional improvement in patients receiving HHC after an episode of care.[2] However, they included a heterogeneous population in terms of their diagnoses and conditions.

## 2.7 GAIT SPEED FOR OLDER ADULTS

Gait speed is a powerful measure that can be used to indicate functional change and prognosis after stroke,[97] plus it can be used to quickly determine overall health compared with any measure of gait performance.[95,98,99] Gait speed is performed by asking a patient to walk a specific distance and recording the time that was taken to ambulate the predetermined distance. Gait distance tested varies in the literature. For the recording distance of gait speed, Collen, et al. (1990) recorded gait speed over 10 meters,[100] however, Guralnik and colleagues (1994) suggested that 4 meters is the distance of choice because of its feasibility for use in the home and clinical settings.[95,101] Gait distance over 10 meters may overestimate walking capacity in subjects with stroke.[102] Therefore, it may be optimal to use shorter distances to measure gait performance for subjects with stroke.[95]

The minimally clinically important difference (MCID) for gait speed also varies in the literature, depending on the subject's gait speed at baseline and also diagnosis.[95] Perera et al.

(2006) measured the MCID from a heterogeneous sample, e.g. older adults with mobility disability, subjects with stroke, and community-dwelling older adults. They reported that 0.10 m/s is a substantial change that should be considered as a meaningful change in gait speed,[103] and that change is associated with reduced disability and better survival rates among older adults.[95,104] The MCID for stroke survivors within two months of onset was 0.16 meter per second.[95,105] Schmid et al. (2007) also reported that successful transition from a lower level to a higher level within the Perry mobility classification (household, limited community, full community) reflect improvements in function, participation, and quality of life.[95,97] Stroke survivors undergoing out-patient rehabilitation services demonstrated an improvement in gait speed by 0.18 m/s, which they considered a meaningful improvement in walking ability.[106]

## 2.8 SAMPLE PROFILE OF PATIENTS' CHARACTERISTICS IN PERSONS UNDERGOING HHC

In 2007, 41% of patients admitted to home health agencies had essential hypertension, 31% had heart disease, 31% of patients had diabetes mellitus, 14% had chronic obstructive pulmonary disease, 10% had osteoarthritis, and 7.1% had cerebrovascular disease among all listed diagnoses at the start of care.[3] There are several studies that determined the utilization of HHC services for older adults. One of theses studies was conducted between April 1997 and March 1998 by Adams et al.[2,107] Adams et al. evaluated the relationship between generic patient conditions and service utilization. They concluded that home health visits have to be concentrated in a condition-specific patient rather than generic patients in order to improve quality of services.[2,107]

Because of heterogeneity of the population in terms of chronic conditions in HHC, there are a limited number of studies that have examined the effect of HHC on specific-diagnostic conditions. Also there are limited studies that have utilized the functional items in the Outcomes and Assessment Information Set (OASIS). Scharpf et al. evaluated functional outcome measures (OASIS-C) for patients with heart failure who were treated by HHC services.[26] In our future studies, we aim to categorize patients into subsets of the population based on medical conditions in order to more accurately describe functional improvements over time.

The main goal of this dissertation is to identify the optimal combination of potential predictors at the start of care for persons undergoing HBR, and describe the associated factors that positively and negatively affect outcome on functional scores and gait performance for each subset of samples. The first part of this dissertation describes the outcomes of HBR on functional performance (ADLs) and gait speed for individuals after stroke and associated factors that contribute to better outcomes after an episode of care. The second study describes improvements in activities of daily living (ADL), gait speed, and associated factors in patients undergoing HBR after hospital admission for heart failure. Finally, the third study will explore the effect of HBR on persons with Parkinson's disease on functional (ADL) and gait performance, and associated factors that positively and negatively affect outcome on functional scores and gait performance after rehabilitation at home.

# 3.0 METHOD

Our retrospective studies reviewed patients' records (8,437 persons over 65 years of age) who were admitted to GENTIVA Health Services in 2010. The GENTIVA health services is a private health care provider serving patients in more than 40 states in the US. GENTIVA health services provide comprehensive nursing, physical and occupational therapy, speech therapy, home health aide, infusion, and hospice care for over 85,000 patients per day. The patient's records were de-identified by an honest broker, and were sent to the University of Pittsburgh for collaborative analysis. The agreement collaboration between GENTIVA and University of Pittsburgh was to analyze the data and to publish regardless of the finding. Our specific aims were independently developed. The University of Pittsburgh's Institutional Review Board (IRB) approved the study.

## 3.1 PATIENT CHARACTERISTICS AND INCLUSION CRITERIA TO HHC

The clinical data were retrospectively collected from over 8,437 patients with various diagnoses from multiple settings across the United States. The dataset includes patients' information from the OASIS-C and gait speed performance at the start of care and at discharge. The dataset has information from one home health agency, GENTIVA Home Health Services. GENTIVA Home Health Services provided data for all persons over the age of 65 who were admitted to the Safe Strides program in 2010; the program is a fall preventive program, and it is summarized below under the Safe Strides program section.

### 3.1.1 Subset of population

The sample in our dataset was heterogeneous with at least 17 diagnostic categories, and more than 800 ICD-9 codes. In our dataset, we are interested in describing improvements in gait speed and functional performance (the composite score for the activity of daily living) component of the OASIS-C for several diagnostic categories, in order to record outcomes based on specific conditions. Several subsets of the sample will be studied including persons post stroke (n= 213), heart failure (n= 1055), and persons with Parkinson's disease (n= 503) (Figure 3).

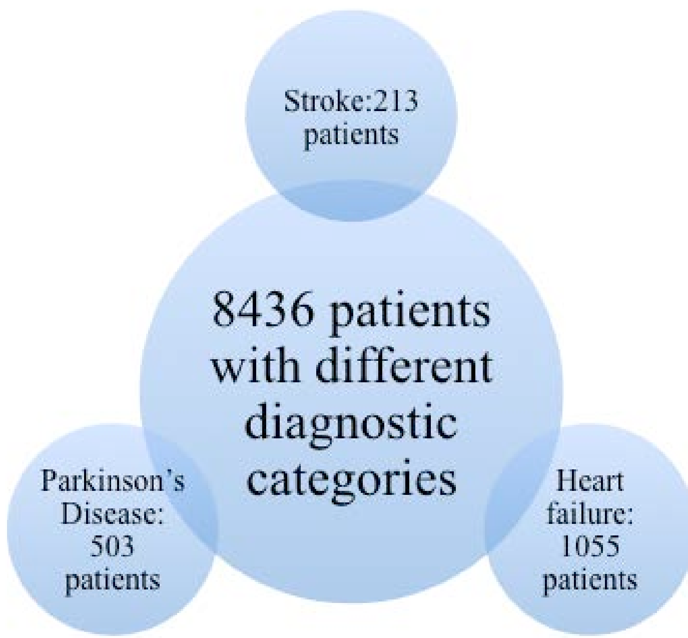


**Figure 3. Subset of population: extraction from the original dataset**

### 3.1.2 Selection criteria for subset of population

For the stroke population, we selected the cerebrovascular (CVA) subjects, who were coded as "430.00" to "438.9" based on the ICD-9 codes in the Inpatient diagnosis items (M1010 item in the OASIS-C evaluation form), the M1010 item is the inpatient diagnosis that was used during an inpatient stay within the last 14 days. Then, we selected subjects who showed stroke manifestations at start of the care by selecting those who were coded as "Late effects of cerebrovascular disease", especially subjects with hemiplegia and hemiparesis (Dominant and non-dominant side) in the primary diagnosis and others diagnoses, which are patient's diagnosis when admitted to the HHC. These steps ensured that subjects were treated by the HHC agency due to stroke. The codes for primary and others diagnoses were (438.2, 438.21, 438.22) in the (M1020 and M1022 items in the OASIS-C). Therefor the total subjects with CVA were 213 and were diagnosed at admission to the HHC as "with late CVA effects e.g. hemiplegia affecting dominant and non-dominant side". For other subsets of population (e.g. heart failure, and Parkinson's disease), we selected patients if they had one of these conditions based on their ICD-9 codes in any of the primary or other diagnosis codes (among all six diagnostic lists: in the M1020 and M1022 items in the OASIS-C). The ICD-9 codes for these conditions are the following: "428.00 to 428.9" for the heart failure population, and "332.00" for the Parkinson's disease's population (Figure 4).

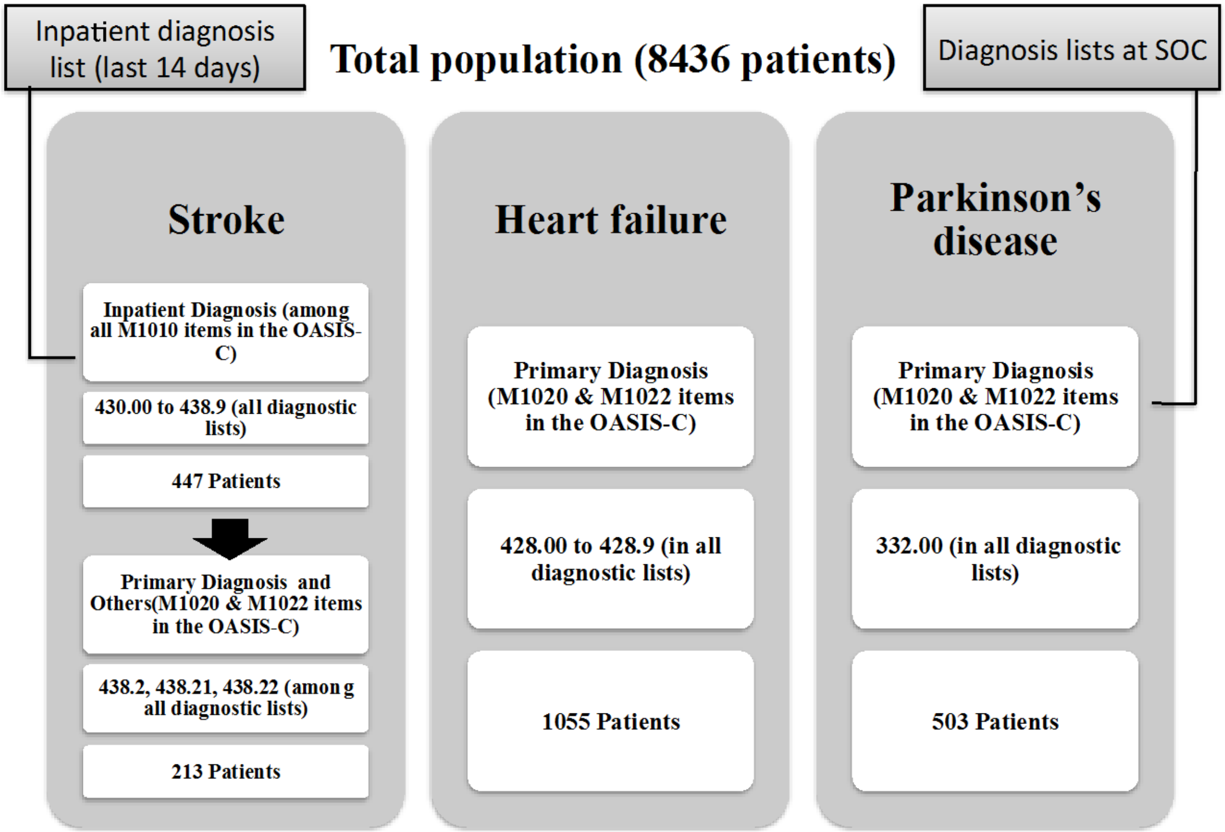


**Figure 4. The process of extraction of the subsets of population based on the ICD-9 codes**

## 3.2 VARIABLES OF INTEREST BASED ON THE OASIS-C

In the dataset, there are more than 20 variables that could be used as predictor variables, such as demographics, psychological and behavioral, cognitive, and health and functional status. These 20 variables were extracted from the OASIS, and the selection of these variables was based on the literature and home health clinicians' judgment. These variables will be tested in order to classify patients receiving HHC into specific characteristics that identify patients with better or worsening gait and balance performance at discharge from HHC services.

The chosen variables include the following: age, type of inpatient facility that they were discharged before starting HHC, gender, history of anxiety and depression, history of confusion, total number of visits, number of physical therapy visits, number of skilled nursing visits, cognitive function, urinary status, medication management, care management, living situation, activities of daily living (ADL) baseline scores (e.g. grooming, dressing upper body, dressing lower body, bathing, toilet transferring, toileting hygiene, transferring, ambulation / locomotion, feeding or eating).[11] These variables were chosen based on the literature and after consultations with five physical therapists and one nurse (Figure 5).

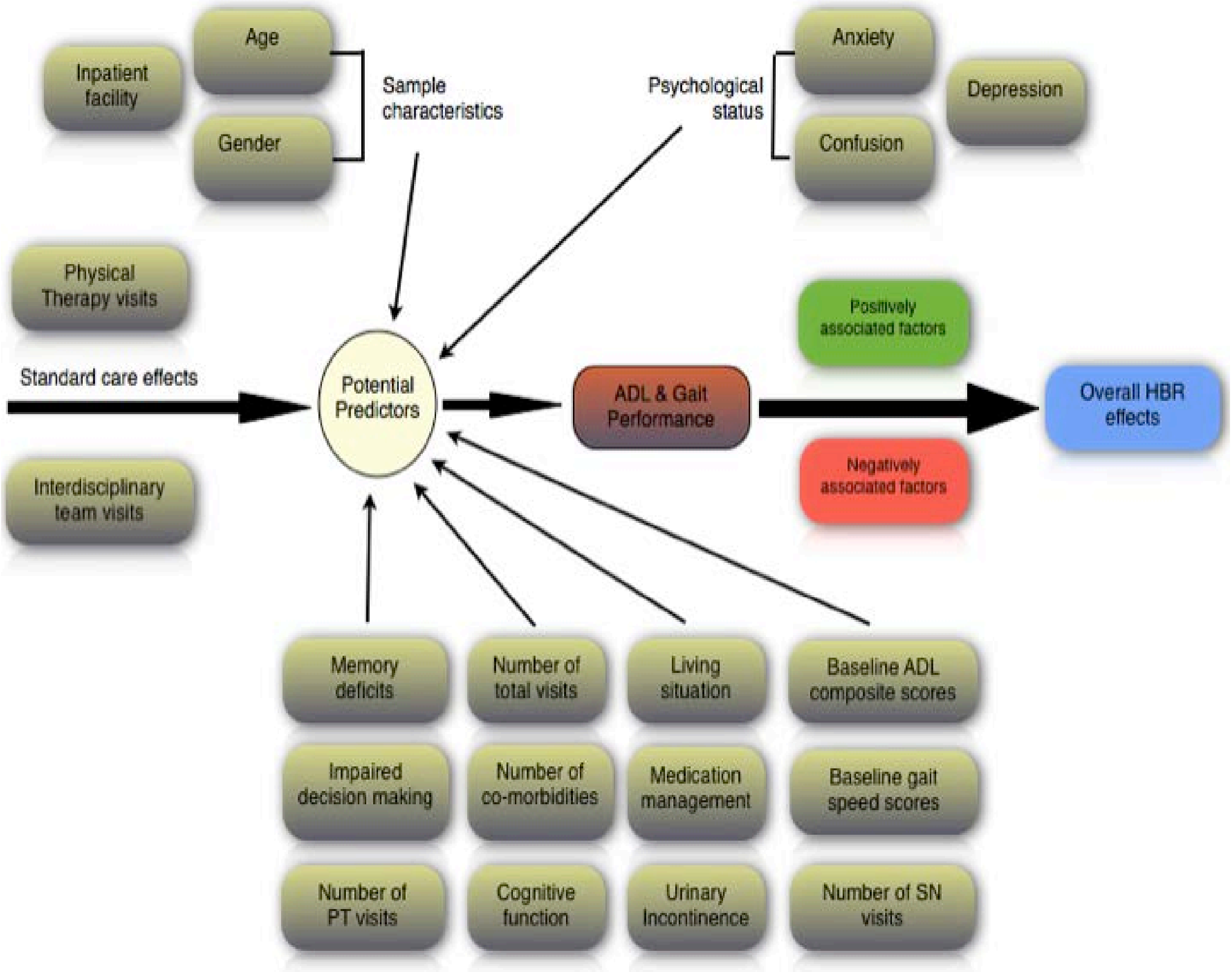


**Figure 5. Flowcharts of the potential predictors and its associations with functional and gait performance**

### 3.3 OUTCOME MEASURES

The main outcome measures are the OASIS-C composite score (obtained by calculating the 9 ADLs items) and gait speed. These measures were collected from all patients in the dataset. Gait speed is one of the Safe Strides measures, which is required to be completed by clinicians in the GENTIVA Corporation. The Safe Strides gait and balance measures include gait speed, the Dynamic Gait Index (DGI),[95,96] the Berg Balance Scale (BBS),[93] neuropathic pain ratings,[108] the Performance Oriented Measurement Assessment (POMA),[94] and the Modified Clinical Test of Sensory Integration and Balance (mCTSIB).[109,110] However, the only Safe Strides measure that was collected for all patients in the dataset was the gait speed.

## 3.4 SAFE STRIDES PROGRAM

The Safe Strides Program is a home-based falls prevention rehabilitation program established by Gentiva Corporation for home health services, and designed for older adults who are at risk for falling. The program includes a falls prevention approach and intervention customized by trained clinicians to improve balance and functional capacity, and increase the level of independence of the patient. The inclusion criteria for the Safe Strides program were a history of falls in the most recent twelve months and/ or one or more modifiable fall risk factor. Modifiable fall risk factors included home hazards,[9,111,112] psychotropic or multiple medications,[9,111] lower extremities weakness,[9,111] walking disorders, loss of balance,[9,111] vestibular disorders symptoms,[9,113] orthostatic hypotension, loss of sensation related to diabetes mellitus,[9,111] visual disorders,[9,111] and use of sedative medications.[9,111]

## 3.5 CLINICIAN TRAINING

Clinicians were trained in home skills validation and documentation credentialing and reinforced by post-training labs. All therapists completed 19.5 contact hours of a comprehensive assessment, e-learning, falls reduction program, and live facilitated continuing education designed for people who are homebound. Therapists were trained related to intervention protocols and collecting through educational materials, e.g. training manuals, a DVD, live instruction, and skills demonstration. In addition, therapists also participated in hands-on evaluation, intervention, and documentation labs and had their clinical records reviewed. During the physical therapy initial examination, the physical therapist determined the physical therapy plan of care, goals and intervention, number of physical therapy visits, and need for other disciplinary care.

## 3.6 DATA SOURCES

### 3.6.1 Data extraction method

The OASIS-C and gait speed data were retrieved from the Gentiva's Center for Outcome Measures, and queried and paired accordingly into Excel. Patients' records were de-identified by an honest broker, and were sent to the University of Pittsburgh for collaborative analysis. The University of Pittsburgh's Institutional Review Board approved the study.

### 3.6.2 Data entry and collection

Data were collected by credentialed clinicians, reviewed for quality assurance, and entered into Gentiva's database. Both OASIS-C and gait speed outcomes have specific rules and procedures for data collection and entry: the rules and procedures are described in the following sections.

#### 3.6.2.1 OASIS-C

Registered nurses, physical therapists, and speech and language pathologists completed the OASIS-C at admission, either at start of care or at resumption of care. All clinicians were required to collect and record the OASIS-C information manually. If the registered nurse completed the OASIS-C, a trained physical therapist completed the Safe Strides measures (gait speed) during the physical therapy initial evaluation. After completing the OASIS-C, a quality assurance registered nurse reviewed and checked for the data accuracy, diagnosis codes, and comorbidities. A data entry employee verified information and keyed the OASIS-C data into Unity, which is a communication data program that complies with the rules and standards of the Centers of Medicare and Medicaid Services (CMS) for electronic record submission. From the OASIS-C, the following information is entered: patient demographics, history, living situation and support, sensation, integumentary, respiration, elimination, behavior, ADL / IADL, medications arrangement, and equipment management.

#### 3.6.2.2 Safe Strides measures (Gait speed)

The gait speed test is ideal to be tested over 6 meters (around 20 feet) and can be tested also over 2.5 meters (8 feet) based on the home environment. The physical therapist tested the patient's gait speed in a straight clear path; turns during walking were not permitted. Patients were instructed to take 1-2 strides before and after the timing zone in order to control for acceleration and deceleration. Gait speed and other Safe Strides measures, e.g. sensation, neuropathic pain rating, the Dynamic Gait Index (DGI), the Berg Balance Scale (BBS), and the Performance Oriented Measurement Assessment (POMA) were collected onto standardized data collection forms. The accuracy of collecting was reviewed by the Specialty director, and submitted electronically to Gentiva's Center for Outcomes Measures. The data then were keyed exactly as written into a secure access database. The collection procedures process is summarized in the figure 6.

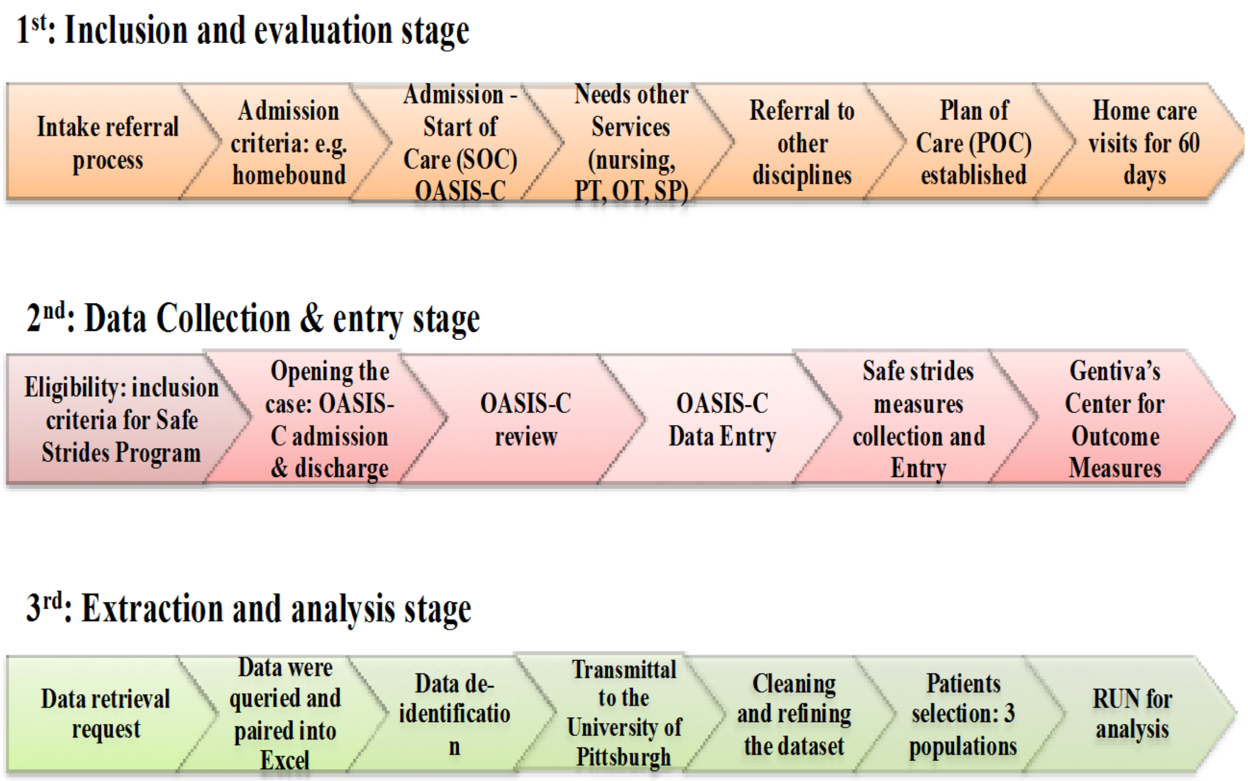


**Figure 6. Stages of data collection and analysis process**

## 3.7 SPECIFIC AIMS AND RESEARCH HYPOTHESES

### 3.7.1 Stroke

Aim 1: To describe the outcomes of home-based rehabilitation on gait and functional performance (activities of daily living ADL) for patients after stroke and the associated factors that contribute to better or worse outcomes after an episode of care.

#### 3.7.1.1 Hypothesis

H1: There will be improvement in activities of daily living (ADL) and gait performance in individuals who are receiving HBR after stroke.

H2: Advanced age, living alone, number of comorbidities, cognitive impairment, discharge from IRF settings, and urinary incontinence would be negatively associated with improvements in gait and functional performance after home-based rehabilitation. Better functional performance (ADL) and gait speed at the start of care would be also positively associated with functional improvement at the end of care.

### 3.7.2 Heart failure

Aim 2: To describe improvements in activities of daily living (ADL) and gait speed and to identify factors that contribute to better outcomes after an episode of care in subjects receiving home-based rehabilitation due to heart failure.

#### 3.7.2.1 Hypotheses

H1: There will be improvement in activities of daily living (ADL) and gait performance after an episode of care for individual with heart failure.

H2: Advanced age, number of comorbidities, female gender, cognitive-behavioral impairment, urinary incontinence, worse ADL at baseline (composite scores) and less number of PT visits are negatively associated with functional recovery and gait performance after rehabilitation in the home for persons with heart failure.

H3: Predictive factors would be also associated negatively with likelihood of exceeding the minimum detectible change (MDC) value in composite ADL score.

### 3.7.3 Parkinson's disease

Aim 3: To explore the effectiveness of home-based rehabilitation on functional activities of daily living (ADL) and gait performance for persons with Parkinson's disease and to identify the factors that affect ADL and gait outcomes.

#### 3.7.3.1 Hypothesis

H1: There will be improvement in activities of daily living (ADL) and gait performance after an episode of care for individual with Parkinson's disease.

H2: Advanced age, baseline gait speed (slower), memory deficits, cognitive impairment, and emotional factors (anxiety and depression) would be negatively associated with improvements in function and gait performance after HHC services.

## 3.8 STATISTICAL ANALYSIS

To choose the appropriate test statistics, two aims or purposes were determined for each subset of samples. The first purpose is to describe the overall improvements for each specific diagnostic group after receiving one episode of home care, and the second purpose is to determine the associated factors that positively and negatively affect outcome on functional scores and gait performance after rehabilitation in the home. Based on these purposes, we will use dependent t-tests for the first aim and General Linear Model (GLM) procedure to test the second aim, which includes several test statistics such as: repeated t-test, the Analysis of Covariance (ANCOVA) and Multiple Regression. Predictive covariates such as age, functional (ADL) and gait speed scores at the start of care (baseline) will be adjusted when we test the second purpose, because patients were discharged from different in-patients facilities and were admitted to the GENTIVA health services with different diagnostic conditions, and we would like to control for the variations at the baseline functional scores.

Based on our selection criteria for the potential predictors, we selected 20 predictor variables that might influence HBR outcomes. These predictors are: age, type of inpatient facility that they were discharged before starting HHC, gender, history of anxiety and depression, history of confusion, total number of visits, number of physical therapy visits, number of skilled nursing visits, cognitive function, urinary status, medication management, living situation, activities of daily living (ADL) baseline scores (e.g. grooming, dressing upper body, dressing lower body, bathing, toilet transferring, toileting hygiene, transferring, ambulation / locomotion, feeding or eating. The change score, for both ADL and gait speed, from admission to discharge is used as a dependent variable. The functional (ADL) change score between admission and discharge is calculated by subtracting the discharge ADL score from the admission score. Positive score represent better ADL improvements.

### 3.8.1 Statistical analysis (First aim)

**First aim:** To describe the overall improvements in functional level and gait performance for each specific diagnostic group after receiving one episode of home care.

In order to test the overall effect of HBR on functional and gait scores independently for each subset of samples, we will use a t-test statistics. The appropriate test for this aim will be the dependent t-test. The test is used to examine the difference between admission and discharge scores on both functional (ADL) and gait speed in each specific diagnostic categories. This approach is widely used in observational studies because it reduces the effect of extraneous factors. The assumption of normality has to be tested before starting hypothesis testing. The difference scores between admission and discharge should be normally distributed in order to meet the assumption. When the normality assumption is violated, another nonparametric statistics will be used such as Wilcoxon signed-rank test. The Wilcoxon signed-rank test is alternative to the parametric tests (dependent t-test) that converts scores to ranks and compare them at admission and discharge instead of comparing means.[114]

### 3.8.2 Statistical analysis (Second aim)

**Second aim:** To determine the associated factors that positively and negatively affect outcome on functional scores and gait performance after rehabilitation in the home.

Performing several steps that include multiple regression (via GLM) will test the second purpose for each subset of samples, which identifies the associated factors that positively and negatively affect outcome on functional scores and gait performance after the episode of home care.[115] These steps are required for each subset of samples in order to determine the best combinations of predictors that predict better or worse functional and gait outcomes. In our dataset, we assumed that patients were admitted to the intervention program with variations in functional and gait scores at the baseline. Therefore, we will adjust for functional and gait scores at baseline, if they were significantly associated with outcomes, to control for the variations on the dependent variable that can be explained by this covariate. Others covariates such as age will be also used since age already suggested in the literature as a covariate predictive for gait and functional outcomes.

There are several assumptions that we have to check initially before we start testing the second hypothesis, in order to validate the analysis. The assumptions are the following: (i) the distributions of residuals should be normally distributed (normality), (ii) No outliers among residuals or errors, (iii) the relationship between the predicted functional and gait scores and residuals should have linear relationship (linearity), (iv) the variability of residuals scores are equal among all predicted functional and gait scores (Homoscdasticity), (v) Independence of residuals (vi) The Independent variables (predictor) should not be high correlated or even a part of another predictor ( assumptions of Multicollinearity and Singularity) .[115]

Univariate predictors with adjustment for covariates were tested independently. Between group post hoc comparisons in mean ADL and gait speed change, based on allocating subjects to the different categories of a predictor variable, were made using a Bonferroni adjusted type I error rate. Multivariate analyses for predictive factors associated with changes in ADL and gait speed were performed using forward stepping regression analyses. The criterion for entry into the model was significance at .10 level. The significance level for the final multivariate model was set at .05 level. Each factor was tested independently before entering into the final model (multivariate linear model) with adjustment for significant covariates via a general linear model (GLM). Also a multivariate GLM with stepwise procedure was used. Stepwise procedure was used to identify the best subset of predictors for both ADL composite score and gait speed change between the start of care and discharge from HHC. A predictor was entered into the model in order based on strength of association, and retained for the final multivariate GLM if significant at the $p < 0.05$ level. The coefficient of determination ($R^2$) was described to interpret the independent contribution of each predictive factor on the change scores in ADL and gait speed. In addition, logistic regression was used to identify the variables predictive of the likelihood of patients to exceed the MDC of the ADL score at the end of care. The predictors were included into the final model when they are independently associated with likelihood of exceeding the MDC in the ADL score, with the level of tolerance at ($p= 0.10$). Odds ratios (OR) and 95% CIs were estimated from predictor variable model coefficients for the continuous covariates and categorical factors associated with likelihood of improvement by a minimum of the MDC in the ADL score. Analyses were performed using SPSS version 20.

# 4.0 PREDICTORS OF FUNCTIONAL AND GAIT OUTCOMES FOR PERSONS POST STROKE UNDERGOING HOME-BASED REHABILITATION

## 4.1 INTRODUCTION

According to the Centers for Disease Control and Prevention (CDC), stroke is the most common condition that leads to long term disability in the United States.[116,117] Six months after stroke onset, 50% of individuals with stroke continued to demonstrate hemiparesis, 30% were unable to ambulate independently, and 26% had difficulties with activities of daily living (ADL).[116,118] The total stroke care costs, both direct and indirect, were estimated to be around $68.9 billion in the US in 2009.[52,116]

Several factors are associated with stroke recovery. These factors include age,[46-51] severity of stroke,[52] stroke type,[46,47,53] which were stated to be predictive factors for walking recovery within the 30 days of stroke onset.[46] Cognitive impairment,[47,54,55] and incontinence [50,58] have been negatively associated with functional recovery at discharge from inpatient rehabilitation settings.[47] Severity of stroke symptoms, such as moderate to severe hemiparesis, is a predictor for re-hospitalization, disability, and increasing mortality rates 5 years after stroke.[52,59] The type of discharge facility was shown to have impact on functional gain for stroke survivors following acute care admissions.[119] At six months follow-up, patients with stroke had more functional improvement when they received rehabilitation services from inpatient rehabilitation facility (IRF) compared with skilled nursing facility (SNF).[119]

Home health care (HHC) is also frequently prescribed after stroke. Of the nearly 1.5 million patients who received home health care services delivered by home health agencies (HHAs) in 2007, approximately 3.3% had stroke as a primary diagnosis at admission and 7.1% had stroke listed as any diagnosis.[3] HHC services have demonstrated significant reductions in cost when compared with long term hospital care for chronically ill elderly persons.[7] The total cost of inpatient hospital care was three times higher than those treated at home.[7] There was a small to moderate positive impact of HHC on the number of re-hospitalization days, which might be helpful in decreasing cost of health expenditures with a statistically significant relationship between decreased inpatient hospital care days and HHC.[5,8] Decreasing hospital stays is one of the HHC benefits in reducing health care expenditures since inpatient costs represent 70% of the first-year costs of stroke management in the US.[120]

Home-based rehabilitation, which involves physical therapists (PT), occupational therapists (OT), and speech and language pathologists (SP), has an impact on functional recovery and is cost-effective.[42] In a recent systematic review for stroke rehabilitation at home, the importance of home-based rehabilitation after stroke was emphasized.[43] The benefits of rehabilitation at home included cost reductions, enhanced patient satisfaction and functional outcomes,[43,44] improved physical health,[42,43] and increased independence in activities daily living.[38,43],[45] In a clinical trial, Mayo et al.[42] assigned stroke survivors into either a home care or usual care group. Home care consisted of services by an interdisciplinary team (nursing, PT, OT, and SP), while the usual care consisted of several services (e.g. PT outpatient clinics, or rehabilitation services in hospital settings) requested by a physician. The home care group had significant improvements compared to usual care in the physical health component of the Measuring Outcomes Study Short-Form-36 (SF-36), the Older Americans Resource Scale for instrumental activities of daily living (OARS-IADL), and in the Reintegration to Normal Living (RNL) scales.[42] There were similar improvements between the two groups in terms of the Barthel Index (BI) and the Timed Up & GO (TUG) at one and three months after stroke.[42] In addition, the home care intervention program had an impact on delaying mortality rates and functional decline two years after intervention.[9,10]

The literature on the impact of home-based rehabilitation on physical function outcomes and walking performance for patients after stroke is limited. Consequently, the purpose of this study was to: 1) describe the outcomes of home-based rehabilitation on gait speed and functional performance (ADLs) for patients after stroke and 2) determine the predictors of change in functional performance and gait speed after an episode of care. It was hypothesized that advanced age, living alone, number of comorbidities, cognitive impairment, discharge from IRF settings, and urinary incontinence would be negatively associated with improvements in gait and functional performance after home-based rehabilitation. Better functional performance (ADL) and gait speed at the start of care would be also positively associated with functional improvement at the end of care. Knowledge of which factors affect outcome in persons who have had a stroke and are undergoing treatment in the home could affect clinical resource allocation, goal setting, the length of the episode of care, and future payment models.

## 4.2 METHODS

### 4.2.1 Data source and study design

The clinical data were retrospectively collected from 8,436 subjects who participated in the Safe Strides program from GENTIVA Home Health Services, at various sites in the United States in 2010. The Safe Strides program was designed for older adults who are at risk for falling. The program includes a falls prevention approach and intervention customized by trained clinicians to improve balance and functional capacity, and to increase the level of independence of the patient. The inclusion criteria for the Safe Strides program, determined by a trained physical therapist (PT), were a history of falls in the most recent twelve months and/ or one or more modifiable fall risk factor. Modifiable fall risk factors addressed through this program have been reported in previous study.[9] The dataset includes patients' information from the OASIS-C and gait speed performance at the start of care and at discharge. The records were de-identified by an honest broker and were sent to the University of Pittsburgh for collaborative analysis. The University of Pittsburgh's Institutional Review Board (IRB) approved the study.

### 4.2.2 Subjects

The full dataset of 8436 subjects included a heterogeneous population with at least 17 diagnostic categories, and more than 800 diagnoses based on the International Classification of Disease (9th version ICD-9) codes. Therefore, several steps were performed in order to select the subjects who would be included in the study (Figure 7). First, subjects were included in the analysis if they had an ICD-9 code for cerebrovascular accident (430 through 438) recorded among the diagnoses listed during the inpatient stay within the last 14 days (i.e. the OASIS-C M1010 items). This reduced the sample to 447 subjects. Next, the sample was reduced further by selecting those persons who had ICD-9 codes that referred to hemiplegia or hemiparesis (438.20, 438.21, 438.22) in the primary or other diagnoses at admission to home-based rehabilitation (i.e. the OASIS-C M1020 and M1022 items). These steps were utilized to attempt to ensure that subjects were treated by the HHC agency due to stroke. The total number of subjects included was 213 (mean age 76.5 ± 9 years, 51% female). The baseline characteristics of subjects with stroke at the start of care are presented in Table 2. Fifty-eight percent (n= 123) of patients were admitted to home health care services as household ambulators (those who walk slower than 0.4 meter per seconds).[97] At admission to HHC, 43% of patients were discharged from nursing or long-term care facilities, 20% from inpatient rehab facilities, and 37% from short stay acute hospitals.

### 4.2.3 Outcome measures

The main outcome measures used in the study were changes in performance of activities of daily living (ADL) and gait speed. In order to assess changes in performance of ADLs, the Outcome and Assessment Information Set (OASIS-C) was used. OASIS is a comprehensive assessment tool for assessing patient characteristics and measuring patient outcomes in HHC between admission and discharge from the episode of care.[1,11] The OASIS-C has six domains that can be assessed at admission and discharge from HHC services including: sociodemographic, environment, support system, health status, functional status, and behavioral status.[11,28] Performance in ADLs was measured by examining the nine ADL items in the OASIS functional status domain. The lowest score in each ADL item represents independent performance of the activity, whereas the highest score is recorded if an individual is dependent or has difficulties in performing the activity. Because the OASIS-C functional items were not developed for scale scoring,[12] the ADL composite score was used to measure overall functional status. The ADL composite score first converts all items into the same scale from 0 to 1 by dividing the unscaled score by the maximum item score. Then all of the scaled item scores are summed.[33] The ADL composite change score ranges from -9 to 9. The score of 9 indicates optimal performance or functional improvement, 0 indicates no change between admission and discharge, and -9 indicates that the individual's ADL score got much worse after the episode of care.

Gait speed has been used to measure walking performance and overall health.[121] Individuals with stroke were asked to take 1-2 strides before and after the timing zone in order to control for acceleration and deceleration. Gait speed was tested over either 6 or 2.5 meters based on the home environment. The accuracy of outcome measures collection was reviewed by the specialty director and submitted electronically to GENTIVA’s Center for Outcome Measures. Gait speed improvements of 0.16 m/s after stroke have been related to clinically meaningful change, and patients are more likely to gain improvement in disability level.[105] A change in gait speed of 0.10 m/s in older adults is also considering clinically meaningful in survival rates.[104]

### 4.2.4 Predictor variables

In the OASIS-C, the predictor variables of interest included: age, type of inpatient facility from which they were discharged prior to HHC onset, current status of anxiety, current status of confusion, cognitive functioning, urinary incontinence, number of comorbidities, living arrangement, activities of daily living (ADL) baseline scores (e.g. grooming, dressing upper body, dressing lower body, bathing, toilet transferring, toileting hygiene, transferring, ambulation / locomotion, feeding or eating).[11] In addition, baseline gait speed was a predictor variable.

### 4.2.5 Statistical analysis

Dependent t-tests were used to examine the difference between admission and discharge scores on both functional (ADL composite) and gait speed scores. Covariates (age, ADL score and gait speed at start of care) hypothesized to be predictive of ADL composite change score and gait speed change were tested with multiple linear regression. Factors hypothesized to be predictive of change in ADL composite score and gait speed with adjustment for significant covariates were tested using a univariate generalized linear model (GLM) which allows inclusion of categorical predictors and continuous covariates. Univariate predictors with adjustment for covariates were tested independently. Between group post hoc comparisons in mean ADL and gait speed change, based on allocating subjects to the different categories of a predictor variable, were made using a Bonferroni adjusted type I error rate. All factors were retained for inclusion in a multivariate GLM if found to be significantly associated from univariate analysis at $p < 0.10$. A multivariate GLM with stepwise procedure was then used to identify the best subset of predictors for both ADL composite score and gait speed change between the start of care and discharge from HHC. A predictor was entered into the model in order based on strength of association, and retained for the final multivariate GLM if significant at the $p < 0.05$ level. The relative contribution of each factor to change in ADL composite score and gait speed was described using the coefficient of determination ($R^2$) from the multivariate GLM. All data analyses were conducted using SPSS version 20.

## 4.3 RESULTS

### 4.3.1 Descriptive statistics

Two hundred thirteen individuals with stroke received HHC in 2010 and were included in the analysis. The percentage of patients who improved in ADL composite score at discharge were 95% (n = 203) compared with 5% (n= 10) who got worse or who had no change in ADL score. The mean ADL composite score improved from 3.15 ± 1.30 points at the start of HHC to 1.12 ±1.20 points at the end of care ($p < 0.001$). The mean gait speed improved from 0.41 ± 0.26 m/s at admission to 0.56 ± 0.29 m/s at discharge (gait speed change 0.15 ± .23 m/sec), $p < 0.001$.

The baseline ADL score was a significant covariate predictor of ADL score change from start of care to discharge ($R^2= 0.33$, $p < 0.001$). The covariate most significantly associated with change in gait speed was baseline gait speed score ($R^2= 0.076$, $p < 0.001$). Age was included as covariate for change in ADL and gait speed even though not significant ($p = 0.081$, $p = 0.109$) respectively, because age was stressed in literature to be predictive factor for walking and functional recovery after stroke.

### 4.3.2 Univariate predictors of change in ADL and gait speed scores

The associations between the predictor variables and the change in gait speed and ADL composite scores were analyzed, after first adjusting for the covariates. After adjustment for age and ADL scores at the start of care, the following factors were significantly associated (at $p < 0.10$) with ADL change scores: discharge facility ($p = 0.012$), presence of confusion ($p = 0.007$), cognitive function ($p = 0.016$), and memory function ($p = 0.028$). Only living arrangement was significantly associated with improvement in gait speed ($p = 0.026$).

Figures 8-10 show the adjusted mean differences among the levels of predictors on both ADL and gait speed changes scores. Subjects who were confused sometimes or most of the time made significantly less change in ADL compared with subjects who were in new or complex situation (Figure 8). Subjects discharged from short stay acute hospital showed significantly greater change in ADL compared with subjects discharged from SNF/ long term care facilities (LTC) (Figure 9). Subjects living in congregate situation had significantly less change in gait speed (Figure 10) compared with subjects living alone or with other person. There was no significant difference between living alone or with other person, and both did almost the same change in gait speed at the end of care.

The number of co-morbidities ($p = 0.469$, $p = 0.451$) and incontinence problems ($p = 0.231$, $p = 0.576$) were found not to be significant predictors of ADL and gait speed change respectively. Also, living arrangement ($p = 0.559$) was also found not to be associated with ADL change at the end of care.

### 4.3.3 Multivariate model predictive of change in ADL and gait speed

The best multivariate model that predicted change in ADL composite score included age ($p = .025$), baseline ADL composite scores ($p < 0.001$), confusion status ($p = 0.007$), and gait speed at the start of care ($p < 0.001$). This multivariate model predicted 41% of the variance in ADL score changes over the course of intervention. The largest influence on the change in the ADL were ADL at start of care ($R^2 = .382$), followed by walking speed at the start of care ($R^2 = .063$), confusion in new/complex situations ($R^2 = .047$), age ($R^2 = .024$), and absence of confusion ($R^2$

= .024). Age was negatively associated with a change in ADL ($R^2$ = .024), while worse ADL performance and greater gait speed at the start of care were associated with improvements in ADL composite change scores (Table 3). Predictive factors such as discharge facility, cognitive function, and memory deficits were not associated with change in ADL when included in the final model since they were inter-correlated with other predictors in the model.

Regarding the change in gait speed, the final multivariate model included living arrangement (alone, with someone, in congregate situation), age, walking speed at the start of care, and ADL scores at the start of care. This model predicted 14% of the variance in gait speed score changes over the course of intervention. The largest influence on gait speed change was walking speed at the start of care ($R^2$ = .097), which explained 10% of variance in gait speed change. Slower ambulators at the start of care had larger changes in gait speed at discharge from HHC. Living with someone ($R^2$ = .027), better ADL scores at start of care ($R^2$ = .022), and living alone were associated with improvements in gait speed ($R^2$ = .019).

## 4.4 DISCUSSION

The overall effects of home-based rehabilitation delivered by home health clinicians had significant positive effects on both ADL function and gait performance. Our results demonstrated that the average ADL composite score improved by 2 points with 95% of individuals with stroke improving their ADL composite score, and there was significant improvement in gait speed with an average change of 0.15 m/s at discharge. ADL scores and gait speed at the start of care had the largest influence on functional and gait improvement, respectively, and were positively associated with change in ADL and negatively associated with change in gait speed at discharge from HHC. Although the predictive factors such as discharge facility, cognitive function, and memory deficits were independently associated with change in ADL, they were not associated when including multiple variables (full model). Living arrangement was a predictive factor for change in gait speed, in that living alone or with other person were positively associated with change in gait speed. Other hypothesized predictors such as gender, number of comorbidities, urinary incontinence did not show significant association with change in ADL and gait speed after the end of care.

There were improvements in gait speed at the end of care with the average gait speed change 0.15 m/s, which exceeds the minimally clinically important difference (MCID).[103] Perera et al.[103] determined the MCID (0.10 m/s) from a heterogeneous sample of older adults with mobility disability, subjects with stroke, and community-dwelling older adults. A change of 0.10 m/s is associated with reduced disability and better survival rates among older adults.[95,104] The MCID for stroke survivors within two months of onset was 0.16 meter per second,[95,105] similar to the mean change of 0.15 m/s in our study. Our study showed that patients who were ambulating at least 0.4 m/s (limited community ambulators) demonstrated significantly greater ADL change than those walking at slower speeds < 0.4 m/s (household ambulators).

Following stroke events, changes in ADL performance were dependent on several predictors. Forty one percent of the variance in the ADL change scores was explained by the following combination of predictors: age, ADL scores at the start of care, speed of walking at the start of care, and confusion status. The ADL score and speed of walking at the start of care alone contribute to the most of the variance of change in ADL composite scores.

The type of discharge facility had an effect on ADL improvement during an episode of HHC (Figure 3). Patients admitted to HHC from SNF facilities made less improvement in mean

ADL score when compared with patients admitted directly from acute care facilities. This effect of discharge setting, however, was not independent of home living arrangement as it was found to be not significant in the multivariate model predictive of ADL improvement. Chan et al. reported that patients post-stroke discharged from IRFs demonstrated greater functional outcome scores compared with those from other settings (including home with HHC services) at 6-month follow-up.[119] Chan et al proposed that higher functional status for patients managed in IRF settings is explained by service intensity and technological superiority of care.[119]

Our findings suggest that patients discharged from short-stay acute care hospitals make greater improvements in mean ADL performance during an episode of HHC compared with patients admitted to HHC from SNF and did not differ significantly from those admitted from IRF. A potential explanation for these ADL improvement differences by post-acute setting is that patients receiving post-acute care in SNFs make the most improvement toward maximum function in that setting before being admitted to home care services. It is also possible that patients capable of returning home immediately post-acute care have less severe post-stroke sequellae and/or greater support resources to allow home discharge compared to those referred for management to SNFs. One final point for consideration is that the HHC practice setting offers environmental specificity for the OASIS-C ADL assessment and subsequent functional rehabilitation. Patients receiving HHC services immediately post-acute care receive training and are functionally evaluated in a familiar home environment as they resolve post-stroke impairments and make progress toward maximal functional potential. The effect of environmental specificity and timing with functional recovery post-stroke should be investigated across different post-acute rehabilitation settings.

Regarding the predictive factors in gait speed change, 14% of the variance in gait speed change scores was explained by the combination of the speed of walking and ADL at start of care, and living arrangement. Gait speed at the start of care was the highest predictor of change in gait speed at discharge, and faster gait speed was associated with poor improvement in gait speed. Others hypothesized predictor did not show significant univariate association with change in gait speed after the end of care.

Predictive factors for improvement in ADL and gait at the care of stroke survivors in the home care have not previously been described. This study included persons post stroke with acute onset. Persons with chronic stroke were not included. Additional longitudinal studies are needed for more accurately generalize the results to the home health population. Additional psychometric work is also needed in order to validate the use of ADL composite score. The reliability and validity of the functional items in the OASIS-C have already been investigated but not the ADL composite score. Landis et al. (1977) found that the inter-rater reliability was adequate or better with kappa's of 0.60 or higher.[26,29-32] The internal consistency was 0.88 and higher by using Cronbach's coefficient alpha for baseline and discharge ADL scores.[26] The OASIS functional scores (ADLs items) were compared with the Older American Resources and Services (OARS) instrument to measure it's concurrent validity with an overall correlation of r = 0.71.[28] The OASIS functional scores are also highly correlated with the Katz Index of Activities of Daily Living.[26,28] however, the functional items in the OASIS-C was not developed for scale scoring.[12] Also, the ability of the functional items within the OASIS-C to detect functional change over a period of time compared with validated outcome measures has not been examined. Therefore, the ADL composite score was used in our study.[33] The clinically important change in

ADL composite score (obtained from the OASIS –C) remains to be identified and should be the objective of future studies.

There are some limitations to this study. The nature of the study design was retrospective. Patients were admitted to the rehabilitation program with high level of impairments at the start of care in terms of number of comorbidities, discharge facility, and their walking speed. Forty three percent of patients were discharged from nursing or long-term care facilities, 94% had 3 or more comorbidities at the start of care beside their primary condition (stroke), and 58% of patients were walking at slower speed < 0.4 m/s (household ambulators). In addition, it was impossible to detect the severity of stroke, which limited our ability to describe whether severity of stroke affected outcomes. Stroke severity has been shown in the literature as the main predictor of functional improvement.[52] Finally, we have only subjects that completed rehabilitation. Future studies must look at factors associated with successful completion of rehabilitation in home versus those who are unable to complete an episode of care.

## 4.5 CONCLUSION

There were significant improvements in ADL function and gait speed in individuals with stroke after receiving home-based rehabilitation. Gait speed and ADL scores at the start of care had the largest influence on functional and gait improvement. The absence of confusion, and confusion in new/complex situations were also considered as positive predictors of ADL improvement. In addition, living arrangement, either living alone or with other persons, was associated with greater change in gait speed. While, faster walkers, and impaired patients in terms of ADL scores at the start of care were associated with poor outcomes in change of gait speed. Knowledge of which factors affect outcome in persons who have had a stroke and are undergoing treatment in the home could affect intervention planning, clinicians' judgment, and future payment models.

**Table 2. Baseline characteristics of individuals with stroke (total n = 213)**

| Characteristics | Subjects (n) | Proportion % |
|---|---|---|
| Gender | 108 Female | 51% |
| Age group | | |
| Under Age 65 | 14 | 6.6 |
| Age 65 - 74 | 64 | 30.0 |
| Age 75 - 84 | 96 | 45.1 |
| Age 85+ | 39 | 18.3 |
| Discharge facility | | |
| Nursing/LTC facilities | 91 | 42.7 |
| Inpatient Rehab Facility | 42 | 19.7 |
| Short stay acute hospital | 78 | 36.6 |
| Anxiety | | |
| None | 113 | 53.1 |
| Less often than daily | 71 | 33.3 |
| Daily/constant | 29 | 13.6 |
| Confusion status | | |
| Never | 97 | 45.5 |
| In new/Complex Situations | 81 | 38.0 |
| Sometimes or most of the times | 35 | 16.4 |
| Cognitive function | | |
| Alert/Oriented | 102 | 47.9 |
| Requires Prompt | 71 | 33.3 |
| Requires Assistance | 40 | 18.8 |
| Living situation | | |
| Lives alone | 45 | 21.1 |
| Live with other person in home | 144 | 67.6 |
| Live in congregate situation | 24 | 11.3 |
| Urinary Incontinence | | |
| No | 119 | 55.9 |
| Yes | 94 | 44.1 |
| Memory deficits | | |
| No | 167 | 78.4 |
| Yes | 46 | 21.6 |

Table 2 (continued).

| | | |
|---|---|---|
| Impaired Decision | | |
| No | 168 | 78.9 |
| Yes | 45 | 21.1 |
| Number of comorbidities | | |
| 1 | 3 | 1.4 |
| 2 | 9 | 4.2 |
| 3 | 26 | 12.2 |
| 4 | 75 | 35.2 |
| 5 | 100 | 46.9 |
| Number of episodes | | |
| Once (60 days) | 133 | 80 |
| 2 or 3 episodes | 34 | 20 |
| Speed group | | |
| Household | 123 | 57.7 |
| Community | 90 | 42.3 |

- LTC: long term care facilities.
- Household: persons who walk < 0.4 m/s at the start of care.
- Community: persons who walk at least 0.4 m/s at the start of care.

**Table 3. Multivariate linear model (stepwise stepping procedure) for the ADL composite score and gait improvement**

| Factors | ADL change | | | Gait speed change | | |
|---|---|---|---|---|---|---|
| | B coefficients | p | Partial R-squared | B coefficients | p | Partial R-squared |
| Age | -.018 | .025 | .024 | -.002 | .236 | .007 |
| Gait speed (baseline) | .095 | < .001 | .063 | -.084 | < .001 | .097 |
| ADL composite (baseline) | .631 | < .001 | .382 | -.025 | .033 | .022 |
| Confusion status* | | | | | | |
| - Absence of confusion | .466 | .025 | .024 | - | ns | - |
| - Confused in new/complex situations | .661 | .002 | .047 | - | ns | - |
| Living arrangement** | | | | | | |
| - Living alone | - | ns | - | .115 | .044 | .019 |
| - Living with other person | - | ns | - | .117 | .018 | .027 |

P <0.05.

* The regression coefficients for the confusion status levels were referenced to the highest group (confusion sometimes or most of the times).

** The regression coefficients for the living arrangement levels were referenced to the highest group (living in congregate situation).

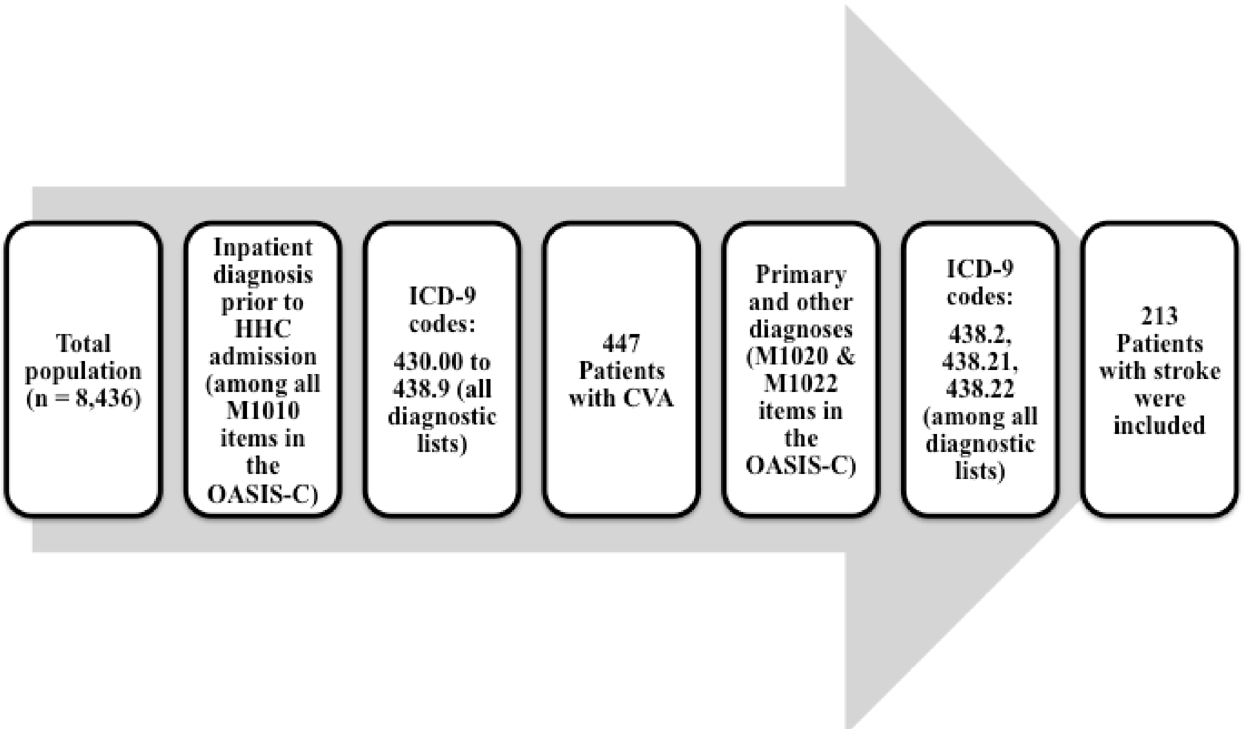


**Figure 7. Selection process of stroke conditions from the general dataset (n = 8,436)**

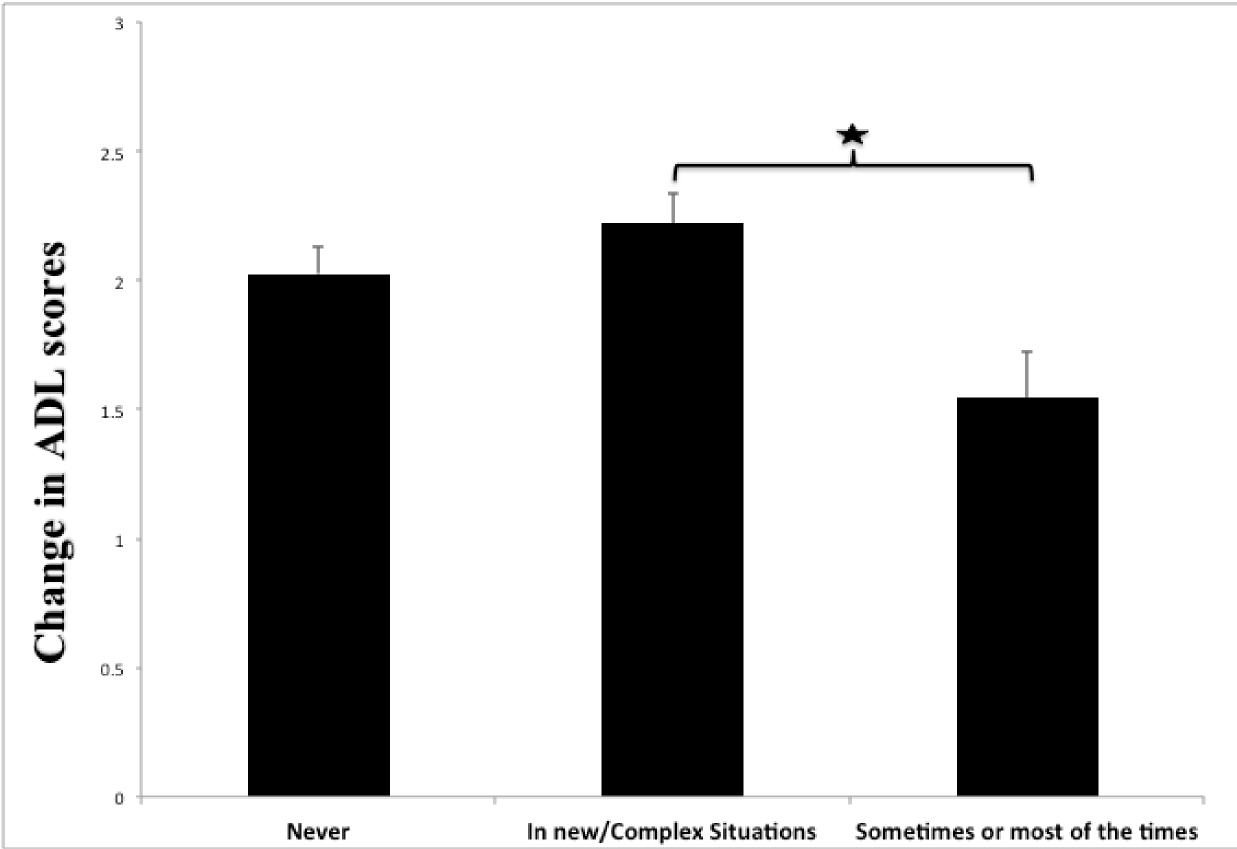


**Figure 8. Effect of confusion status on adjusted change in activities of daily living (ADL) scores (mean ±SE)**

Never: patients did not experience confusion within the last 14 days.
In new/ complex situations: patients were confused in new or complex situations only.
Sometimes or most of the time: patients were confused on awaking or at night only, during the day and evening, or constantly.
Greater change in ADL refers to improvement in ADL composite score at the end of care.
Covariates were adjusted at the following values: Age = 76.58, baseline ADL = 3.1459.
* $P < 0.05$

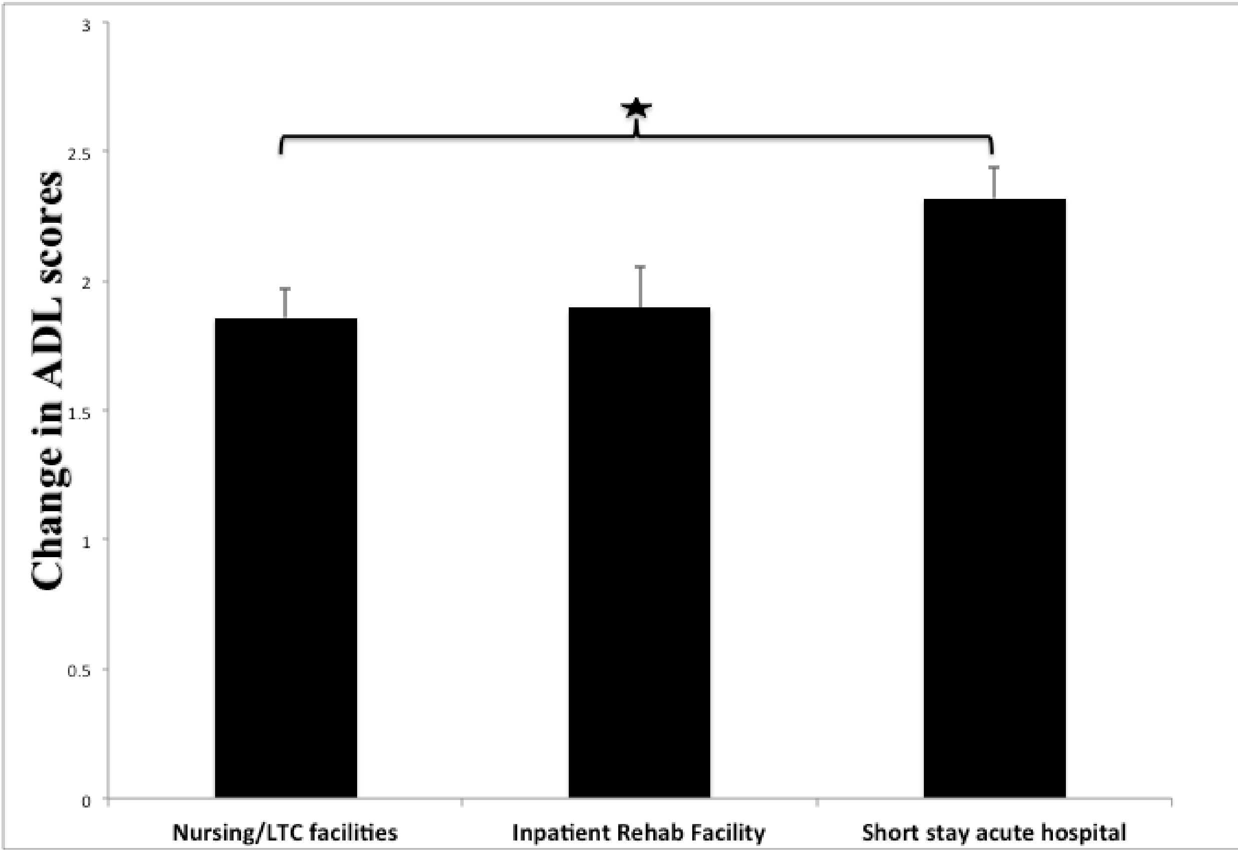


**Figure 9. Effect of discharge facility on adjusted change in activities of daily living (ADL) scores (mean ±SE)**

LTC: Long term care facilities.
Greater change in ADL refers to improvement in ADL composite score at the end of care.
Covariates were adjusted at the following values: Age = 76.53, baseline ADL = 3.1675.
* P <0.05

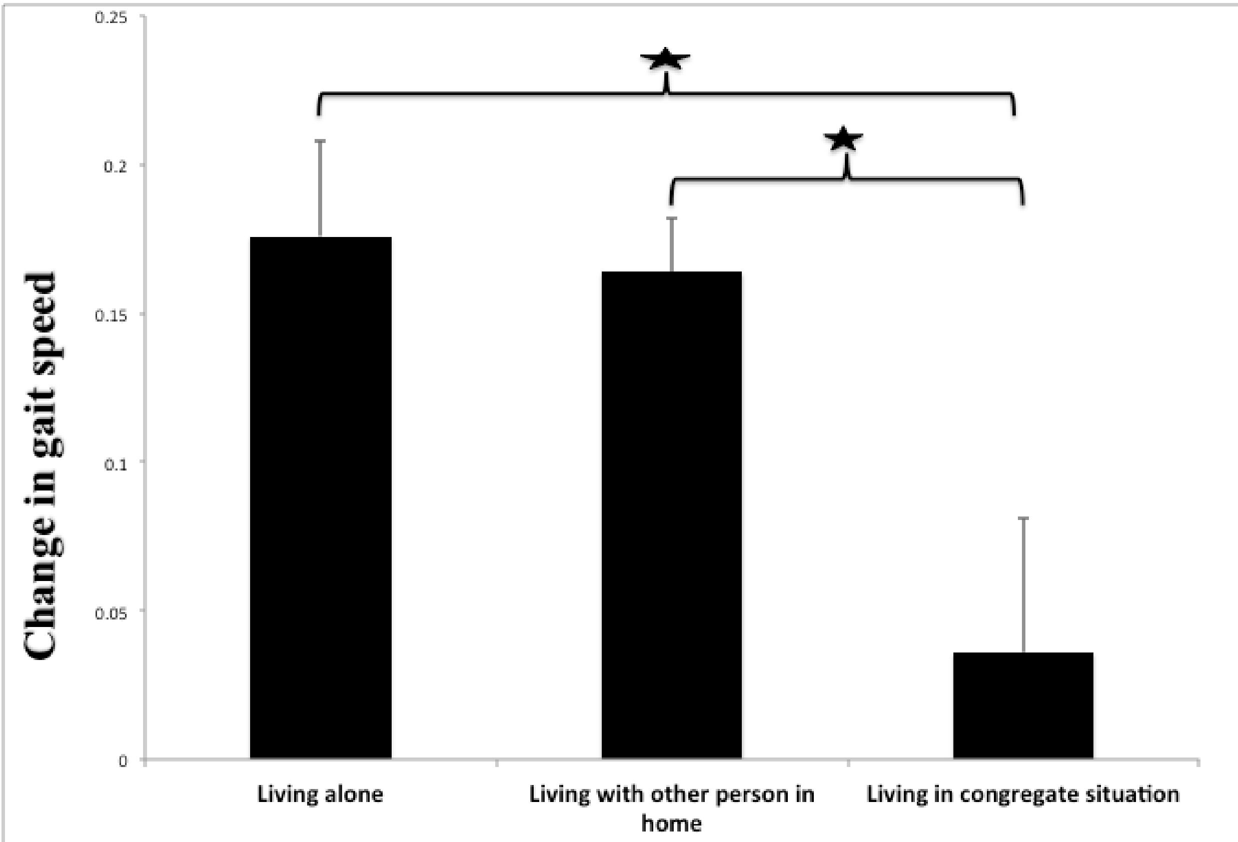


**Figure 10. Effects of living arrangement on adjusted change in gait speed scores (mean ±SE)**

Congregate situation (e.g. assisted living facilities).
Covariates were adjusted at the following values: Age = 76.58, baseline gait speed = .411 m/s.
* P <0.05

# 5.0 IMPROVEMENT IN ACTIVITIES OF DAILY LIVING FUNCTION (ADL IN THE OASIS-C) AND GAIT PERFORMANCE IN OLDER ADULTS WITH HEART FAILURE RECEIVING HOME-BASED REHABILITATION: A RETROSPECTIVE COHORT STUDY

## 5.1 INTRODUCTION

Heart failure affects more than five million older adults with 550,000 persons diagnosed per year[122,123] and 300,000 deaths annually are due to heart failure in the United States (U.S.).[124] Heart failure is the leading cause for re-hospitalization.[125] Six months after discharge, 50% of patients with heart failure were readmitted related to heart failure.[126] Approximately 62,500 patients with heart failure received home health care (HHC) services, representing 4.3% of HHC patients in 2007 in the U.S.[3] The impact of intensive HHC on patients with heart failure decreased the re-hospitalization rate, the re-admissions was decreased to 1.2 re-admissions per year compared with 3.2 re-admissions for those who did not receive HHC.[8,127]

Exercise with individuals with heart failure was shown to be effective after a short period of time of rehabilitation,[60,61] and showed positive impact on physical performance and endurance capacity.[62-64] Exercise has also demonstrated a 17% increase in peak oxygen consumption,[62-64] quality of life,[60-62,64,65] and decreases re-hospitalization and mortality rate.[60-62,64,65] Several studies conducted in the home suggested that home-based exercise showed improvements in quality of life of individuals with heart failure,[62,66] self-efficacy enhancement,[62,67] increased maximum exercise periods,[62,68] significant reductions in hospitalization rate after six months of walking exercise at home,[62,69,70] improvement in the blood flow in the lower extremities,[62,71] fatigue improvement,[67] and enhanced emotional function in individuals with heart failure.[67] Age, diabetics, and chronic obstructive pulmonary diseases associated with heart disease have impact on physical activities and functional recovery, also are associated with high rates of re-hospitalization.[72,73]

In terms of comparing between hospital-based exercises and home-based exercises for individuals with heart failure, several studies found that both the hospital based group and the home based group show similar improvements on the six-minute walk test, quality of life (measured by the short form survey SF-36), psychological symptoms (Beck depression inventory),[74] and functional capacity (obtained by maximal oxygen uptake pVO2).[74,75] Home-based exercises were equally as effective as hospital or center-based exercise programs on physical activity for individuals with heart failure after eight weeks and six months of follow up.[76]

In an analysis of 19 randomized clinical trials that investigated the benefits of home-based exercise for individuals with heart failure compared with standard care or center-based exercise, home-based exercises demonstrated improvements in peak oxygen consumption, exercise duration, and walking capacity.[62]

However, rehabilitation programs provided in the previous studies were either center-based programs followed by home instructions in patient's home, or home-based exercises alone without clinician supervision. The studies of supervised HBR programs for individuals with heart failure are limited. Wall et al. examined the impact of home-based exercise on individuals with heart failure under supervision of a cardiac rehabilitation specialist and the findings were compared with conventional intervention.[60] A home-based exercise program comprised of three home visits per week by cardiac rehabilitation specialists and treadmill utilization for at least fifteen minutes, was compared with conventional therapy that included outpatient, home visits, and education sessions related to nutrition and intake medication. Although there was no significant difference between groups at the end of care, there was a greater improvement for the home-based program group on the Yale Physical Activity Survey (YPAS). The YPAS measures activity dimensions and the improvement was four times greater than the conventional group.[60]

Home-based rehabilitation may be important for the heart failure population because HBR maintained exercise benefits after discharge from outpatient or center-based rehabilitation,[62] and has an impact in enhancing and restoring functional capacity.[62] Factors predictive of functional improvement for patients with heart failure in home care settings include gender,[12] number of physical therapy (PT) visits, urinary incontinence, and living alone.[12] Also, multiple medications (5 or more medications)[111] and history of falls were associated with risk for falling in older adults.[128] Therefore, we expect these factors might have influence on HBR for patients with heart failure.

The study of home-based rehabilitation (HBR) outcomes is limited in this population. Therefore, the purpose of this study was to describe improvements in activities of daily living (ADL) and gait speed and to identify factors that contribute to better outcomes after an episode of care in subjects received home-based rehabilitation due to heart failure. We hypothesized that advanced age, number of comorbidities, cognitive-behavioral impairment, urinary incontinence, better ADL at baseline (composite scores) and less number of PT visits are negatively associated with functional recovery and gait performance after rehabilitation in the home for persons with heart failure.

## 5.2 METHODS

### 5.2.1 Study population

Among 8,437 older adults admitted to GENTIVA home health services in 2010 in the Safe Strides program. 1,055 patients received home-based rehabilitation for heart failure. Persons with heart failure were selected if they were coded as having heart failure disease as the primary diagnosis (M1020 in the OASIS-C) or among the other diagnostics lists (M1022 lists in the OASIS-C), and the codes were based on the International Classification of Disease (9th version ICD-9) codes. The ICD-9 codes for the heart failure disease range from "428.00" to "428.9" (Figure 11). The inclusion criteria to the program were: 1) a history of falls in the most recent twelve months and/or 2) one or more modifiable fall risk factors. The modifiable risk factors have been reported in our previous studies.[9] The total number of patients with heart failure was 1,055 (mean age 82 ± 8 years, 61% female). The baseline characteristics of patients with heart failure at the start of care are presented in Table 4.

### 5.2.2 Predictive factors

The predictors of interest included in the study: age, gender, cognitive-behavioral status (composite scores for the presence of the following conditions: cognitive impairment, confusion, impaired decision making, and memory deficits), anxiety, the total number home care of visits, the number of physical therapy visits, the number of skilled nursing visits, urinary incontinence, multiple medications, living situation, and activities of daily living (ADL) at the start of care.[11] We obtained the PT visits, total visits, and nursing visits from 80% of the patients.

### 5.2.3 Data collection and sources

From multiple home health settings across the United States (179 offices), treatment charts were collected and reviewed from over 8,437 patients. In 2010, patients were admitted to GENTIVA health services, and were provided with a falls prevention rehabilitation program. The inclusion criteria for admission to the program were determined by trained physical therapists PT. Patients' records included information from the Outcome and Assessment Information Set version C (OASIS-C) and gait speed scores at admission and discharge from home health services. An honest broker de-identified the patients' records and sent the dataset to the University of Pittsburgh for analysis. The University of Pittsburgh's Institutional Review Board (IRB) approved the study.

### 5.2.4 Outcome measures

The two main outcome measures used in this study included changes in activities of daily living (ADL) composite scores, which were obtained from the OASIS-C functional items and gait speed. The OASIS-C is a comprehensive assessment tool that is a mandatory assessment measure for all home health agencies in the US, the OASIS-C has also been used for assessing patient characteristics, health and functional status.[1,11] The OASIS-C consists of six domains:

sociodemographic factors, environment situation, support or living system, health status, functional status, and behavioral status.[11,28] The functional items of the OASIS-C contain nine ADLs. Low scores suggest greater independence while the highest scores suggest dependence or difficulties in performing that activity. The nine functional items in the OASIS-C were not developed for scale scoring,[12] therefore, we used the ADL composite score since it was suggested in the literature to be the appropriate choice for research purposes.[26,33] The ADL composite score measures overall functional status at admission and discharge from HHC.[33] The ADL change score (composite score) ranges from "-9" to "9". The positive scores indicate better performance after discharge. The ADL change score was measured continuously, for multivariate linear predictive factors and also was measured categorically (outcomes > minimum detectable change (MDC) vs. outcomes < MDC) in order to identify the predictive factors that exceed the MDC for the ADL score at discharge.

Gait speed is used to quickly determine overall health status.[95,98,99] Gait speed is feasible, can be used in home settings, and is sensitive to detect functional changes in older adults.[129] Gait speed is performed by asking a patient to walk a specific distance and recording the time that was taken to ambulate the predetermined distance. Gait distance tested varies in the literature. Collen, et al recorded gait speed over 10 meters,[100] however, Guralnik and colleagues suggested that 4 meters is the distance of choice because of its feasibility for use in the home and clinical settings.[95,101] Individuals with heart failure were asked to take 1-2 strides before and after the timing zone in order to control for acceleration and deceleration. The distances for recording gait speed in the study range from 2.5 meters to 9 meters. In some situations, gait speed was recorded over 6 meters, yet sometimes it was recorded over 2.5 meters based on home environment. All data collected was reviewed by the specialty director for accuracy and then were submitted to

Gentiva's Center for Outcome Measures.

### 5.2.5 Statistical analysis

Descriptive analysis (means, standard deviations, frequencies, and proportions) was conducted to describe the characteristics of the heart failure sample, which included their demographic, psychological status, living situation, health and functional status at the start of care (Table 4).

Factors predictive of pre- to post changes in ADL scores and gait speed were estimated using multivariate linear models (via general linear model [GLM]). In order to determine the predictors that significantly contributed to improvement in ADL and gait speed, we used multivariate linear regression modeling using the forward selection method to identify the proportion of variance in the dependent variables (change in ADL, gait speed scores) that can be explained by the predictors of interest. Each dependent variable was tested independently into the model with adjustment to covariates (age, baseline gait speed, and baseline ADL scores) that were hypothesized to be predictive of mean ADL and gait speed change scores. Once the factor was significantly associated with the adjusted dependent variables (change scores in ADL and gait speed) at the level of tolerance ($p= 0.10$), we entered the associated factors into the multivariate model. The cognitive-behavioral status was entered into the multivariate model instead of separate factors because all four cognitive-behavioral factors were highly correlated at baseline, which violates the assumption of multicollinearity. The level of statistical significance in the multivariate analysis was set at $p < 0.05$.

The minimal detectable change (MDC) in total ADL score was estimated. Internal consistency (IC) among the nine items of the ADL composite scores at baseline was calculated to estimate the MDC of the ADL composite score. Cronbach's alpha coefficient was used as an indicator to measure the IC of the baseline ADL scores.

$$\textit{Standard error of measurement (SEM)} = \textit{SD of ADL change} \times \sqrt{(1\text{-}IC)}$$

$$MDC = 1.96 \times SEM \times \sqrt{2}$$

Logistic regression was used to identify the variables predictive of the likelihood of patients to exceed the MDC of the ADL score at the end of care. The predictors were included into the final model when they were independently associated with likelihood of exceeding the MDC in the ADL score, with the level of tolerance at ($p= 0.10$). The best fitting model predicting the probability of exceeding the ADL MDC between start of care and discharge was determined using the log likelihood ratio (-2 log Q) statistic. The -2 log Q statistic is the difference between the log-likelihood fit estimates for each successive model as a new independent variable is included and was evaluated against a chi square distribution with 1 degree of freedom. The difference in fit was determined to be significant at $p < 0.05$ compared with a reduced model without the added variable. Odds ratios (OR) and 95% CIs were estimated from predictor variable model coefficients for the continuous covariates and categorical factors associated with likelihood of improvement by a minimum of the MDC in the ADL score. All data analysis was conducted using SPSS version 20 (IBM SPSS Statistics).

## 5.3 RESULTS

Patients with heart failure (n = 1,055) received a mean of 31± 20 total visits and 14 ± 7 physical therapy (PT) visits. Mean age was 82.35 ± 8 years and 61% of the patients were female. The mean change in total ADL composite score from admission to discharge was 1.6 ± 1.2 points. In addition, the mean change for gait speed was 0.17 ± 0.21 meter per second. Age, baseline ADL and gait scores were all significant predictors ($p < .001$) of ADL change at the end of care ($R^2 = .36$). Age ($p < .001$) and baseline gait speed ($p < .001$) were significant covariates predictive of change in gait speed ($R^2 = .05$).

### 5.3.1 Predictors of outcomes (ADL and gait speed change scores)

Several predictors were associated significantly with change in ADL and gait speed after adjustments for age, ADL and gait speed at the start of care (Table 5). The univariate predictors of ADL composite scores, after adjustment for the three covariates (age, baseline gait speed and ADL scores) included: gender ($p = .023$), cognitive-behavioral status ($p < .001$), cognitive function ($p < .001$), confusion status ($p < .001$), impaired decision making ($p < .001$), memory deficits ($p < .001$), and living situation ($p = .001$). After adjustment for age and baseline gait speed, the univariate-associated predictors of change in gait speed were impaired decision making ($p = .10$), memory deficits ($p = .086$), and urinary incontinence ($p = .071$). From 80% of patients, total visits ($p = .016$) and PT visits ($p= .001$) were associated with gait speed change scores, whereas nursing visits ($p = .016$) were negatively associated with change in ADL change scores.

### 5.3.2 Multivariate linear model (the final model)

The final model significantly predicted improvement in mean change ADL and gait speed score independently, with 42% of the variance in ADL and 8.5% of the variance in gait speed were explained by set of predictors. The change in ADL composite score was significantly predicted by age ($p < .001$), baseline ADL score ($p < .001$), baseline gait speed scores ($p < .001$), cognitive-behavioral status ($p < .001$), and living situation ($p = .004$) (over all model contribution $R^2 = .42$). In addition, the change in gait speed scores was significantly predicted by age ($p < .001$), gait speed at the start of care ($p < .001$) (over all model contribution $R^2 = .085$).

Cognitive-behavioral status and living situation factors had effects on mean ADL change at the end of care (Figure 14-15). Person with four conditions made less improvement compared with those who had three or less conditions. Persons with no cognitive-behavioral problems (M = 1.75, CI 1.63 – 1.86) made significantly greater mean ADL change ($p < .001$) compared with involvement of all four conditions of the cognitive-behavioral status (M = 1.05, CI .82 – 1.27) (Figure 14). Also, a person who was living alone (M = 1.69, CI 1.54 – 1.85) made significantly greater improvement in ADL function ($p = .003$) when compared with those who lived in congregate situations such as assisted living facilities (M = 1.34, CI 1.19 – 1.48) (Figure 15).

### 5.3.3 Predictors of the probability of exceeding the MDC in the ADL score

The MDC for the ADL composite score was estimated at 1.34, and was exceeded by 57% of patients (n = 599) at the end of care. The Cronbach's alpha coefficient was .85, suggesting very good internal consistency reliability for the baseline ADL scale. Table 6 showed the best-fitting model predicting the probability of exceeding the ADL MDC between start of care and discharge that was determined by calculating the difference in log-likelihood statistics between the reduced and added model. The best fitting model included age, baseline gait speed, baseline ADL, and cognitive-behavioral status was statistically significant ($p < .001$), indicating that the final model was able to distinguish between patients who exceeded the MDC and those who did not exceed the MDC (Table 7). The predictors, in the final model, explained between 27% and 36 % of the variance in exceeding the MDC of the ADL score. The likelihood of exceeding the ADL MDC decreased with increasing age (OR = .96, 95% CI .94-.98) and improved with increasing baseline ADL score (OR = 3.14, 95% CI 2.89 - 4.03) as well as with faster gait speeds (OR =1.76, 95% CI 1.30 – 2.21). In addition, the likelihood of improvement by a minimum of the ADL MDC decreased with more cognitive-behavioral involvement (3 or 4 conditions, relative to no conditions). The odds of exceeding the MDC for those with three and four conditions were less likely (OR = .42, 95% CI .26 - .68, and OR = .20, 95% CI .12 - .35) respectively, compared with those presenting with no cognitive-behavioral involvement.

## 5.4 DISCUSSION

Persons with heart failure who are at risk for falling showed positive improvement in both gait speed and ADL scores after discharge from the home care program (Figures 12-13). The best multivariate model that predicted the change in ADL score included age, baseline ADL score, baseline gait speed, cognitive-behavioral status (cognitive, confusion, impaired decision, and memory deficits), and living situation. This set of predictors explained 42% of the variance in ADL change score after discharge. In addition, the change in gait speed was predicted by age, baseline gait speed, and interactions of factors of multiple medications by urinary incontinence, which predicted 8.5% of the variance in gait speed change score.

The average gait speed change was 0.17 ± 0.21 m/s, which exceeds the minimally clinically important difference (MCID) in literature. An older adult with mobility disability with .10 m/s change in gait speed was considered a substantial change,[103] and was associated with decreasing disability and mortality rates.[95,104] Our study showed that the mean change in gait speed was a considered as meaningful change in home care settings, because the change score exceeded the suggested MCID.

There was also improvement in mean change in ADL scores. The ADL change scores improved 1.6 ± 1.2 points at discharge. The mean change in ADL was beyond the MDC for the measure, which estimates the smallest amount of change that can be obtained in ADL beyond the measurement error. The MDC for the ADL composite scores was 1.34 points in our study, and was exceeded by 57% of patients at the end of care.

Gait speed and ADL scores at the start of care were the largest influence on ADL change scores at discharge. Gait speed and ADL scores predicted 4.3% and 37% of the variance respectively and were positively associated with ADL change scores. Patients who were admitted to HHC with faster gait speed made greater changes in ADL composite scores at discharge. Also, patients with high ADL composite scores (very impaired) at the start of care improve at discharge. Our findings, in terms of baseline ADL scores, are consistent with previous work.[12] Madigan et al.[12] suggested that baseline ADL scores are the largest influence on ADL improvement, and patients who were more impaired at admission had greater ADL changes at discharge. Baseline ADL scores did not predict change in gait speed scores. Age was negatively associated with both ADL and gait speed change scores. Baseline gait speed was negatively associated with change in gait speed scores with faster walkers at baseline made less change in gait speed at discharge.

A number of cognitive-behavioral involvement and living situation effect ADL improvement at discharge. Patients with heart failure and with involvement of all four cognitive-behavioral conditions (cognitive, confusion, memory deficits, and impaired decision making) had less functional gains in terms of ADL change compared with those who were admitted to the

HHC with no or 1-3 conditions involvement (Figure 14). As the number of cognitive-behavioral conditions decreased, there were greater ADL improvements at the end of care.

Some factors that did not show an association with change in ADL and gait speed, have been associated with change in ADL in previous studies, such as anxiety, number of comorbidities, urinary incontinence, and history of falls. Urinary incontinence, number of comorbidities, and anxiety were suggested to be predictive factors in ADL improvement for patients with heart failure receiving HHC.[12] Their data were derived from various home health agencies type from over 82,000 patients across the United States, which represented a larger population, which might provide better estimation for heart failure population receiving HHC. Our data included those who might gain more functional improvement since they required only physical therapist visits and admitted to safe strides because of fall risk, which was not the case in the Madigan's study that included all patients who required nursing or rehabilitation services.

There are several limitations with this present study. Measurement of gait speed was not standardized. The collection of gait speed was varied based in home environment, which is the nature of home health settings. The distance of gait speed collection ranged from 2.5 meters to 10 meters. Physical therapists used 3 to 6 meters to measure the gait speed from 96 % of patients. The distance of 4 meters was suggested in the literature as optimal for measuring gait speed in home settings.[95,101] Therefore, physical therapists were stressed to collect gait speed between 3 to 6 meters, and to avoid shorter distances that may underestimates gait speed for neurological patients. We analyzed only patients who completed HHC (OASIS-C discharge), so we can't generalize our results to all patients with heart failure admitted to the HHC, since some of them may have discontinued care due to several reasons such as re-hospitalization or mortality. Also, there was insufficient data related to re-hospitalization or mortality rate in order to examine the long-term effect of HHC for heart failure patients.

A previous study stressed the importance of PT visits in improving ADL for heart failure after discharge from HHC, and was considered as the second largest influence on ADL change following baseline ADL scores.[12] Physical therapy visits from 80% of heart failure patients (in our study) were positively associated with change in gait speed, but not with ADL change scores. With greater physical therapy visits, there was greater change in gait speed at the end of care. The physical therapy visits increased the total percentage of the variance in the final model in gait speed change scores from ($R^2$ = 8.5%) to ($R^2$ = 11%).

Further studies are needed for greater clarity in examining the long-term effects of HBR with regard to re-hospitalization and mortality rate, and sustained HBR effects on functional level and gait performance. Additional psychometric work is needed for the ADL composite score. The MDC for the ADL scores was estimated by calculating internal consistency (Cronbach's coefficient alpha) for baseline ADL scores. However, there was no external anchor that could estimate whether the MDC is a clinically important difference. A self-report measure, such as global rating scale, is needed in future studies in order to be used as an external estimation for the ADL MCID.

## 5.5 CONCLUSION

Home-based rehabilitation makes significant improvements in ADL function and gait speed performance for persons with heart failure admitted to HHC. Greater ADL improvements are associated with younger age, faster gait speed at baseline, and greater impairment of baseline

ADL scores.  Involvement of all cognitive-behavioral conditions and living situation factor are barrier to functional ADL improvement. Age, baseline gait speed and ADL are significantly related to making a change beyond measurement error in ADL score.

**Table 4. Baseline characteristics of individuals with heart failure (n = 1,055)**

| Characteristics | Values (Mean or n) | Proportion % |
|---|---|---|
| Age | 82.35 ± 8 years | - |
| Age group | | |
| Under Age 65 | 33 | 3.1 |
| Age 65 - 74 | 140 | 13.3 |
| Age 75 - 84 | 412 | 39.1 |
| Age 85+ | 470 | 44.5 |
| Gender | 647 Female | 61.3% |
| Confusion status | | |
| Never | 505 | 47.9 |
| In new/complex situations | 403 | 38.2 |
| Sometimes or most of the time | 147 | 13.9 |
| Cognitive function | | |
| Alert/Oriented | 567 | 53.7 |
| Requires prompt | 337 | 31.9 |
| Requires assistance | 151 | 14.3 |
| Living situation | | |
| Lives alone | 297 | 28.2 |
| Live with other person in home | 567 | 53.7 |
| Live in congregate situation | 191 | 18.1 |
| Urinary Incontinence | | |
| No | 501 | 47.5 |
| Yes | 554 | 52.5 |
| Memory deficits | | |
| No | 840 | 79.6 |
| Yes | 215 | 20.4 |
| Impaired Decision Making | | |
| No | 883 | 83.7 |
| Yes | 172 | 16.3 |
| Number of comorbidities | | |
| 1 | 3 | .3 |
| 2 | 36 | 3.4 |
| 3 | 155 | 14.7 |
| 4 | 365 | 34.6 |
| 5 or more | 496 | 47 |

- LTC: long term care facilities.

**Table 5. Univariate association of predictors with adjusted mean change in ADL and gait speed**

| Factors | ADL change Sig (p) | Gait speed change Sig (p) |
|---|---|---|
| Gender | .023* | .942 |
| Discharge facility | .387 | .594 |
| Anxiety | .354 | .660 |
| Confusion status | < .001* | .404 |
| Cognitive function | < .001* | .174 |
| Impaired decision | < .001* | .101* |
| Memory deficits | < .001* | .086* |
| Cognitive-behavioral status | < .001* | .553 |
| Living situation | < .001* | .467 |
| Urinary Incontinence | .131 | .071* |
| Number of comorbidities | .364 | .846 |
| Multiple medications | .114 | .049* |
| History of falls | .321 | .705 |
| Total number of visits** | .061* | .016* |
| PT visits** | .414 | < .001* |
| Nursing visits** | .016* | .112 |

Mean ADL change adjustment: covariates were evaluated at the following values: Age = 82.35, Baseline gait speed = 0.41 m/s, Baseline ADL scores = 2.80.
Mean gait speed change adjustment: covariates were evaluated at the following values: Age = 82.35, gait speed at the start of care = .41 m/s.
* Significant at the level of tolerance (p = .10), will be entered into the final model.
** Total number of visits, PT visits, and nursing visits were obtained from 80% of patients with heart failure.

**Table 6. The best fitting model that predicts the probability of exceeding the ADL MDC between start of care and discharge from HHC**

| Model | Log-likelihood statistics | P | Cox & Snell $R^2$ | Nagelkerke $R^2$ |
|---|---|---|---|---|
| Baseline ADL scores | 1195.73 | < 0.001* | .209 | .280 |
| Baseline ADL scores<br>Age | 1170.86 | < 0.001* | .227 | .305 |
| Baseline ADL scores<br>Age<br>Baseline gait speed | 1147.72 | < 0.001* | .244 | .328 |
| Full model<br>Baseline ADL scores<br>Age<br>Baseline gait speed<br>Cognitive-behavioral status | 1110.58 | < 0.001* | .270 | .363 |

Model was evaluated as chi-square with 1 degree of freedom.
ADL: Activities of daily living.
MDC: minimum detectable change.
HHC: home health care.
Significance level at $p < .05$ level for the difference in the model fit.

**Table 7. The final model (Multivariate Logistic regression procedure) for exceeding the minimum detectable change (MDC) of the ADL composite scores**

| Factors | True ADL improvement (<MDC vs. >MDC) | | | |
|---|---|---|---|---|
| | B | p | OR | 95% CI for Odds Ratio |
| Age | -.039 | < .001 | .962 | .944 - .979 |
| Gait speed (baseline) | .17 | < .001 | 1.759 | 1.400 – 2.211 |
| ADL composite (baseline) | 1.228 | < .001 | 3.414 | 2.893 – 4.029 |
| Cognitive-behavioral status* | - | < .001 | - | - |
| 1 condition | -.403 | .062 | .669 | .438 – 1.021 |
| 2 conditions | -.325 | .110 | .723 | .485 – 1.076 |
| 3 conditions | -.844 | < .001 | .418 | .258 - .678 |
| 4 conditions | -1.566 | < .001 | .202 | .115 - .353 |

* Cognitive-behavioral status (no conditions) was set as reference group.

Cognitive-behavioral status was the composite scores for the following factors: cognitive, confusion, impaired decision, and memory deficits.

ADL: activities of daily living.

CI: Confidence interval.

OR: Odds ratio favoring exceeding the MDC for ADL score.

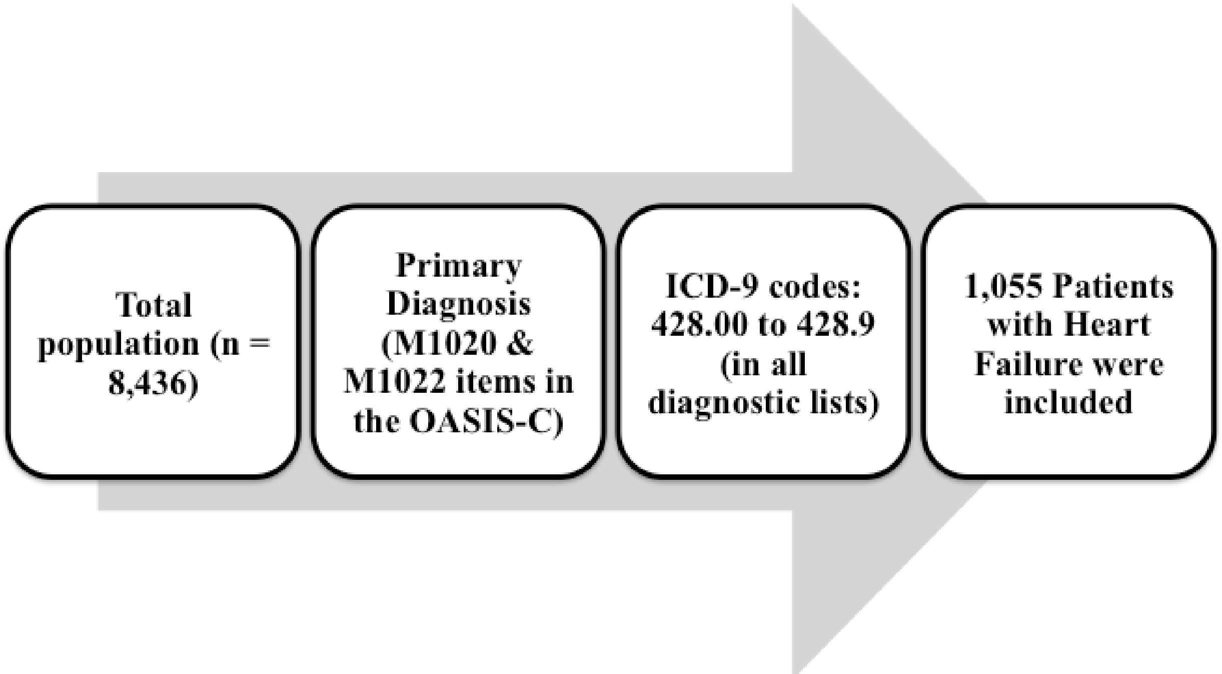


**Figure 11. Selection process for heart failure conditions from the general dataset (n = 8,436)**

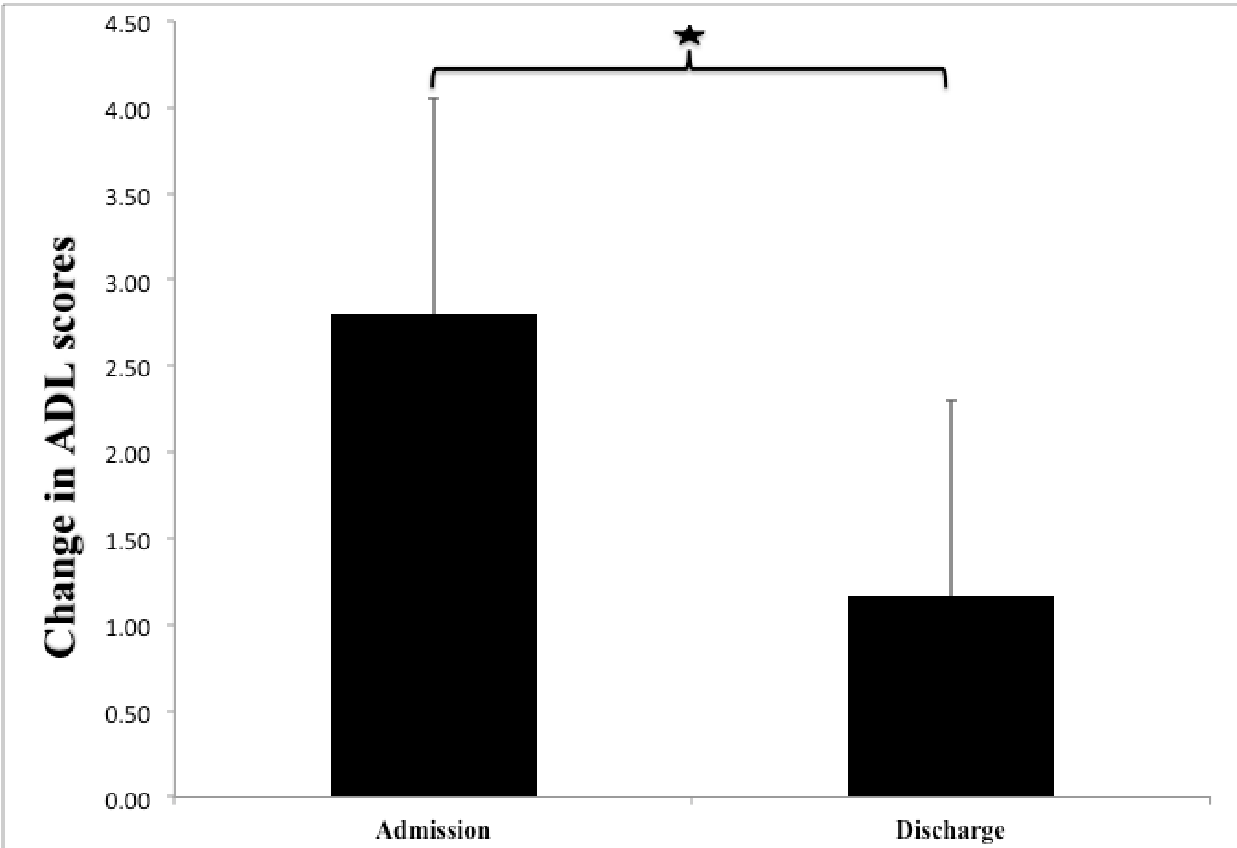


**Figure 12. ADL (composite scores) changes between admission and discharge from home based rehabilitation (mean, ± SD)**

- ADL: activities of daily living.

* Significance level at .05

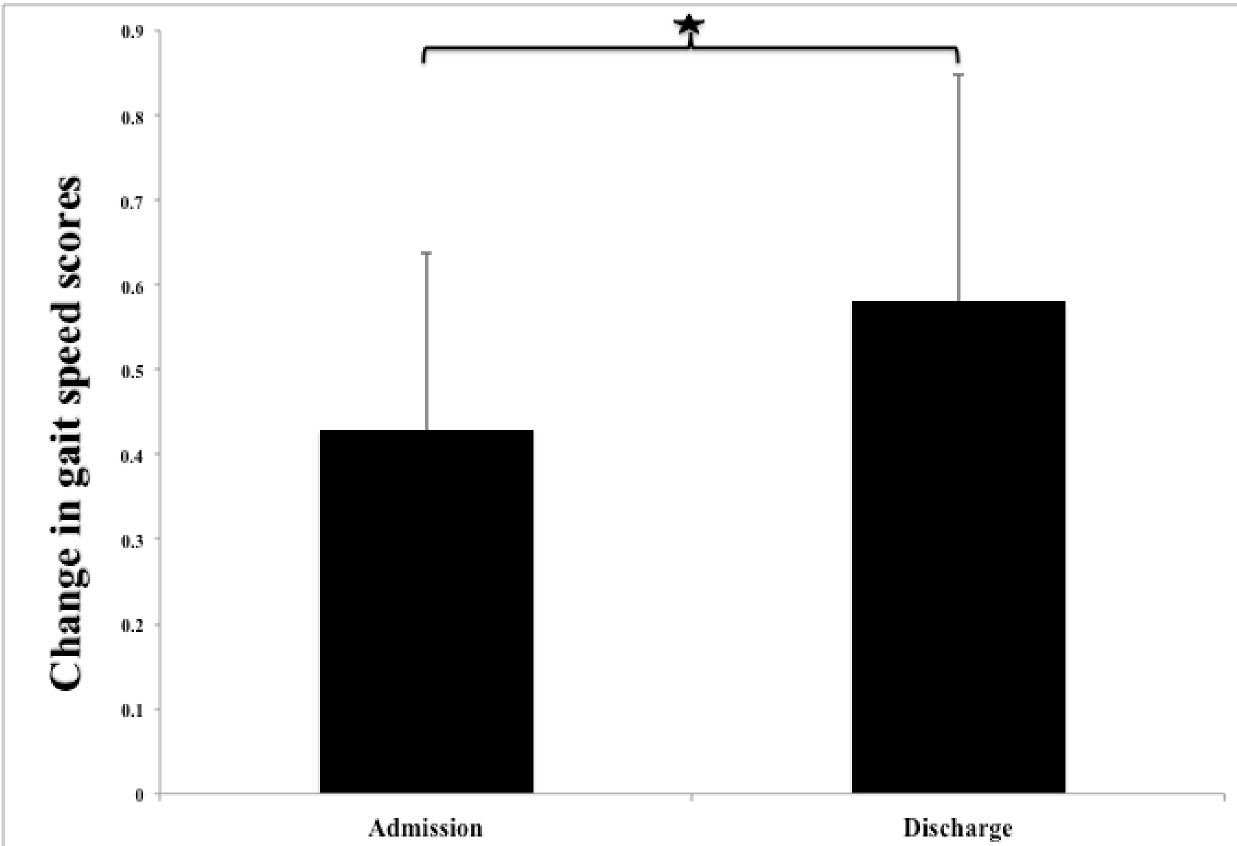


**Figure 13. Gait speed changes between admission and discharge from home based rehabilitation (mean ± SD)**

* Significance level at .05

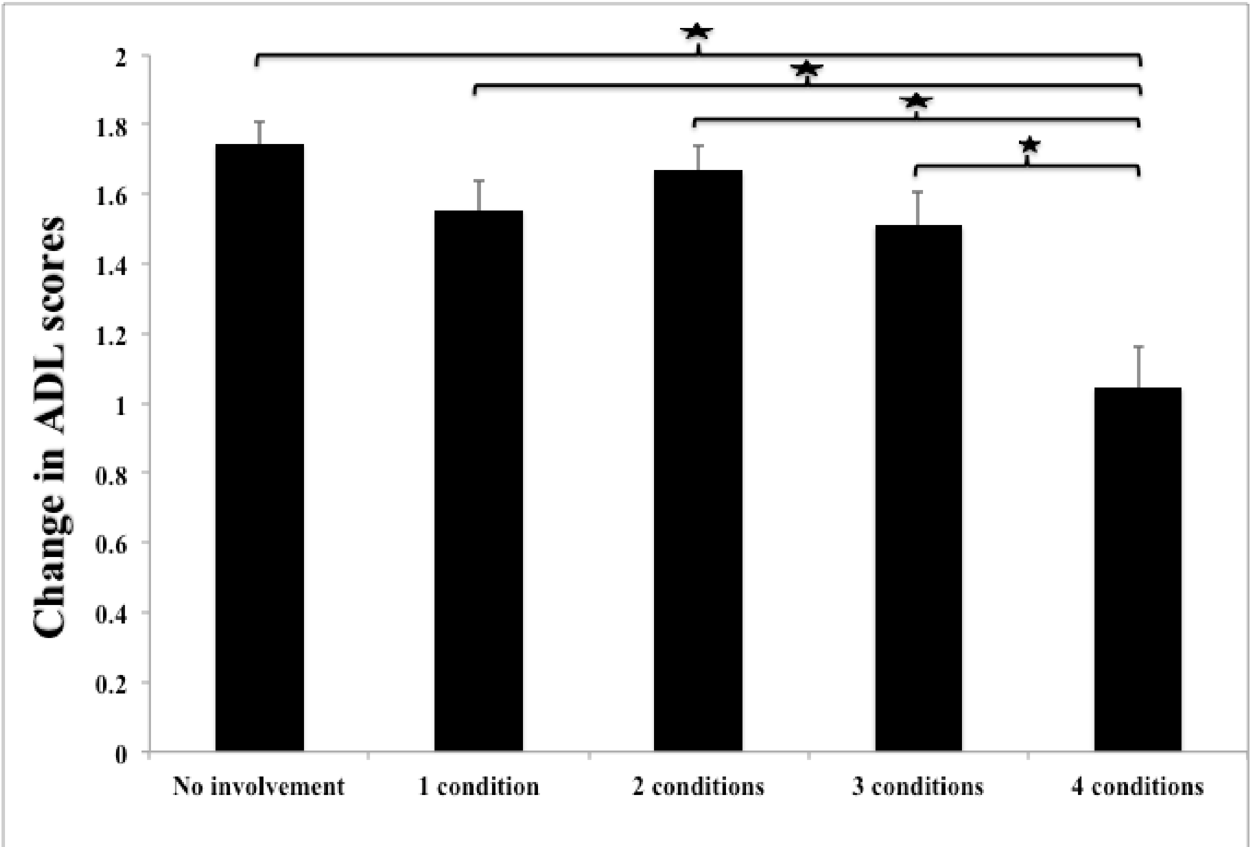


**Figure 14. Home-based rehabilitation effects on adjusted change in activities of daily living (ADL) scores by number of cognitive-behavioral conditions (cognitive, confusion, memory deficits, and impaired decision making) (mean ±SE)**

- ADL: activities of daily living.
- Change in ADL refers to improvement in ADL composite score at the end of care.
- Covariates were evaluated at the following values: Age = 82.35, Baseline gait speed = .411 m/s, Baseline ADL (composite scores) = 2.7996

* Significance level at .05

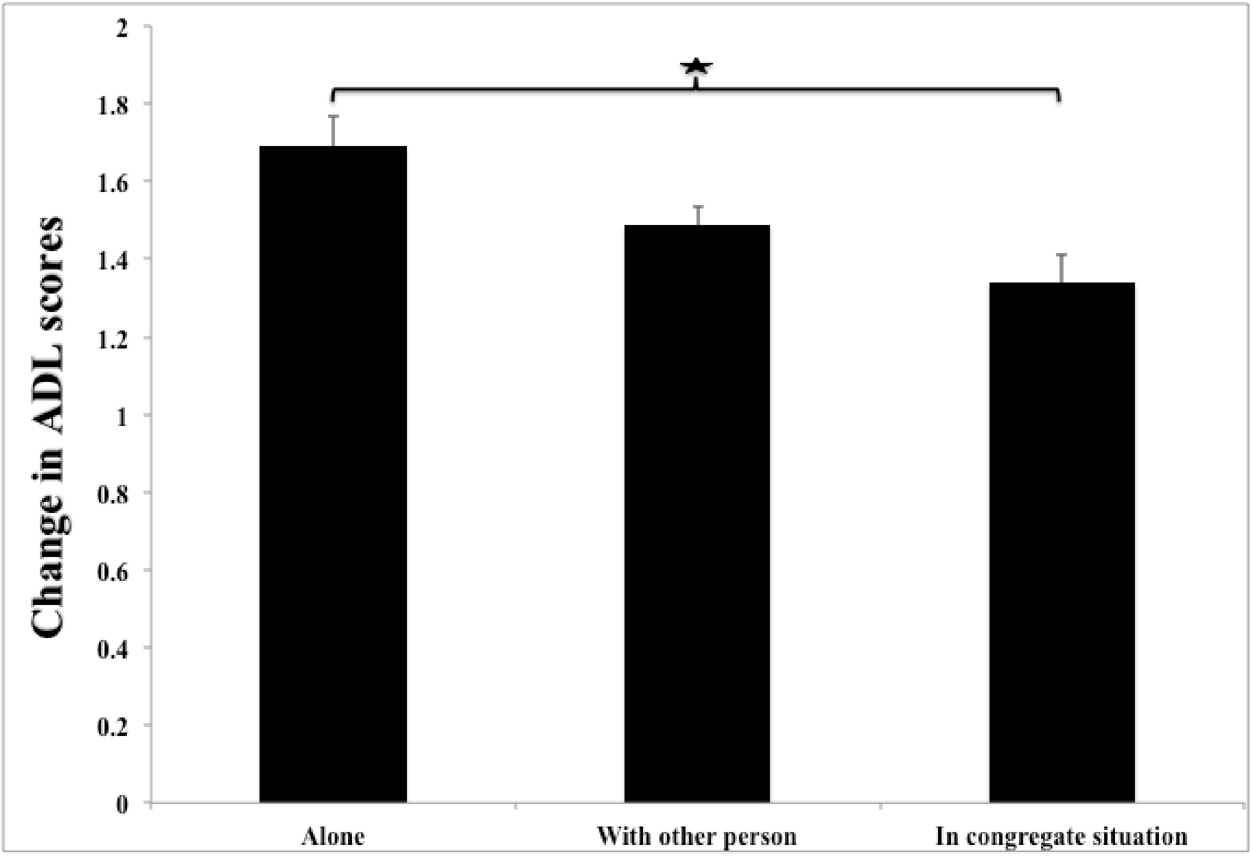


**Figure 15. Home-based rehabilitation effects on adjusted change in ADL scores when people live alone, live with other person, or when they live in a congregate situation (mean ±SE)**

- ADL: activities of daily living.
- Congregate situation (e.g. assisted living facilities).
- Greater change in ADL refers to improvement in ADL composite score at the end of care.
- Covariates were evaluated at the following values: Age = 82.35, Baseline gait speed = .411 m/s, Baseline ADL (composite scores) = 2.7996.

* Significance level at .05

# 6.0 FUNCTIONAL AND GAIT PREDICTORS IN PERSONS WITH PARKINSON'S DISEASE RECEIVING HOME-BASED REHABILITATION

## 6.1 INTRODUCTION

Parkinson's disease is a progressive neurological disorder characterized by rigidity, tremor, gait and balance disorders[77,78] which have an impact on activities of daily living (ADL) and gait performance. Psychological, sensory changes, and cognitive involvement are also reported in Parkinson's disease.[78] The prevalence of Parkinson's disease in older people over 65 years of age is above 2%,[78] and 4% in people over 80 years of age.[79,80] Incidence of Parkinson's disease is positively correlated with increasing age.[77,78] The estimated projected number of people with Parkinson's disease in 2030 will be approximately 8 to 9 million worldwide.[79,81]

The cost of care for individuals' with Parkinson's disease was estimated to be around $25,000/ year and the overall expenditures in the United States was approximately $34 billion in 2004.[77] Individuals with Parkinson's disease had higher rates of health care utilization among elderly beneficiaries, were more likely to use home health care services,[77] and the annual health care expenditures in 2002 was significantly higher than others Medicare beneficiaries (without Parkinson's disease) which was approximately $18,528 and $10,818 respectively.[77] Factors associated with functional outcomes for individuals with Parkinson's disease include age, gait and balance disorders, cognitive impairment, anxiety and depression are associated with decline in health-related quality of life.[82]

Exercise training programs (resistive exercises and balance training) are effective in enhancing quality of life[78,83,84] and motor performance in individual's with Parkinson's disease during the early to mid stages of the disease.[78,83,85] Flexibility exercises and functional training have an impact on improving spinal flexibility and balance in individuals with Parkinson's disease.[79,86] Endurance exercises such as aerobic training also enhance function.[79,87] In a recent meta-analysis,[88] exercise programs designed for individuals with Parkinson's disease improve functional and gait performance, balance, and lower extremity strength.[88,89]

Exercises for persons with Parkinson’s disease living in the home are beneficial, especially in the early stages of Parkinson’s disease when compared with usual care (home education and general instructions).[90] A home-based exercise program is an essential aspect of rehabilitation for individuals with Parkinson's disease due to the progressive nature of disease. Regular exercise prevents deconditioning[78] and aids in maintaining and restoring function and gait performance.[78,79]

Ashburn et al. examined the effectiveness of home-based exercises that were designed for use in the home to maintain movement initiation and compensation strategies.[90] The home-based group consisted of physical therapy (PT) visits plus follow-up phone calls. The usual care group had no exercise program; only nursing recommendations and instructions were provided. There were differences in the number of reported falls at eight weeks and six months post for the in home exercise group. There were also improvements in functional reach scores and quality of life performance after six months in exercise group.[90] Schenkman et al. (2012) compared the benefits of a supervised training group, in an outpatient setting, with a home-based exercise group. The supervised training program consisted of flexibility, balance, and functional exercises for four months (3 times per week) while the home-based exercise group was instructed to perform the exercises described in the exercises developed by the National Parkinson Foundation (e.g. stretching, strengthening, gait and balance exercise). Although the supervised group did better with overall function and ADL scores after 4 months, there were no differences in functional reach scores in the home-based exercise group. The importance of exercise supervision was stressed and exercise's benefits did occur with less improvement when there was no supervision.[79,88] There were, however, no differences between supervised PT and home-based exercises in improving motor function in individuals with Parkinson's disease.[78,92]

The purpose of this retrospective cohort study was to explore the effectiveness of home-based rehabilitation on functional activities of daily living (ADL) and gait performance for persons with Parkinson's disease and to identify the factors that affect ADL and gait outcomes. It was hypothesized that advanced age, baseline gait speed (slower), memory deficits, cognitive impairment, and emotional factors (anxiety and depression) would be negatively associated with improvements in function and gait performance after HHC services.

## 6.2 METHOD

### 6.2.1 Study design

In this retrospective study, patients with Parkinson's disease received care from one home health agency (GENTIVA Health Services) from multiple settings (n = 179 offices) across the United States in 2010. GENTIVA provided a home-based rehabilitation program (Safe Strides) for people with Parkinson's disease who were at risk for falling. Patients were included in the program if they had a history of falls within the last year and/or one modifiable fall risk factors. Modifiable risk factors have been previously reported.[9] The study is part of collaborative analysis with GENTIVA health services and was approved by the University of Pittsburgh's Institutional Review Board (IRB).

### 6.2.2 Selection criteria

From over 8,436 patients' records that were admitted to the rehabilitation program, 503 patients with Parkinson's disease were reviewed in the analysis. Patients were included if they were referred for home-care rehabilitation with the international classification of disease code version 9 (ICD-9) indicating Parkinson's disease. Patients were selected if they had Parkinson's disease based on their ICD-9 codes in any of the primary or other diagnosis codes (among all six diagnostic lists in the M1020 and M1022 items in the OASIS-C).[11] Figure 16 described the selection process for the persons with Parkinson's disease.

### 6.2.3 Outcome measures

The primary outcome measures were the functional items of the Outcome and Assessment Information set version C (OASIS-C).[11] The composite ADL scores of the OASIS-C were used to measure functional performance at the end of care. The ADL scores were measured as the sum of the transformed scores in the nine individual OASIS ADL items (M01800-1870).[12,26] Higher scores on the change in ADL composite represent greater improvement at discharge. Gait speed was used to evaluate mobility status for patients with Parkinson's disease at the start and end of the episode of care. Gait speed has the ability to determine changes in function in older people.[129] Physical therapists were trained in collecting the gait speed measure and were instructed to record gait speed over 6 meters when possible based on the home environment. Patients were asked to take 1-2 strides before and after the timing zone in order to control for acceleration and deceleration. The patient's demographic data at the start of care are detailed in the Table 8. Table 9 describes the predictive factors of ADL and gait speed change scores that included health functional related factors and cognitive behavioral factors.

### 6.2.4 Data Analysis

The effects of home-based rehabilitation were examined between the start and the end of care from HHC services by using dependent t-tests statistics. Multiple regression was used to determine the hypothesized covariates for change in ADL and gait speed and were used to adjust for predictive factors of mean change in ADL and gait speed scores. Age, baseline ADL and gait speed were hypothesized to be covariate variables. Multivariate analyses for predictive factors associated with changes in ADL and gait speed were performed using forward stepping regression analyses. The criterion for entry into the model was significance at .10 level. The significance level for the final multivariate model was set at .05 level. Each factor was tested independently before entering into the final model (multivariate linear model) with adjustment for significant covariates via a general linear model (GLM). The coefficient of determination ($R^2$) was described to interpret the independent contribution of each predictive factor on the change scores in ADL and gait speed. Analyses were performed using SPSS version 20.

## 6.3 RESULTS

Five hundred and three patients with Parkinson's disease were admitted to the Safe Strides program designed for older adults at risk for falling. The mean age was 80 ± 7.6 years and 50% of patients were female (n = 252) (Table 8). Patients showed significant improvement at the end of care on both ADL and gait speed change scores. The mean change in ADL was 1.58 ± 1.25 points and gait speed was 0.15 ± 0.23 m/s (Figure 17-18). Eighty-nine percent (n = 448) of the patients with Parkinson's disease made positive changes in ADL composite scores compared with 11% (n = 55) who got worse or had no change in ADL composite scores at discharge.

Eighty-six percent were admitted to the rehabilitative program with 3 or more comorbidities. Sixty-four percent of patients were admitted to HHC with no history of inpatient stay within the last 14 days, whereas the others patients were discharged from skilled nursing facilities, long-term care, inpatient rehabilitation, or a short stay acute hospitals (Table 8).

### 6.3.1 Covariate predictive factors for ADL and gait speed change scores

The covariates predictive of ADL and gait speed change scores were identified using multiple regression, in order to use adjustment factors during the univariate association of others hypothesized predictive factors. Baseline ADL composite scores ($p = < .001$) and age ($p = .185$) were significantly associated with change in ADL scores ($R^2 = .182$). We included age as a covariate for ADL change scores without regard to the level of significance because it was suggested in the literature as a significant predictor factor for functional and quality of life outcomes in the Parkinson's population.[82] Age ($p = .011$) and baseline gait speed ($p < .001$) were used as covariate variables for change in gait speed ($R^2 = .109$).

### 6.3.2 Univariate and multivariate predictive factors for the ADL and gait speed change scores

After adjustment for age and baseline ADL, cognitive function ($p = .019$) (Figure 19) and memory deficits ($p < .001$) made a significant contribution to change in ADL scores. For the change in gait speed, anxiety status ($p = .025$) was independently associated when the age and baseline gait speed scores were adjusted (Figure 20). The level of significance was set at $p < .10$ for further considerations in the final model using multivariate linear model (GLM). Cognitive function ($p = .434$) and memory deficits ($p = .172$) did not show significant association with gait speed change scores. Anxiety status ($p = .771$) did not contribute to change in ADL composite scores at the end of care.

Regarding the final model for both ADL and gait speed change scores, the best set of predictive factors predicted 23% percent of the variance of the change in ADL scores. The final model included baseline ADL scores ($p < .001$, $R^2 = .215$), memory deficits ($p < .001$, $R^2 = .025$), and baseline gait speed ($p = .003$, $R^2 = .017$). Change in gait speed scores was predicted by the following factors: age ($p = .007$, $R^2 = .015$), baseline gait speed ($p < .001$, $R^2 = .102$), and anxiety status ($p = .029$, $R^2 = .014$) that explained 13% of the variance of gait speed at discharge from the HHC (Table 10).

There was significant difference among the levels of cognitive function (alert/oriented, requires prompt, and requires assistance) ($p = .019$) and memory deficits (absence vs. presence of deficit) ($p < .001$) on ADL change scores after adjustment of age and baseline ADL. The significant difference was also found among the level of anxiety status (none, less often than daily, and daily/constant) ($p = .025$) on gait speed change scores after adjustment for age and baseline gait speed. These factors showed significant differences among their levels at $p < .05$.

Patients who were alerted/oriented to cognitive tasks at the start of care had greater changes in ADL composite scores than patients who required assistance or prompting (Figure 19). The significance difference were shown only between alerted/oriented patients and patients who required assistance ($p = .017$). Also, patients with no memory deficits had greater changes in ADL composite scores than patients with memory deficits ($p < .001$). Cognitive function and memory deficit effects on ADL scores were adjusted for age and baseline ADL scores. In the Figure 20, a greater change in gait speed was seen in patients with "less often than daily" anxiety events, and they were significantly different than patients who reported to be daily anxious or constantly anxious ($p = .048$). There was no significant difference between patients with "less often than daily" and patients who "never" had anxiety events ($p = .088$), however, there was greater gait speed change in patients with "less often than daily" anxiety.

## 6.4 DISCUSSION

Patients with Parkinson's disease receiving HBR had changes in ADL and gait speed at the end of care. Although the Parkinson's disease is a progressive disease, the mean ADL composite score change was 1.58 points and 0.15 m/s in gait speed at discharge. The improvement in ADL composite score was predicted by memory deficits, baseline ADL and gait speed. Improvements in gait speed were predicted by age, baseline gait speed, and anxiety status within the last 14 days. These factors were the best subset of predictors that explained the greatest amount of the variance in ADL and gait speed change scores.

The minimally clinically important difference (MCID) for gait speed is 0.10 m/s in older people.[103] The change in gait speed for patients with Parkinson's disease exceeded that MCID

(.15 m/s), which suggests that patients who exceed the .10 m/s had less mobility impairment and decreased risk of mortality.[95,104]

Baseline ADL score was the largest predictor of ADL change scores. Baseline ADL scores predict 22% of the variations in the ADL change, followed by no memory deficits ($R^2$ = 2.5%) and baseline gait speed ($R^2$ = 1.7%). Baseline ADL and gait speed were positively associated with changes in ADL, which suggested that patients with greater impairment in ADL at the start of care made greater improvement in ADL. Patients with faster gait speeds had greater improvement in ADL also. No memory deficit was associated positively with ADL improvement compared with impaired memory. Baseline ADL and gait speed plus memory function factors were the best subset of predictors that explained 23% of the variance in ADL improvement.

For changes in gait speed, the best predictors were age, baseline gait speed, and anxiety status. These factors explained 13% of the variance in gait speed improvement. The baseline gait speed was the largest contributor to improvement in gait speed with 10% of the variance in gait speed change. Age and anxiety explained 3% of gait speed improvement. Slower walkers and patients with advanced age at the start of care made poor changes in gait speed after rehabilitation in the home. Finally, patients who were admitted to HHC with “less often than daily” of anxiety events were significantly contributed to positive change in gait speed at the end of care.

Cognitive function and memory deficits had significant effects on adjusted change in ADL, while anxiety status had significant effects on adjusted change gait speed scores. Patients admitted to HHC with no cognitive impairments made greater improvement in ADL than patients with cognitive impairments. Patients alert or oriented made significant improvement in their ADL scores compared with patients who required assistance with cognitive tasks. Also, patients with intact memory functioning made more improvement in ADL compared with persons with memory deficits at discharge from HHC. In addition, our findings showed that patients with less events of anxiety within the last 14 days of admission made the largest improvement in gait speed and improved compared with those who had daily or constant events of anxiety.

In terms of patient's severity at the start of care, most patients had multiple comorbidities when they received HBR. Eighty-six percent of patients were admitted to HHC with 3 or more conditions. However, our findings did not show any significant difference in terms of ADL and gait change scores among the number of comorbidities. Patients with no comorbid involvement made the same changes in ADL and gait speed compared with those with multiple comorbidities.

Involvement of supervision in the home-based rehabilitation program is one of the study strengths. The Parkinson's disease population has been reported to have less adherence to the home exercise program due to the association of the disease with cognitive or behavioral factors.[91] A recent study on individuals' with Parkinson's disease suggested that older people with anxiety, depression, and with mental or cognitive abnormalities were shown to have less adherence to home exercises programs.[91]

Published outcomes of HBR on patients with Parkinson's disease delivered by home health clinicians are limited. Future studies are recommended with a stringent study design such as a prospective randomized design. In addition, long-term effects of HBR are warranted for persons with Parkinson's disease due to the nature of the progressive disease.

One of the limitations of our study is that only people who completed or were discharged were included. Those who did not complete the homecare program could have characteristics that might lead to different outcomes. All patients in our study completed the HHC services with 64% of the patients completing the HHC with one episode of care, and 36% completing with 2 or 3 episodes of care. Therefore, future studies should address the difference between those who completed the episode of care and those who did not complete the home care episode.

The recording of gait speed was not standardized across all patients. Gait speed was recorded over 3 meters for 55% of patients and 6 meters for 24% of patients. The reminder of the patients had gait speed recorded between 3 and 6 meters. The physical therapists were instructed to avoid shorter distances when possible. Four meters has been suggested to be used as a practical choice for recording gait speed in home health settings.[95,101]

## 6.5 CONCLUSION

Patients with Parkinson's disease improve after receiving home-based rehabilitation. Gait speed and ADL at the start of care plus memory deficits were the best subset of predictors of ADL improvement. Baseline ADL and gait speed were positively associated with ADL improvement. Furthermore, age, anxiety status and gait speed at the start of care were predictive factors for gait speed improvement at discharge. Age and gait speed at the start of care were associated with poor gait speed outcomes. Considering the predictive factors are important for home health clinicians for better intervention planning and goal setting.

**Table 8. Baseline characteristics of individuals with Parkinson's disease (n = 503)**

| Characteristics | Values (Mean or n) | Proportion % |
|---|---|---|
| Age | 80 ± 7.6 years | - |
| Age group | | |
| Under Age 65 | 17 | 3.4 |
| Age 65 - 74 | 88 | 17.5 |
| Age 75 - 84 | 243 | 48.3 |
| Age 85+ | 155 | 30.8 |
| Gender | 252 Female | 50.1% |
| Anxiety | | |
| None | 271 | 53.9 |
| Less often than daily | 156 | 31 |
| Daily/constant | 76 | 15.1 |
| Confusion status | | |
| Never | 188 | 37.4 |
| In new/Complex Situations | 199 | 39.6 |
| Sometimes or most of the times | 116 | 23.1 |
| Cognitive function | | |
| Alert/Oriented | 219 | 43.5 |
| Requires Prompt | 188 | 37.4 |
| Requires Assistance | 96 | 19.1 |
| Living situation | | |
| Lives alone | 104 | 20.7 |
| Live with other person in home | 297 | 59 |
| Live in congregate situation | 102 | 20.3 |
| Memory deficits | | |
| Yes | 143 | 28.4 |
| No | 360 | 71.6 |

- LTC: long term care facilities.

**Table 9. The definitions of the variables of interests included in the study**

| Factor | Items |
| --- | --- |
| Baseline ADL (composite scores) | There are 9 ADLs in the OASIS-C:<br>1- Grooming (0-3)<br>2- Ability to dress upper body (0-3)<br>3- Ability to dress lower body (0-3)<br>4- Bathing (0-6)<br>5- Toilet transferring (0-4)<br>6- Toileting Hygiene (0-3)<br>7- Transferring (0-5)<br>8- Ambulation/Locomotion (0-6)<br>9- Feeding or Eating (0-5)<br><br>For each item, (0) represents that the patient is independent in that activity, while the highest score suggested that the patient is more dependent/or unable to perform the activity.<br><br>ADL Composite scores range from (-9 to 9):<br>(-9) meaning that the patient did worse in ADL change after discharge. A score of 9 means the patient did better and zero suggests there is no change in ADL score. |
| Cognitive function | 1- Alert/Oriented<br>2- Requires prompt<br>3- Requires assistance |
| Memory deficits | 1- No deficits<br>2- Deficits |
| Anxiety status | 1- None<br>2- Less often than daily<br>3- Daily/Constant |
| Age | Age at the start of HHC |
| Baseline gait speed | Meters per seconds |
| Baseline ADL composite scores | Sum of item scores ranging from 0 to 9:<br>0 independent in ADL<br>9 dependent in ADL |

ADL: Activities of daily living.
HHC: home health care.

**Table 10. Predictive factors associated with the adjusted ADL and gait change scores during the univariate and multivariate model**

| Factors | ADL change | | | | Gait speed change | | | |
|---|---|---|---|---|---|---|---|---|
| | B | p | Partial R-squared | Final model (p) | B | p | Partial R squared | Final model (p) |
| Age | -.011 | .112 | .005 | NS | -.003 | .005 | .016 | .007 |
| Gait speed (baseline) | .053 | .008 | .014 | .003 | -.090 | < .001 | .098 | < .001 |
| ADL composite (baseline) | .392 | < .001 | .18 | < .001 | -.012 | .108 | .005 | NS |
| Memory deficit (No deficits) | .508* | < .001 | .037 | < .001 | .032* | .172 | .004 | NE |
| Cognitive function | - | .019 | .016 | NS | - | .434 | .003 | NE |
| Anxiety status | - | .771 | .001 | NE | - | .025 | .015 | .029 |
| | $R^2$ total for final model = .232 | | | | $R^2$ total for final model = .126 | | | |

All factors were adjusted for age and baseline gait speed on gait speed change scores, and also were adjusted for age and baseline ADL on ADL change scores.

NE: not eligible for final model (multivariate model) because it was not associated at the level of tolerance ($p < .10$).

NS: not significant at the level of .05.

* Coefficient regression value for memory deficit was referenced to the involvement of memory deficits group.

ADL: Activities of Daily Living

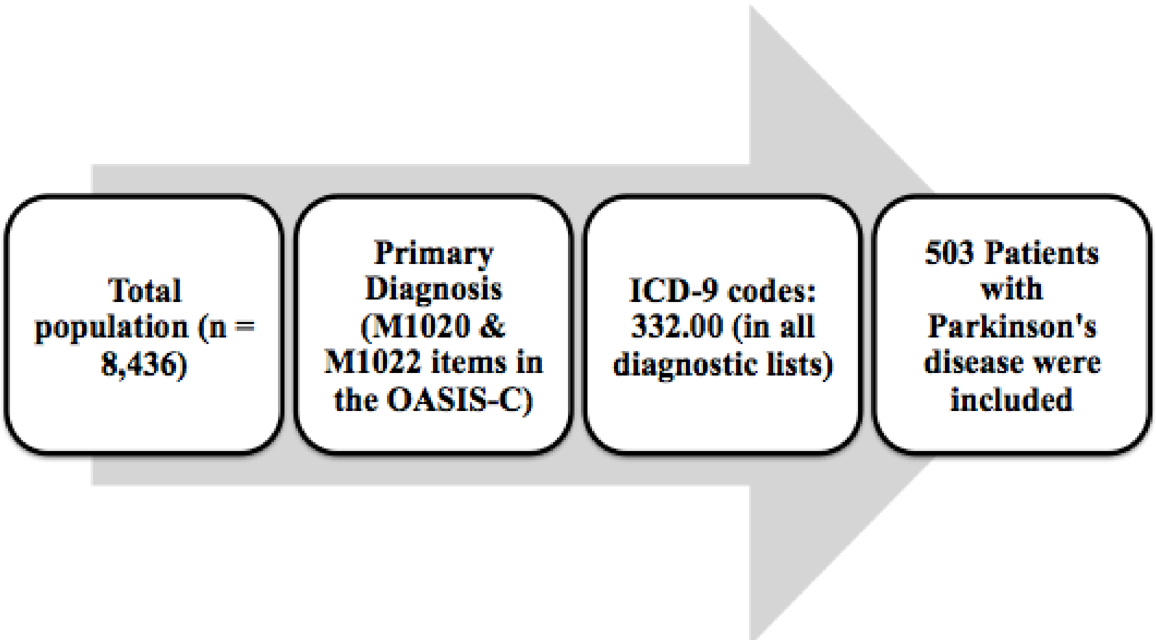


**Figure 16. Selection process for Parkinson’s conditions from the general dataset (n = 8,436)**

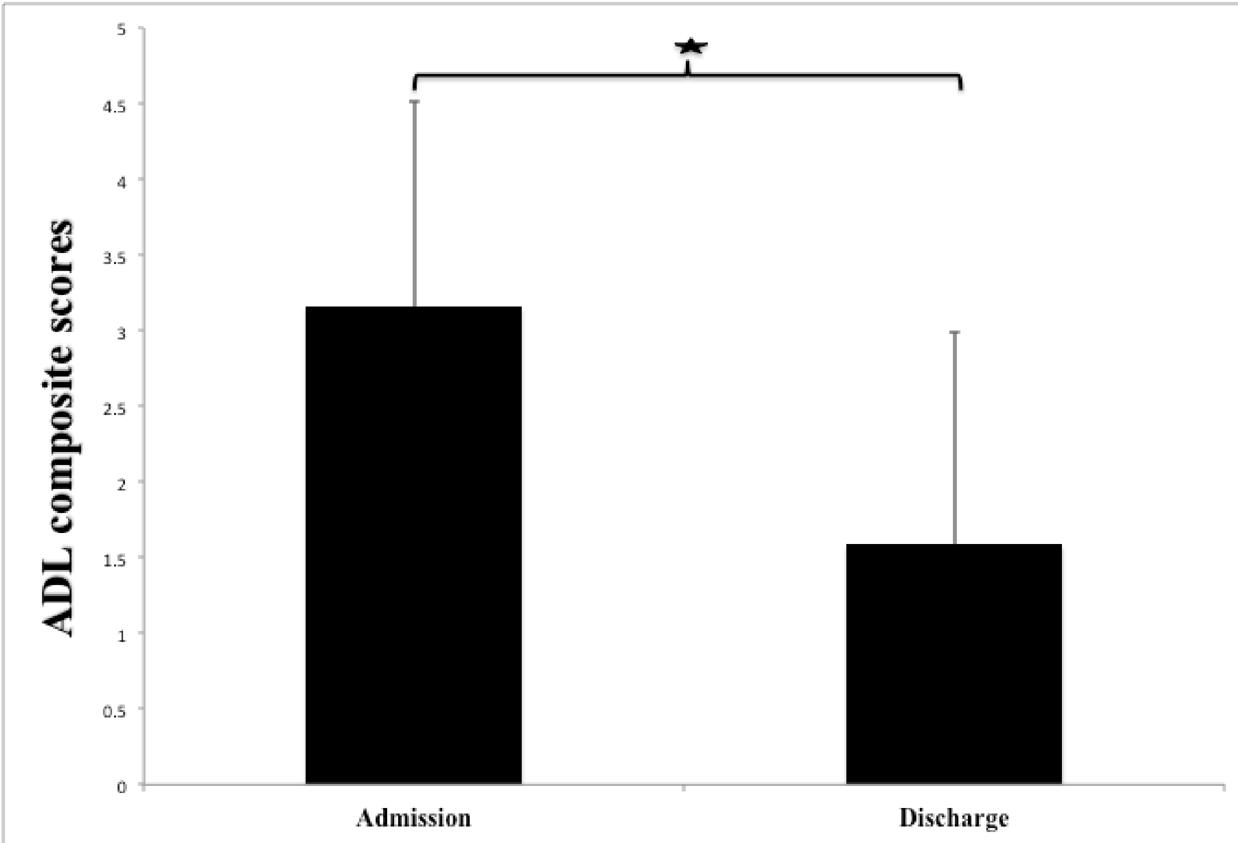


**Figure 17. ADL (composite score) changes between admission and discharge for patients with Parkinson's disease receiving home based rehabilitation (mean, ± SD) (n = 503)**

- ADL: activities of daily living.

* Significance level at .05

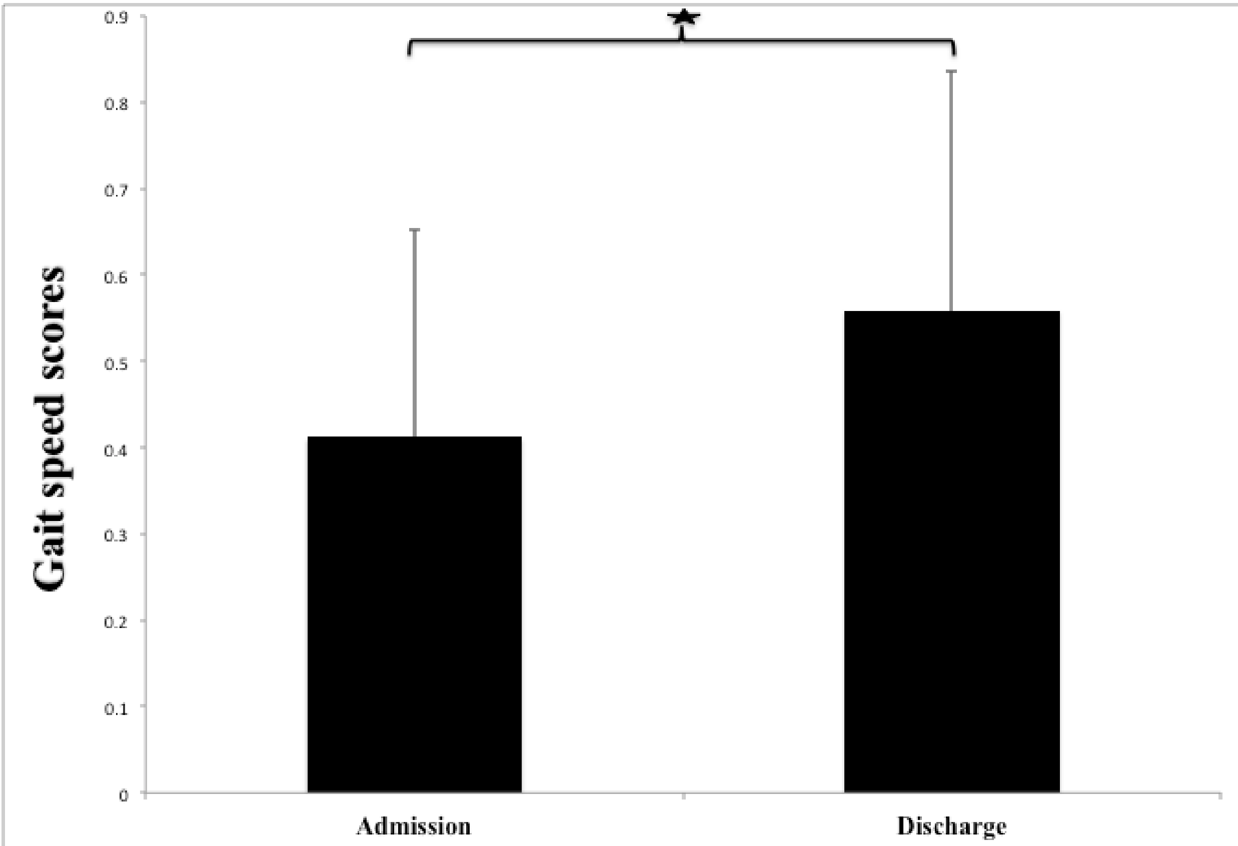


**Figure 18. Gait speed changes between admission and discharge for patients with Parkinson's disease receiving home based rehabilitation (mean, ± SD) (n = 503)**

* Significance level at .05

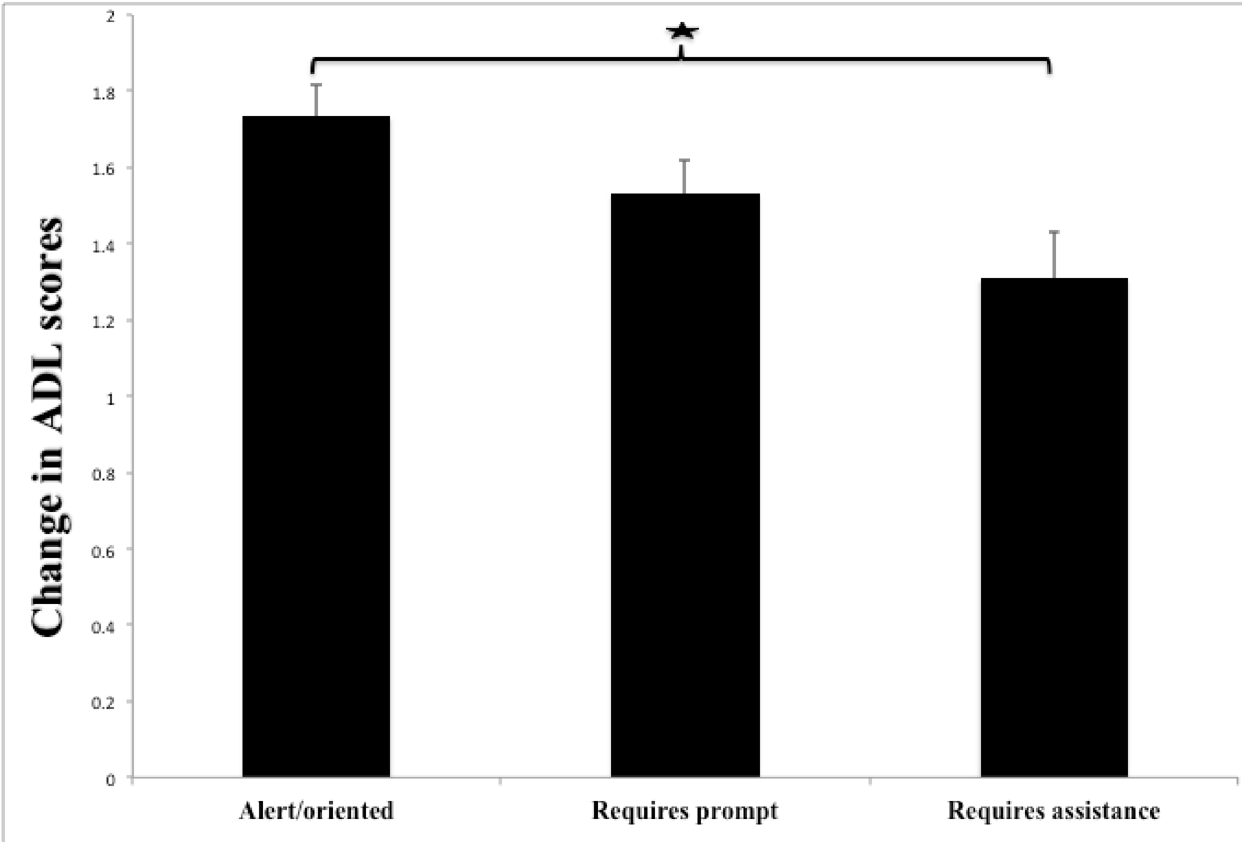


**Figure 19. The effects of home-based rehabilitation on adjusted change in activities of daily living (ADL) scores among the level of cognitive function at the start of care (mean ±SE) for patients with Parkinson's disease**

- ADL: activities of daily living.
- Greater change in ADL refers to improvement in ADL composite score at the end of care.
- Covariates were evaluated at the following values: Age = 80.07, Baseline ADL (composite scores) = 3.1597

* Significance level at .05

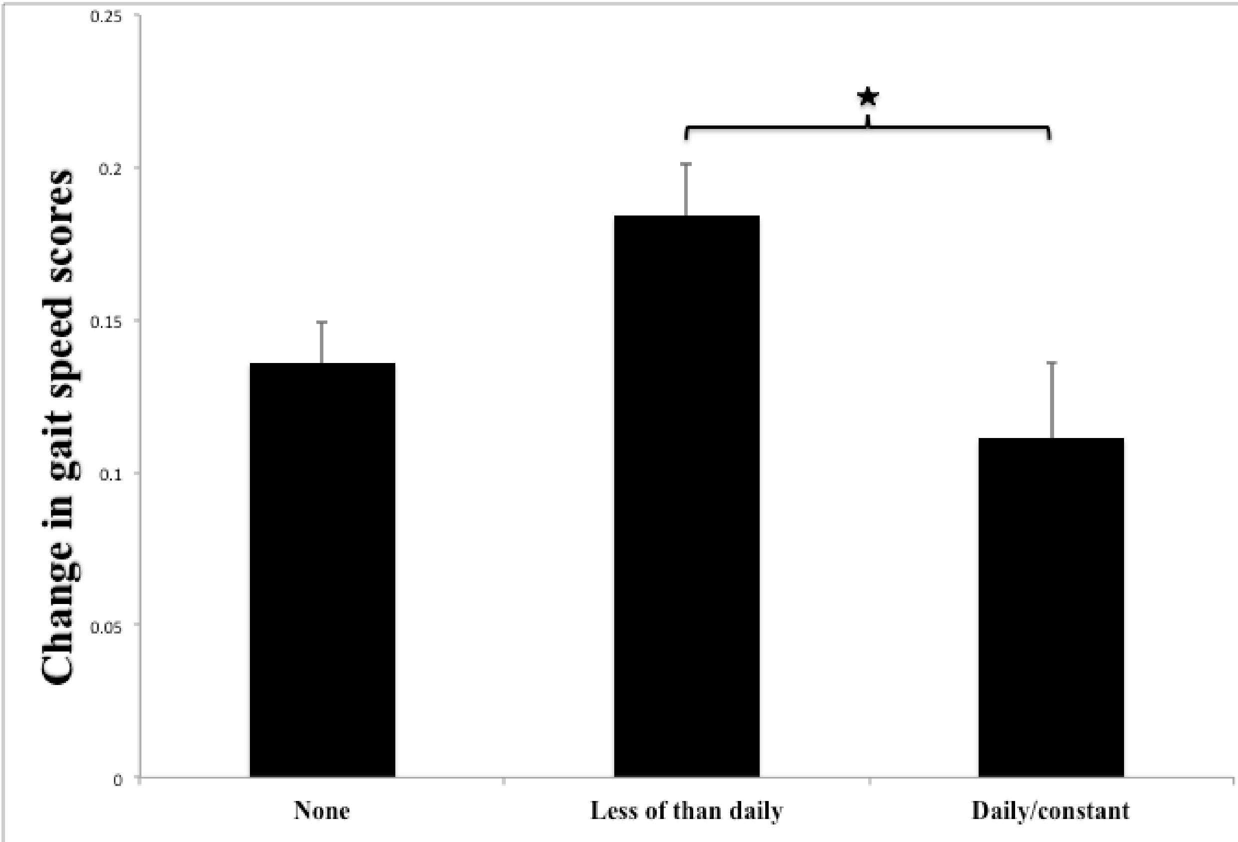


**Figure 20. The effects of home-based rehabilitation on adjusted change in gait speed scores among the anxiety status at the start of care (mean ±SE) for patients with Parkinson's disease**

* Significance level at .05

- Covariates were evaluated at the following values: Age = 80.07, Baseline gait speed = .412 m/s.

# 7.0 GENERAL DISCUSSION AND FUTURE CONSIDERATIONS

The limited number of studies that examined the effect of HBR on functional status and gait speed performance emphasized the need to describe effectiveness of HBR and explore associated factors related to functional and gait improvement, especially for individuals with stroke, heart failure, and individuals with Parkinson's disease. Therefore, the effects of HBR on functional (ADL) and gait performance were examined at the end of HHC services. We found that there were significant change in function and gait at the end of care among all three specific-diagnostic groups. We also identified the optimal combination of potential predictors (e.g. demographic, psychological, clinical, and social variables) at the start of care that predict the probability of functional and gait improvement after a rehabilitation in the home.

There were overall significant improvements in ADL function and gait performance in all 3 groups. Among all three diagnostic groups, the strongest predictors of improvement in ADL and gait change scores were gait speed and ADL composite scores at the start of care. Greater ADL improvement was associated with faster gait speed and higher level of impairment in ADL at the start of care. Also, greater improvement in gait speed was associated with, slower gait speed less impairment of ADL composite scores at the start of care. Type of discharge facility and living arrangement have effects on HBR outcomes for stroke survivors. Cognitive-behavioral status and living arrangement have effects on HBR outcomes for patients with heart failure. Memory deficits and anxiety (constant) were associated with less change in ADL and gait speed respectively in patients with Parkinson's disease. In addition, greater change in ADL was associated with cognitively intact patients with Parkinson's disease. The rehabilitation in the home found to be significantly important due it its effectiveness on function and gait performance as we found in our studies, plus other benefits from previous studies such as cost reductions,[43,44] and delays in functional decline.[9,10] Our studies will be considered as a basis for future physical therapy research in home health settings. Also, considering of which factors affect outcome in patients undergoing HBR could affect goal setting, the length of the episode of care, and future payment models.

## 7.1 LIMITATIONS AND FUTURE CONSIDERATIONS

There are several limitations in our three studies. The nature of the study design was retrospective. Future studies are recommended with a stringent study design such as a prospective randomized design that examine the effectiveness of HBR on the three diagnoses (stroke, heart failure, and Parkinson's disease) and other select diagnoses.

Another limitation was that only people who completed the HHC services (OASIS-C discharge) were included in our analysis. Those who did not complete the HHC program could have characteristics that might lead to different outcomes. Therefore, future studies should address the difference between those who completed the episode of care and those who did not complete the episode of home care. Also, there was insufficient data related to re-hospitalization or mortality rate and condition's severity for analysis. Further studies are needed for greater clarity in examining the long-term effects of HBR with regard to re-hospitalization and mortality rate. In addition, follow-up about the long term effects of HBR on functional level and gait performance for patients with stroke, heart failure, and patients with Parkinson's disease is warranted.

Additional psychometric work is required for the ADL composite score. The minimum detectable change (MDC) for the ADL scores was used in our study. However, the MDC could not estimate whether the MDC is a clinically important difference. A self-report measure, such as a global rating scale, is needed as an external estimation for the ADL MCID. In addition, the recording of gait speed was not standardized across all patients. Four meters has been suggested for use as a practical choice for recording gait speed in home health settings.[95,101]

## 7.2 CONCLUSION

There were overall significant improvements in ADL function and gait performance in the groups of stroke survivors, persons with Parkinson's disease, and heart failure who underwent home-based rehabilitation. Among all three diagnostic groups, gait speed and ADL composite scores at the start of care had the largest influence on functional and gait improvement. Greater ADL improvements were associated with faster gait speed at the start of care and higher level of impairment in baseline ADL composite scores. Greater improvement in gait speed was associated with slower gait speed at the start of care and less impairment of baseline ADL composite scores.

## APPENDIX . Outcome Assessment Information Set (OASIS-C)

## FUNCTIONAL STATUS (ACTIVITIES OF DAILY LIVING ADLS) IN THE OUTCOME ASSESSMENT INFORMATION SET (OASIS-C).[11] (ADAPTED FROM THE CMS)

| **(M1800) Grooming:** |
|---|
| Current ability to tend safely to personal hygiene needs (i.e., washing face and hands, hair care, shaving or make up, teeth or denture care, fingernail care). |
| 0 - Able to groom self unaided, with or without the use of assistive devices or adapted methods.<br>1 - Grooming utensils must be placed within reach before able to complete grooming activities.<br>2 - Someone must assist the patient to groom self.<br>3 - Patient depends entirely upon someone else for grooming needs. |

| **(M1810) Ability to Dress Upper Body:** |
|---|
| Current **Ability to Dress Upper Body** safely (with or without dressing aids) including undergarments, pullovers, front-opening shirts and blouses, managing zippers, buttons, and snaps: |
| 0 - Able to get clothes out of closets and drawers, put them on and remove them from the upper body without assistance.<br>1 - Able to dress upper body without assistance if clothing is laid out or handed to the patient.<br>2 - Someone must help the patient put on upper body clothing.<br>3 - Patient depends entirely upon another person to dress the upper body. |

| (M1820) Ability to Dress Lower Body: |
| --- |
| Current **Ability to Dress Lower Body** safely (with or without dressing aids) including undergarments, slacks, socks or nylons, shoes: |
| 0 - Able to obtain, put on, and remove clothing and shoes without assistance**.**<br>1 - Able to dress lower body without assistance if clothing and shoes are laid out or handed to the patient.<br>2 - Someone must help the patient put on undergarments, slacks, socks or nylons, and shoes.<br>3 - Patient depends entirely upon another person to dress lower body. |

| (M1830) Bathing: |
| --- |
| Current ability to wash entire body safely. **Excludes grooming (washing face, washing hands, and shampooing hair).** |
| 0 - Able to bathe self in shower or tub independently, including getting in and out of tub/shower.<br>1 - With the use of devices, is able to bathe self in shower or tub independently, including getting in and out of the tub/shower.<br>2 - Able to bathe in shower or tub with the intermittent assistance of another person:<br>(a) For intermittent supervision or encouragement or reminders, OR<br>(b) To get in and out of the shower or tub, OR<br>(c) For washing difficult to reach areas.<br>3 - Able to participate in bathing self in shower or tub, but requires presence of another person throughout the bath for assistance or supervision.<br>4 - Unable to use the shower or tub, but able to bathe self independently with or without the use of devices at the sink, in chair, or on commode.<br>5 - Unable to use the shower or tub, but able to participate in bathing self in bed, at the sink, in bedside chair, or on commode, with the assistance or supervision of another person throughout the bath.<br>6 - Unable to participate effectively in bathing and is bathed totally by another person. |

| (M1840) Toilet Transferring: |
|---|
| Current ability to get to and from the toilet or bedside commode safely and transfer on and off toilet/commode. |
| 0 - Able to get to and from the toilet and transfer independently with or without a device.<br>1 - When reminded, assisted, or supervised by another person, able to get to and from the toilet and transfer.<br>2 - Unable to get to and from the toilet but is able to use a bedside commode (with or without assistance).<br>3 - Unable to get to and from the toilet or bedside commode but is able to use a bedpan/urinal independently.<br>4 - Is totally dependent in toileting. |

| (M1845) Toileting Hygiene: |
|---|
| Current ability to maintain perineal hygiene safely, adjust clothes and/or incontinence pads before and after using toilet, commode, bedpan, urinal. If managing ostomy, includes cleaning area around stoma, but not managing equipment. |
| 0 - Able to manage toileting hygiene and clothing management without assistance.<br>1 - Able to manage toileting hygiene and clothing management without assistance if supplies/implements are laid out for the patient.<br>2 - Someone must help the patient to maintain toileting hygiene and/or adjust clothing.<br>3 - Patient depends entirely upon another person to maintain toileting hygiene. |

| (M1850) Transferring: |
|---|
| Current ability to move safely from bed to chair, or ability to turn and position self in bed if patient is bedfast. |
| 0 - Able to independently transfer.<br>1 - Able to transfer with minimal human assistance or with use of an assistive device.<br>2 - Able to bear weight and pivot during the transfer process but unable to transfer self.<br>3 - Unable to transfer self and is unable to bear weight or pivot when transferred by another person.<br>4 - Bedfast, unable to transfer but is able to turn and position self in bed.<br>5 - Bedfast, unable to transfer and is unable to turn and position self. |

| (M1860) Ambulation/Locomotion: |
| --- |
| Current ability to walk safely, once in a standing position, or use a wheelchair, once in a seated position, on a variety of surfaces. |
| 0 - Able to independently walk on even and uneven surfaces and negotiate stairs with or without railings (i.e., needs no human assistance or assistive device).<br>1 - With the use of a one-handed device (e.g. cane, single crutch, hemi-walker), able to independently walk on even and uneven surfaces and negotiate stairs with or without railings.<br>2 - Requires use of a two-handed device (e.g., walker or crutches) to walk alone on a level surface and/or requires human supervision or assistance to negotiate stairs or steps or uneven surfaces.<br>3 - Able to walk only with the supervision or assistance of another person at all times.<br>4 - Chairfast, unable to ambulate but is able to wheel self independently.<br>5 - Chairfast, unable to ambulate and is unable to wheel self.<br>6 - Bedfast, unable to ambulate or be up in a chair. |

| (M1870) Feeding or Eating: |
| --- |
| Current ability to feed self meals and snacks safely. Note: This refers only to the process of eating, chewing, and swallowing, not preparing the food to be eaten |
| 0 - Able to independently feed self.<br>1 - Able to feed self independently but requires:<br>(a) Meal set-up; OR<br>(b) Intermittent assistance or supervision from another person; OR<br>(c) A liquid pureed or ground meat diet.<br>2 - Unable to feed self and must be assisted or supervised throughout the meal/snack.<br>3 - Able to take in nutrients orally and receives supplemental nutrients through a nasogastric tube or gastrostomy.<br>4 - Unable to take in nutrients orally and is fed nutrients through a nasogastric tube or gastrostomy.<br>5 - Unable to take in nutrients orally or by tube feeding. |

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