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Hospital Depressive Symptoms and ADL Disability in Older Adults: A Longitudinal Analysis of Course and Associations

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Hospital Depressive Symptoms and ADL Disability in Older Adults: A Longitudinal Analysis of Course and Associations

by

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Dedication

This dissertation is dedicated to my husband Cliff whose unrelenting support assisted me through uncertain times during the educational process as well as to my friends, family and former students/colleagues who supported early decisions without hesitation and whose advice and laughter carried me through to the end.

Acknowledgements

I would like to begin by thanking Glenn Ostir for his willingness to provide mentorship and support during the last two years. Drs. Ken Ottenbacher, Beatriz Abreu, and Yong-Fang Kuo have provided invaluable time, guidance, and role modeling in all areas of research, presentation and professionalism. I gratefully thank all of the members of my dissertation committee for the time and commitment that it takes to guide a novice scholar through a long and tedious process. Last, I gratefully acknowledge the assistance of the Tuesday morning research group, James Graham, Steve Fisher and Ivonne Berges, who listened patiently and advised wisely throughout the dissertation review.

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Depressive symptoms and disability in activities of daily living (ADL) often increase in older adults during hospitalization and for many persist post-discharge. However, little is known about the psychological and functional response of older adults admitted to an Acute Care for Elders (ACE) unit. Questions remain about the association between depressive symptoms and ADL disability and factors that moderate these associations are unknown. Objectives of this study were to investigate: 1) change in depressive symptoms and ADL function from hospital to 3 month follow-up; 2) the association between depressive symptoms in hospital and ADL function 3 months post-discharge; and 3) moderators of the depression-ADL association.

A tri-ethnic (white, black and Hispanic) sample of 403 older adults within an ACE database contributed subjective and objective information related to depressive symptoms, clinical variables and activity/participation measures across two time frames, admission and three months post discharge. A large minority reported high depressive symptoms in hospital and over half reported ADL disability. Across both assessment

periods, risk factors for having high depressive symptoms were being unmarried and having any level of ADL disability. Conversely, risk factors for ADL disability were pain and depressive symptoms. At 3 months post discharge, the recovery rate from depression and incident ADL disability was high. Positive change in depression was significantly associated with positive change in ADL status. Increasing severity of hospital depression was associated with increased odds of ADL disability at the 3 month follow-up. Neither gender, marital status, pain nor medical history moderated this relationship.

This study indicates that while older adults experience higher depressive symptoms and ADL disability while hospitalized, resolution of symptoms occur for many. This research contributes to the literature by extending our knowledge of the course and associations between depressive symptoms and ADL disability in hospitalized, older adults. Future research which focuses on interventions to minimize depressive symptoms and ADL disability is warranted.

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Chapter 1: Introduction

SPECIFIC AIMS

Depressive symptoms and disability in activities of daily living (ADL) often increase in older adults during hospitalization and for many persist post-discharge. However, little is known about the psychological and functional response of older adults admitted to an Acute Care for Elders (ACE) unit. Questions remain about the association between depressive symptoms and ADL disability and factors that moderate these associations are unknown. **Objectives of this study were to investigate: 1) change in depressive symptoms and ADL function from hospital to 3 month follow-up; 2) the association between depressive symptoms in hospital and ADL function 3 months post-discharge; and 3) moderators of the depression-ADL association in a tri-ethnic sample of older adults.** Specific aims of this study were to:

1. Determine the trajectory of depressive symptoms from hospitalization to 3 months post discharge. Prevalence estimates in hospital and post-discharge, as well as change in depressive symptoms, will be explored by relevant sociodemographic and clinical characteristics such as age, gender, ethnicity, pain and ADL function.
2. Determine the trajectory of ADL function from hospitalization to 3 months post discharge. Prevalence estimates in hospital and post-discharge, as well as change in ADL function, will be explored by relevant sociodemographic and clinical characteristics such as age, gender, ethnicity, pain and depressive symptoms.
3. Examine the direct associations between hospital depressive symptoms and ADL function 3 months post-discharge, controlling for relevant sociodemographic and clinical variables such as age, gender and pain.
4. Examine the interaction between hospital depressive symptoms and select personal and health characteristics on ADL status 3 months post-discharge. Personal and health characteristics will include measures such as gender, marital status and pain.

Data are from a sample of 306 white, black and Hispanic older adults admitted to the Acute Care for Elders (ACE) unit at the University of Texas Medical Branch (UTMB) from 2005-2007 (ACE unit defined: Chapter 2: Section II.C.2.c). Data were collected face-to-face within 24 hours of admission and by telephone interview 3 months post discharge. The UTMB ACE unit specializes in helping older adults recover from acute medical events; it presents unique opportunities for research related to the hospitalization of older adults.

SIGNIFICANCE OF RESEARCH

An ACE unit is uniquely structured to promote positive experiences for hospitalized older adults, yet little research is available that defines the outcomes for patients served. Through a broad and longitudinal examination of depressive symptoms and ADL status, we hope to better understand potential psychological and functional benefits of an ACE unit admission. Second, while research describing an association between depressive symptoms and ADL status is available, the review provided in this work brings organization to existing studies within the framework of the International Classification of Function.[1] (Chapter 2: Section 3). Finally, our exploration of novel longitudinal questions and interaction effects will contribute depth to our understanding of the depression-ADL association for researchers and clinicians working with hospitalized older adults.

OUTLINE OF THE DISSERTATION

Chapter 1 provides a brief overview of the study, including the specific aims, study population, design and the contributions of this study to understanding issues with hospitalized older adults. Chapter 2 provides background literature on depressive symptoms, ADL and the depression- ADL association. Chapter 3 describes the study design, conceptual model, measures and data analyses. Chapter 4 contains the results for each specific aim via text, tables and figures. Finally, Chapter 5 interprets the study results within the context of current literature, as well as describes study strengths and limitations. References and the author vitae conclude this work.

Chapter 2: Background

This chapter provides rationale for our study methodology and context for interpreting the study results. A review of depression and depressive symptoms is provided first by defining constructs, risk factors and course of illness for older adults. Next, an overview of ADL disability is presented, including estimates of disability prevalence, risk factors and course of change in ADL status for older adults admitted for hospitalization. Finally, a summary of the association between depressive symptoms and ADL disability is provided, with background supporting potential moderators of this association.

SECTION 1: DEPRESSIVE SYMPTOMS

Section 1 provides a broad background for depressive symptoms in older adults. Additional review information is provided in Appendices A-C.

A. Construct Definitions

A.1. Major Depression

Major depression is a diagnosis provided by a psychologist or psychiatrist using criteria listed in the Diagnostic and Statistical Manual, now in its 4th edition. (DSM-IV).[2] To meet criteria for major depression, a patient must have 1-2 core symptoms (depressed mood and lack of interest) along with 4 or more of the following symptoms for at least 2 weeks: 1) feelings of worthlessness or inappropriate guilt, 2) diminished ability to concentrate or make decisions, 3) fatigue, 4) psychomotor agitation or retardation, 5) insomnia or hypersomnia, 6) significant decrease or increase in weight or appetite and 7) recurrent thoughts of death or suicide. The prevalence of major depression is estimated to range from 1-4% of the general population.[3] In older adults, major depression has been associated with negative health care outcomes such as poorer recovery from illness, increased utilization of health services and mortality.[3, 4,5,6,7-10]

A.2. Minor Depression

Minor depression, also called *subsyndromal or subthreshold* depression, is also diagnosed using the DSM-IV when one or more of the core symptoms and 1-3 of the

additional symptoms listed above are present. Using DSM-IV criteria, minor depression is estimated to be as high as 9% in the general population.[11]

A.3. Depressive Symptoms

Depression is also quantified by the number and frequency of depressive symptoms reported during examination. Using established cut-off points, the person is categorized as having "high" or "low" depressive symptoms. Both minor depression and high depressive symptoms have been termed "clinically-significant" or "clinically-relevant" depression, as both are associated with increased risk for diminished functional outcomes and major depression episodes.[12-15]

B. Measurement of Depressive Symptoms in Older Adults

A common method for assessing depressive symptoms in epidemiologic studies is through the use of screening tools or depression rating scales. These assessments are performed by licensed practitioners or lay interviewers and are based on examiner report or self-report of depressive symptoms. Appendix A is a table of the most common screening tools with information on purpose, cut-off points for case definition and established sensitivity and specificity. In brief, the Hamilton Rating Scale uses DSM-IV criteria to rate depressive symptoms; cut-off points are provided for clinically significant and severe depression.[16] Sensitivity and specificity have also been studied by neurological categories.[17] The Geriatric Depression Scale (GDS) is widely used in older adult depression research due to its ease of administration and self-report format.[18] The GDS has high sensitivity and specificity when used in hospitalized older adults. The Beck Depression Inventory (BDI) measures the severity of cognitive, affective and somatic symptoms of depression through patient self-report.[19] A broad range of cut-off scores have been published for this measure and specificity and sensitivity information has been established for use with the Psychological Subscale. The Center for Epidemiological Studies-Depression scale, the measure used in our study, is reviewed in greater detail in the next section.

B.1. Center for Epidemiologic Studies-Depression Scale (CESD)

The CESD is a measure of the severity of depressive symptoms in clinical and community epidemiological samples.[20] This 20 item self-report measures four

constructs related to depression: 1) positive affect, 2) negative affect, 3) interpersonal symptoms and 4) somatic symptoms. Numerous published studies have used a cut-off point of ≥ 16 to classify a patient with clinically significant or clinically-relevant depressive symptoms. Minor depression has been operationally defined as a CESD score of 11-15.[3]

Beekman et al. have suggested a higher cut-off score of ≥ 20 in hospitalized older adult populations.[21] One rationalization for using the higher cut-off score is the belief that somatic symptoms measured by the CESD may be confounded by other medical conditions with similar symptoms. For example, the CESD measures difficulty with sleep, a side effect of numerous medical conditions. Other researchers dispute the validity of minimizing the impact of somatic complaints, suggesting that body symptoms are just as reliable in classifying depression as cognitive/interpersonal symptoms.[22] Regardless, both cut-off points demonstrate acceptable sensitivity and specificity for hospitalized older adults. Taken together, a number of tools are used to assess depression in hospitalized older adults. Case definition cut-off points are available for classifying high depressive symptoms; sensitivity and specificity scores are available by population sampled, medical condition or diagnostic cut-off score.

B.2. Clarification of Study Terminology

Patients in this study with a CESD score of ≥ 16 are defined as having high depressive symptoms; low depressive symptoms are quantified by a CESD score of <16. Terms such as clinically-relevant or clinically-significant depression are used interchangeably with high depressive symptoms.

C. Prevalence of High Depressive Symptoms in Older Adults

C.1. Community-Dwelling Older Adults

High depressive symptoms are estimated to range from 8- 16%,[3] but have been as high as > 37% in samples of older adults that live in community settings.[23] Figure 1 illustrates the prevalence of high depressive symptoms (CESD ≥ 16) in community-based samples of older adults by country or region of the United States.[23-27] Older

adults with high depressive symptoms are less likely to participate in research, a thwart to accurate measurement.[28]

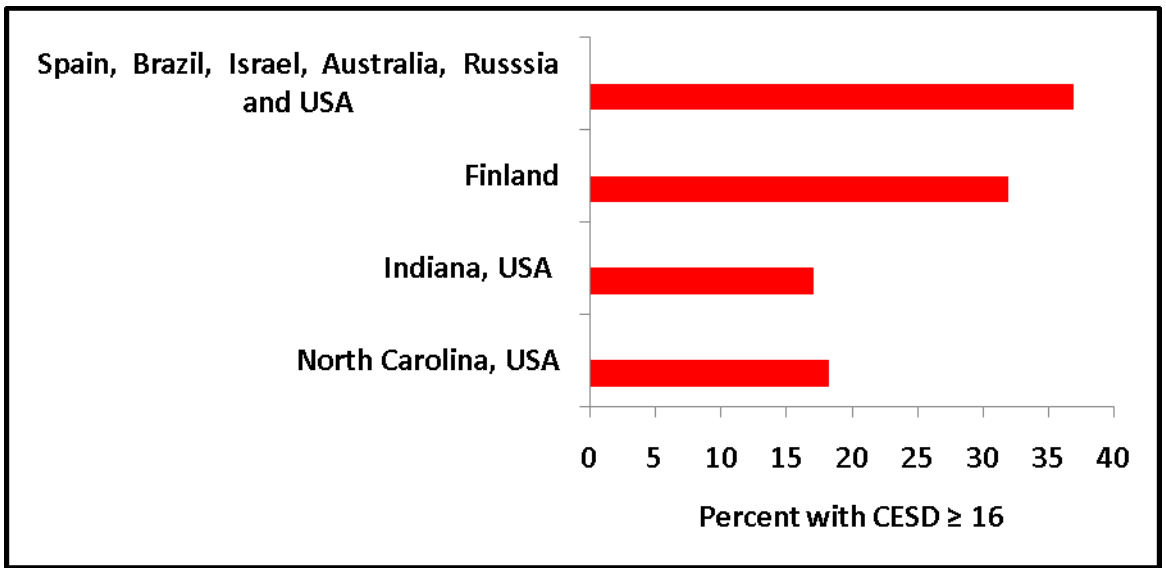


Figure 1. Prevalence of high depressive symptoms in community samples of older adults by country or region. *Source:* Data from Herrman et.al 2002.

C.2. Hospitalized Older Adults

In a review of the literature over the last 15 years, we found 12 studies that assessed the prevalence of high depressive symptoms in hospitalized older adults (Appendix B). Clinically-significant depression ranged from 3-51%.[9, 29-39] Only one study occurred on an ACE unit with a specific population of people with cancer.[29] The wide range in prevalence estimates is likely due to the use of different assessments or different cut-off points used with similar assessments.

D. Factors Associated with Depressive Symptoms

To justify the covariates selected in the statistical models of this study, a brief review of select literature on factors associated with depressive symptoms was conducted. Initially, within this review, studies were separated by community-dwelling and hospitalized samples. However, after review, the correlates of depressive symptoms are remarkably similar, regardless of whether the sample was community or hospital-based; so, while differences cannot be emphasized, when helpful, sample differences will be mentioned.

D.1. Sociodemographic Characteristics

D.1.a. Gender

Gender is associated with depressive symptoms in studies with community and hospital-based samples. Females are 1-3x more likely to be depressed than men.[3, 11, 40-42] Disability, higher in females due to chronic conditions and longer life span, is thought to contribute to this increased risk.[3]

D.1.b. Age

Age has been studied extensively as a risk factor for high depressive symptoms due to the belief that depressive symptoms increase with age. In hospital studies, when patients are analyzed by age, younger patients were more likely to be depressed than older ones, when factors such as gender and disability are controlled for.[3,34, 37, 43-45]

D.1.c. Ethnicity

Study results vary when analyzing the association between ethnicity and depressive symptoms. Blazer et al.[46] found black race to be protective against high depressive symptoms (compared to whites), but other researchers find no significant difference in depressive symptoms between blacks and whites.[3, 25, 34, 40, 44] Huisaini reported that any symptom differences between blacks and whites were due to lower levels of social support, general stress and or more medical issues.[47] In studies comparing community-dwelling Hispanics to whites, Hispanics were more likely than whites to have high depressive symptoms, especially those who were less acculturated.[43, 48-50]

D.1.d. Marital Status

Marital status is associated with depressive symptoms. Specifically, being unmarried increases the risk of high depressive symptoms in community and hospital-based samples.[11, 40, 43, 44, 51-53] Living alone, loneliness and low social support also increase the risk of depression in community-dwelling and hospitalized older adults.[34-36, 42-45, 54] In a study of adults ≥ 75 years in Finland, those who reported being lonely "often or always" were at 9x the risk for being considered depressed compared to those reporting lower levels of loneliness.[26]

D.1.e. Education

Education is also associated with depressive symptoms. In particular, higher education has been associated with decreased risk of depression in community and hospital samples, but this association may vary in its effect by age.[40, 41, 43, 46, 48, 52, 53, 55, 56] In a longitudinal sample of > 33,000 adults in Norway, the protective effect of higher education decreased with increasing age up to 64 years; then, from ages 65-74 years, the protective effect of higher education increased.[57] On the other hand, higher education has been associated with persistent depression three months post-hospitalization in adults.[58]

Considering the sociodemographic characteristics discussed, being female, under 65 years, unmarried, of Hispanic race or having a low educational status are risk factors associated with clinically-significant depression. Therefore, stratification of these variables will be used in our predictor models to delineate risks or protective factors.

D.2. Clinical Characteristics

D.2.a. Medical Conditions

The presence or history of certain diagnostic categories such as digestive, neurologic and cardiac disorders has been associated with increased risk of high depressive symptoms (OR: 1.79, 1.65 and 1.82 respectively).[51] History of stroke, diabetes, arthritis, immune disorders, chronic obstructive pulmonary disease or any chronic illness is also associated with increased risk of depressive symptoms in community-dwelling older adults.[26, 44, 54, 59, 60] Additionally, history of previous myocardial infarction is associated with high depressive symptoms in hospitalized elders.[34]

D.2.b. Pain

The prevalence of chronic pain has been reported to be as high as 80% in hospitalized or institutionalized older adults and as high as 50% in community-dwelling older adults.[61, 62] The presence of pain is associated with high depressive symptoms in hospitalized[60] and non-hospitalized samples.[63] Risk of clinically-significant depression is

also more likely in community-dwelling adults 85 years and older who use analgesics (OR: 2.7; 95% CI: 1.7-4.4)[54]

D.2.c. Body Mass Index (BMI)

Being either overweight or underweight has been studied as both a cause and outcome of depression.[64, 65] In one study of hospitalized older adults in Japan, BMI was not significantly associated with high depressive symptoms,[32] but other studies of both hospitalized and non-hospitalized samples have suggested a u-shaped relationship, in which those who were underweight or overweight were at greater risk for high depressive symptoms than those at normal weight.[65]

Taken as a whole, the presence of specific medical conditions and pain, as well as BMI above or below normal, are potential risk factors for high depressive symptoms and thus will be analyzed in our predictor models.

E. Longitudinal Change in Depressive Symptoms in Older Adults

E.1. Community-Based Older Adults

Recovery of depressive symptoms in community samples is reported by percent of recovery and percent with ongoing depressive symptoms. Recovery occurs for 12-73%, intermittent reoccurrence for 44-84%, while 2-49% have chronic symptoms.[66 26, 67-69] Most improvement occurs within 6 months and people with minor depression generally have more positive outcomes; they were also at greater risk for other psychiatric diagnoses.[68, 69] Overall, most people experience a chronic fluctuation of depressive symptoms rather than a full recovery.[67-69]

E.2. Hospitalized Older Adults

In hospitalized older adults, change is assessed by prevalence differences at admission and follow-up. Studies in post stroke populations show significant increases in depressive symptoms across follow-up periods after in-patient rehabilitation.[70, 71] By contrast, high depressive symptoms decreased significantly over time in patients admitted to non-rehabilitation units. Initial prevalence rates of 28-34% drop to 17% by 2-4 weeks post discharge.[30, 34]

Taken together, results of studies using *prevalence estimates* of depression indicate high percentages of recovery. These studies tend to provide dichotomous results (depressed versus not depressed) captured at one time point during follow-up. In studies assessing change in depression by *percentage of remission*, results indicate a fluctuating or chronic course of depression captured by measuring depression at ≥ 2 time points at follow-up. Appendix C provides a table which outlines studies assessing change in depressive symptoms in hospitalized older adults over the last 15 years.

E.3. Factors Associated with Change in Depressive Symptoms

Factors that contribute to recovery from high depressive symptoms are important to understand. Some physicians argue that hospitalization is the primary predictor of depressive symptoms in hospitalized, older adults and that, for the majority, symptoms resolve after discharge home.[72] According to this hypothesis, other factors, such as sociodemographic characteristics, ADL status or depression intervention, are less relevant for recovery. In this review, no other studies could be found that assessed factors associated with change in high depressive symptoms. However, Koenig et al. identified factors associated with improved time to remission of major and minor depression, finding that less severe depression, less severe medical illness, less intense or no previous use of anti-depressants, black race and higher social support all contributed significantly to shorter remission time.[73]

F. Section 1 Summary

Section 1 provided a broad overview of depressive symptoms in the older adult. Depressive symptoms were defined by clinical and epidemiological constructs. High depressive symptoms are more prevalent in hospitalized older adults than in community-dwelling adults and are less likely to remit; in both cases, depressive symptoms are marked by fluctuation in symptoms rather than full recovery. Risk factors for depressive symptoms include female gender, younger age, Hispanic ethnicity, low education and presence of pain. Factors associated with improvement of depression include lower severity of depression and higher social support.

SECTION 2: ACTIVITIES OF DAILY LIVING (ADL)

Section 2 provides a broad background for activities of daily living in the older adult through a review of 1) measurement of ADL; 2) prevalence and risk factors associated with ADL disability, and 3) change in ADL during and after hospitalization.

A. Construct Definition

Activities of daily living are generally defined as those functional activities considered basic for taking care of one's own body. Eating, bathing, toileting, grooming and dressing represent essential sub-elements within ADL but can also include a wide variety of tasks such as moving in and out of bed and managing medications.[74] Disability in ADL is typically defined as a gap between what a person can do and the demands imposed by the task.[75]

B. Measurement of ADL in Epidemiological Studies

Traditionally, ADL in epidemiological studies are assessed through measures of self-report or proxy interview.[74] Participants are asked questions related to ADL tasks, such as "do you have any difficulty with bathing, eating, toileting, etc.?" Answers to these questions include 1) a dichotomous response of yes or no; 2) categorical responses that expand the previous dichotomous response such as independent, needs assistance, or not able to perform; and 3) type (physical or cognitive) and/or degree of assistance required (minimal, moderate, total). The tool used in our study, the Katz ADL scale, is reviewed in the next section.[76]

B.1.Katz ADL Scale

Katz et al. developed the Katz ADL scale to monitor ADL recovery in patients with chronic disease.[76] Dressing, bathing, feeding, transferring (from bed to chair), using the toilet and continence made up the original scale, which has been broadly used in institutional and community settings.[77, 78] A modified version is more commonly used now; continence was removed and grooming and a short walk were added to more broadly assess basic function.[79, 80] Each ADL item is assessed by the categorical variables: no help needed, help needed or unable to perform, although these variables are commonly collapsed into independent and dependent in analyses.[74]

B.2. Bias in Self-Report Measurement

While self-report of functioning is widely used, such instruments are criticized for potential bias. First, subjective report measures, completed by a patient or family member, are subject to reporting biases.[74] Family members tend to over report functional disability in older adults.[81, 82] Self-report differences by age are non-significant but gender differences exist[83, 84] and are discussed in more detail in Section 2.D.1.B. Second, differences in question construction make comparison between studies difficult. For example, ADL disability is assessed by a yes/no response to "difficulty in task performance" or to "being dependent on a caregiver". These bias issues may be minimized by using ADL tools that measure the amount of assistance needed,[85] although such assessments are not typically used in large scale epidemiological studies.

C. Prevalence of ADL disability

C.1. Community-Dwelling Adults

Prevalence estimates of ADL disability differ based on sample stratification.[86-90] When adults ≥ 65 years are analyzed as a group, a general decline in disability is reported. Figure 2 illustrates the prevalence of chronic disability by number of limitations in U.S. adults aged 65 years and older. For adults with 1-2 ADL limitations, prevalence of disability decreased from 6.8% (1982) to 5.6% (2005). For those with moderate levels of chronic disability (3-4 ADL limitations), disability increased from 2.9% (1982) to 3.8% (2005). Finally, for those with significant ADL disability (5-6 limitations), prevalence dropped from 3.5% to 3.2%.[88]However, when samples are stratified by age as discussed in Section D.2.a, disability prevalence is changed.

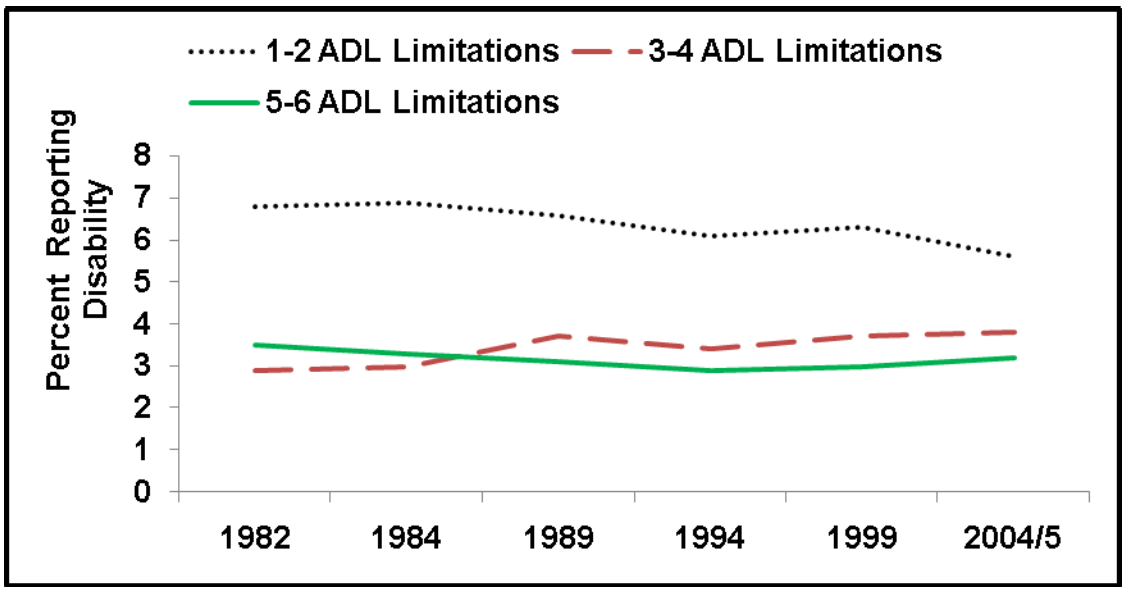


Figure 2. Prevalence of chronic disability by number of ADL limitations, adults aged 65+ (1982-2005). *Source*: Data from Manton 2008, Table 1.

In a separate study, Seeman et al. studied disability trends by age from 1988-2004 using National Health and Nutrition Examination Survey (NHANES).[90] For older adults aged 70-79 years and ≥ 80 years, no significant change in prevalence of ADL disability was found as illustrated in Figure 3. However, in those aged 60-69 years, more people reported ADL disability in 2004 compared to 1988.

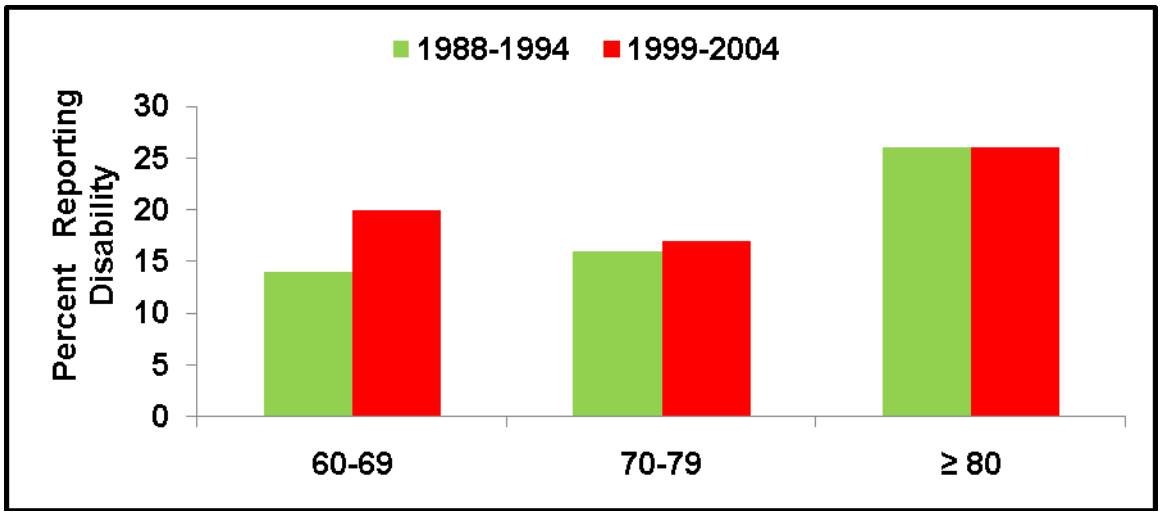


Figure 3. Comparison of percent reporting ADL disability by age group using NHANES data (1988-2004). *Source:* Data from Seeman et al. 2010, Figure 1.

C.2. Hospitalized Older Adult

Previous research has shown that 30-60% of older adults develop new dependencies in activities of daily living or lose mobility skills during an acute hospital stay.[91-93] Figure 4 illustrates incident ADL by category in a group of hospitalized adults ≥ 70 years. Within this sample, 15-24% report new difficulties in ADL and 35% were discharged with worse than baseline function.[91]

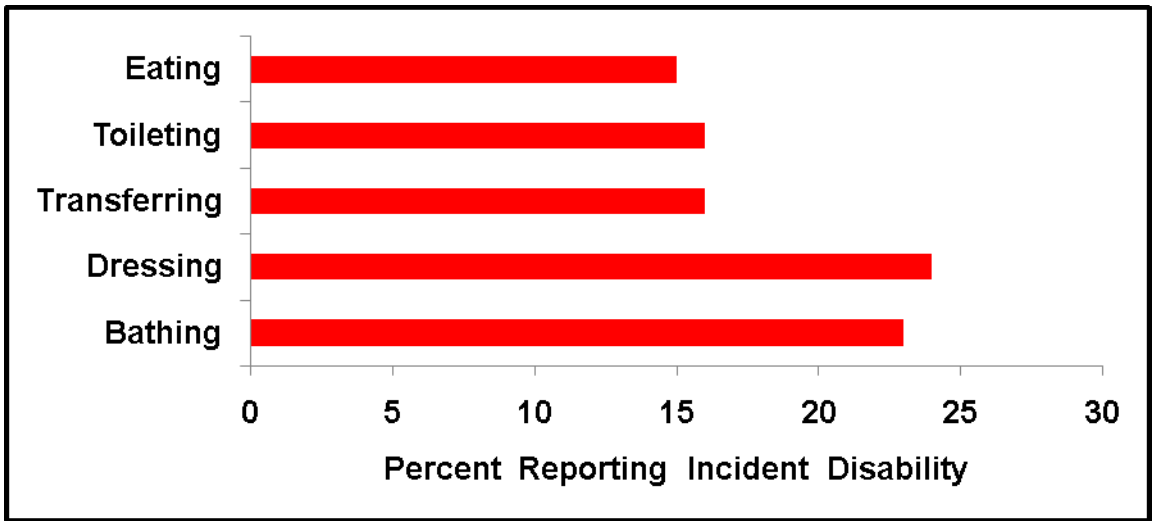


Figure 4. Percent reporting incident ADL disability during hospitalization. *Source:* Data from Covinsky et.al. 2003.

C.2.a. Relationship with Pre-hospitalization ADL

ADL function prior to hospital admission has been shown to be important in assessing hospital ADL function. Boyd et al. studied patients ≥ 70 years admitted to a community teaching hospital for trends in ADL recovery after an acute medical illness.[93] Of those discharged with a new ADL disability, 54.7% were independent in ADL at baseline. In contrast, of those with no new ADL disability at discharge, 73.5% were independent in ADL prior to hospitalization ($p<.001$). In a second study, Covinsky et al. examined 2,877 older adults admitted to a general medical service unit for the relationship between pre-hospitalization ADL and hospital ADL performance.[94] They found that only 2-6% of those reporting independence in hospital ADL reported any dependencies two weeks prior to hospitalization. Thus, the evidence suggests that the prevalence of ADL disability for hospitalized older adults is highly dependent on baseline ADL performance.

C.2.b. Model explaining change in ADL due to hospitalization

Brief episodes of hospitalization can be devastating to the ADL performance of an older adult. Gill et al. examined the risk of ADL disability due to hospitalization in a group of 753 community-dwelling older adults.[95] The hazard ratio for developing ADL disability within one month of hospitalization was 61.8 (95%CI: 49.0-78.0) while the hazard ratio for developing ADL disability after restricted activity was only 5.54 (95% OR: 4.3-7.2). These risks appear to have a physiological basis.[96] Creditor developed a model that demonstrates the effect of hospitalization on the physiology and function of older adults.[96] Prior to hospitalization, older adults are disadvantaged by processes related to usual aging such as reduced muscle strength and impaired sensory abilities. During hospitalization, environmental factors such as immobilization, fluid inaccessibility and sensory deprivation initiate a "cascade" (p.219) of primary effects (deconditioning, delirium and dehydration) as well as secondary effects (fall, physical and chemical restraint) as illustrated in Figure 5. [96]

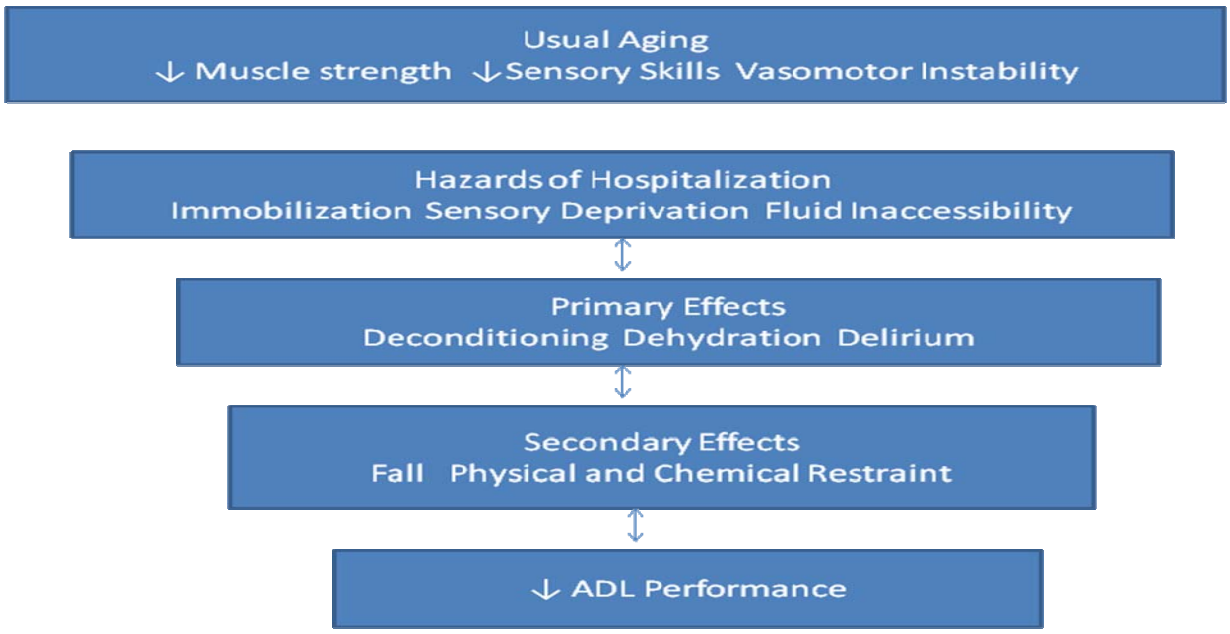


Figure 5. *Modified* Cascade to Dependency. *Source:* Creditor 1993, Figure 1.

Taken together, these physical, sensory and cognitive changes increase the risk for limitations in activities in daily living during hospitalization. To minimize the risk of decline due to hospitalization, researchers have advocated for formal models of

anticipating, monitoring and assessing changes in function in the hospitalized older adult.[96]

C.2.c. Acute Care for Elders (ACE) Unit

To provide more structured oversight for hospitalized older adults, a model of care called "Acute Care for Elders" (ACE) units have been developed. An ACE unit is a hospital unit that focuses specifically on the recovery needs of older adults with acute medical illnesses.[97] The underlying philosophy is that the hospital environment aids in the process of debilitation and that accommodations for specific older adult needs will result in fewer hospital complications and increase positive outcomes.[97, 98] To achieve these goals, ACE units rely on interdisciplinary team interaction and environmental modifications that support older adult strengths and limitations. ACE units are designed to provide homelike environments (larger patient rooms, family gathering areas) and design elements that support older adult function (carpeted floors, handrails in halls and proper lighting). Activities and tools that enhance orientation (calendars, clocks, daily bathing and dressing encouragement) are routine parts of care delivery.

In a randomized-controlled trial (RCT) studying patients' response to an ACE unit admission, Landefeld et al. demonstrated less degradation and more improvement in ADL functioning in adults (p=.0009) admitted to an ACE unit vs. a usual hospital unit.[99] Improvements were also seen in discharge status measures such as decreased depressive symptoms, improved ability to walk and fewer nursing home placements. In a second RCT, Counsel et al. reported improvement in satisfaction for patients, physicians and nurses, as well as reductions in restraint use, days to discharge and prescriptions of high risk medicine.[100] Neither study could demonstrate a reduction in mortality or reduction in-hospital costs, highlighting the need for more research on this specialized level of care.

D. Factors Associated with ADL Status

D.1. Sociodemographic Characteristics

D.1.a. Age

As expected, age is associated with ADL status. Older adults experience increased prevalence and incidence of ADL disability. In a 10 year study of 2,000- 4,000 community dwelling elders 60 years and older in Hong Kong, the prevalence of disability increased with each 5 year increase in age as illustrated in Figure 6.[89] The most dramatic increase in disability occurred in the oldest group, adults ≥ 80 years, in which the prevalence increased from 12.3% in 1996 to 20.4% in 2004. Older adults are also more likely to move into more severe categories of disability and less likely to recover fully from disability.[101]

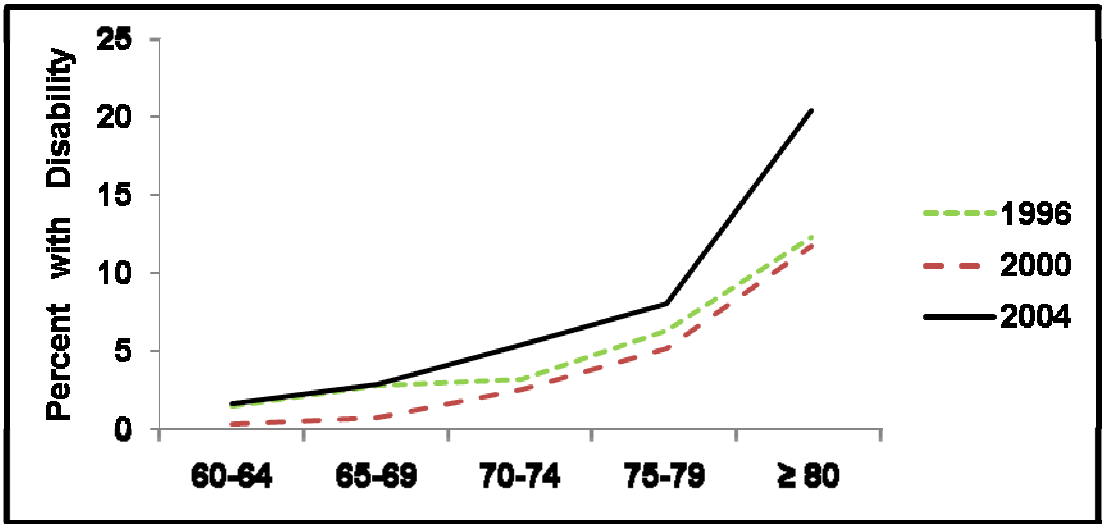


Figure 6. Prevalence of disability in five age groups of community-dwelling adults aged 60+ years in Hong Kong (1996-2004). *Source*: Data from Chou et al. 2008, Table 3.

These findings complement hospital-based research on the effect of age on ADL disability in hospitals. Covinsky et al. report that older patients (≥ 90 years) are three times more likely to have new ADL limitations while in the hospital than those aged 70-74 years (OR: 3.4; 95% CI: 1.9- 6.1).[91] Collectively, these studies suggest that older age is a predictor for incidence and prevalence of ADL disability.

D.1.b. Gender

Studies attempting to elucidate gender differences in ADL disability report less clear findings. Females tend to report more ADL disability than males, although this difference does not always reach statistical significance in fully adjusted models.[84, 89] Hypotheses explaining this disparity suggest that females tend to over report disability, while males under report. Merrill et al. tested this theory by assessing self-report and functional performance in a group of 1,458 adult males and females, finding that self-report was accurate for the majority. For those who reported self-care inaccurately, females were more likely to under report ability and males more likely to over report. Gender differences in reporting have been associated with presumed societal expectations for respective genders, and the awareness of and reporting of discomfort.[84]

D.1.c. Ethnicity

Ethnic differences in ADL are understudied in samples that include whites, blacks and Hispanics. Only one study of incident ADL disability within a tri-ethnic population was found. Researchers examined community-dwelling adults ≥ 65 years in a longitudinal study.[87] At the 6- year follow-up, 21.2% reported incident ADL disability. African Americans accounted for 30.4%, Hispanics (interviewed in Spanish) 32.7%, Hispanics (interviewed in English) 19.98% and whites, 20%. Ethnicity was not a significant predictor of disability, but factors typically associated with ethnicity such as socioeconomic status, education and health insurance access were significant.

D.1.d. Education and Marital Status

Education and marital status have not been tested repeatedly as factors associated with ADL status. Two studies assessed education using multivariate models to predict ADL disability; both found higher levels of education to be protective of ADL disability.[102, 103] Of three studies assessing marital status as a correlate of ADL disability, two found that being single or unmarried was protective against ADL disability,[104, 105] while one found marital status to be a non-significant predictor.[103]

D. 2. Clinical Characteristics

D.2.a. Medical Conditions

Various medical diagnoses have been analyzed as covariates in the analyses of ADL disability. Depression is a significant correlate of ADL disability.[14, 33, 102-104, 106, 107] While higher comorbidity index scores have been linked to ADL disability,[102] findings are not consistent.[108] Individual diseases associated with ADL disability include cardiovascular disease (including heart attack and stroke), diabetes, cancer, hip fracture, hypertension and arthritis.[103-105]

D.2.b. Body Mass Index

While not examined extensively, an association between body mass index and ADL status appears emergent. High body mass index (BMI > 28) is predictive of ADL disability; however the association may be less pronounced in males.[102, 103, 108] People with a low body mass index (BMI<20) are more likely to have ADL disability than those with normal BMI (20-28).[103] Therefore, those with normal BMI appear to have lower risk for ADL disability.

D.2. c. Pain

In several studies, pain is associated with ADL status. The presence of pain, as well as qualifiers such as daily pain, moderate levels of pain and having multiple sites of pain, are associated with greater ADL disability.[102, 107] In studies of patients with specific diagnostic categories such as polyneuropathy or osteoarthritis, pain is significantly correlated with ADL disability.[102, 107, 109-111]

E. Longitudinal Change in ADL Disability in Older Adults

In previous sections, we showed that prevalence estimates of ADL disability have remained fairly stable over time. However, these estimates are based on a series of point prevalence assessments, which includes persons who have changed ADL status categories, positively or negatively. Therefore, we must know the trajectory of ADL disability to fully understand the risk associated with incident disability, particularly for

hospitalized, older adults. In this section, we review change in ADL disability and correlates of ADL recovery in community-based and hospital-based samples.

E.1. Community-Dwelling Older Adults

The literature related to change in ADL disability contains two types of samples: those that do or do not have baseline disability. In samples with baseline disability, remittance of ADL occurs for roughly 1/3 of participants; factors associated with recovery are generally younger age, higher cognition, higher mobility and fewer depressive symptoms.[8, 112] For samples with no baseline disability, acute episodes of disability are brief and largely resolve within 12 months.[113]

E. 2. Hospitalized, Older Adults

While most community-dwelling adults seem able to recover from incident disability, hospitalized older adults with new disability have a more negative course. Figure 7 illustrates the findings of a study that examined health outcomes 12 months post discharge in a group of 2,279 hospitalized, older adults.[93] Of those discharged with a new disability, 30.1% returned to baseline function, 28.6% did not recover baseline ADL function and 41.3% died by the 12 month follow-up. Conversely, in the group discharged at baseline ADL function, 67% remained stable, 15.2% were worse than baseline function and 17.8% died by the 12 month follow-up.

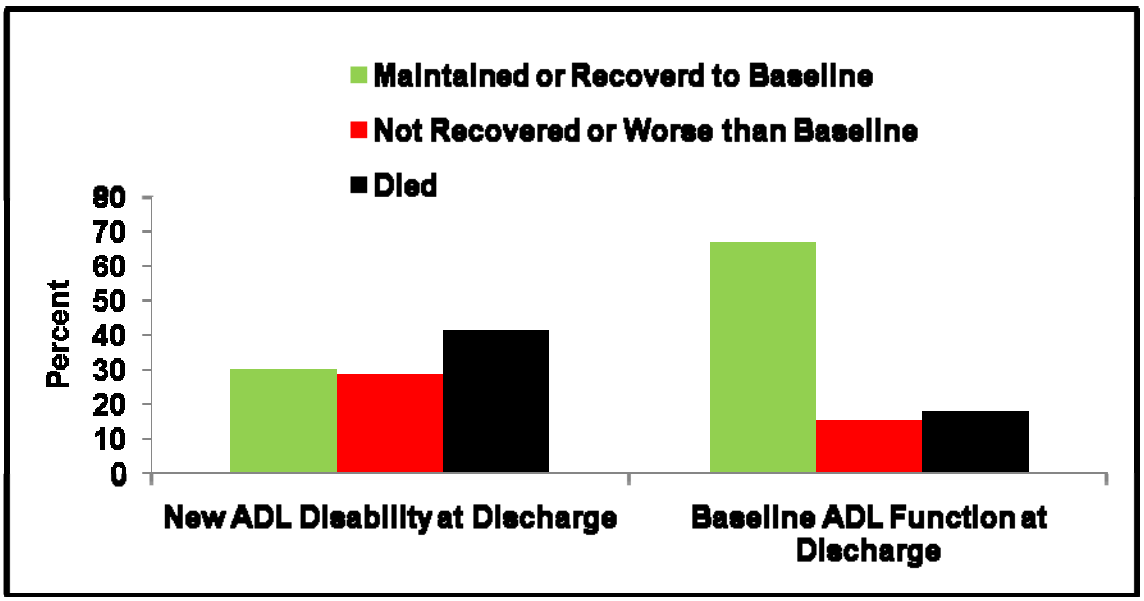


Figure 7. Twelve month outcomes in ADL and mortality by ADL discharge status. *Source*: Data from Boyd et. al. 2008.

Failure to recover ADL function was independently predicted by the presence of cardiovascular disease, cancer, dementia, increasing numbers of instrumental activities of daily living (IADL) disabilities and age ≥ 90 years. Within this same population, the frequency of ADL decline between baseline and discharge by age was found to differ significantly. The decline was 23% for those 70-74 years, 28% for those 75-79 years, 38% for those 80-84 years, 50% for those 85-89 years and 63 for those ≥ 90 years.[91] Thus, ADL during hospitalization was highly correlated with greater age.

F. Summary of Section II

In Section II, we provided a broad overview of ADL disability. The prevalence of incident ADL disability in community-dwelling adults is relatively low, stable and recoverable. Among hospitalized older adults, ADL disability is common, fluctuating and difficult to fully recover from, especially for the oldest old. Sociodemographic risk factors associated with ADL disability in the hospital and in the community are older age, female gender, lower education and being married. Clinical characteristics associated with ADL disability are the presence of high depressive symptoms, chronic conditions (cardiovascular disease, cancer, hip fracture, hypertension and arthritis), pain and low or high BMI. Factors associated with recovering ADL function include fewer depressive symptoms, younger age, better lower body strength, higher cognition and good nutritional status.

SECTION 3: THE ASSOCIATION BETWEEN ACTIVITIES OF DAILY LIVING AND DEPRESSIVE SYMPTOMS

Section 3 provides an overview of the relationship between depressive symptoms and ADL using a contextual model to organize the literature.

A. International Classification of Functioning, Disability and Health (ICF)

To encourage an integrated and standard framework for describing health and health related tasks, the World Health Organization promotes the use of a model called the International Classification of Functioning, Disability and Health (ICF).[1] Per the ICF, human function is the product of interactions between health conditions and contextual factors. Function is defined at three levels: 1) body function/structure (physiological body systems and anatomical parts; i.e., grip strength), 2) activity (task execution by an individual; i.e., reaching to put on socks) and 3) participation (involvement in life situations; i.e., dressing before work).

Disability denotes difficulty at any level of function, occurring both within the individual and within society. Function is influenced by health conditions (disease) and contextual factors, both environmental (social and physical) and personal (sociodemographics and lifestyle). All of these constructs act to influence one another either directly or indirectly in a bidirectional manner.[1] To better explain the current literature and study hypotheses for this section, we used the International Classification of Function (ICF) framework to show potential direct and indirect pathways of association between depressive symptoms and ADL as illustrated in Figure 8.

B. Direct Pathways of Association

Using the ICF model, we hypothesize that depressive symptoms have a direct relationship with both body functions and disability. The first plausible pathway is the direct association of depressive symptoms and ADL, a relationship which is arguably reciprocal.

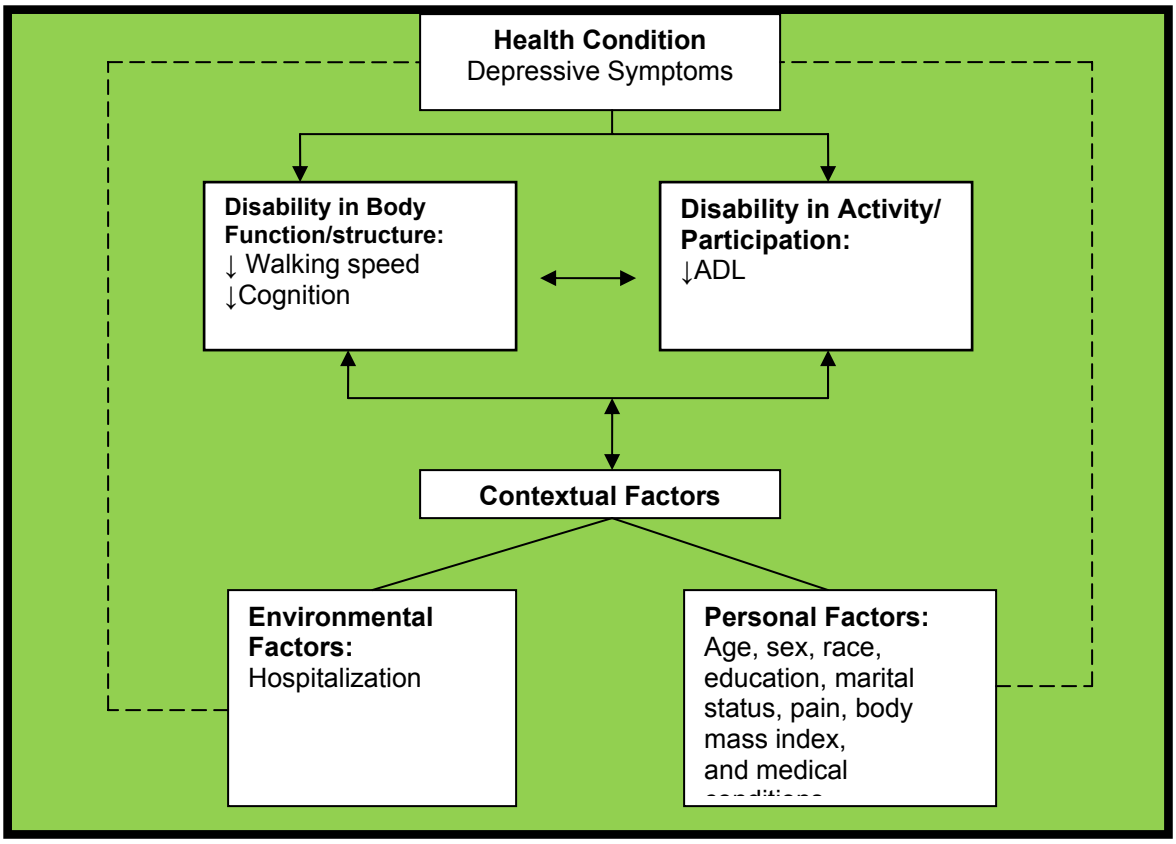


Figure 8. ICF model illustrating direct and indirect pathways of association between depression and ADL and the potential moderating effect of contextual factors. *Source:* Adapted from World Health Organization 2002, Figure 1.

B.1.Associations in Prevalence and Incidence

In cross-sectional and longitudinal studies using multivariate analysis methods, depressive symptoms and ADL or IADL disability have been correlated regardless of age, gender, race or income.[31, 42, 52, 54, 68, 104, 114, 115] Depression/depressive symptoms and ADL disability are also predictors of incident cases. In a study that assessed variables associated with incident depression, ADL function contributed significantly to the incidence of new depression.[116] Similarly, depressive symptoms are associated with incident disability in ADL function. In a study of > 6,000 people who were initially free of disability, those with high depressive symptoms had a 30% greater chance of developing a new ADL disability over six years.[103]

B.2. Association by Severity of Symptoms

The severity of depressive symptoms is also associated with the severity of ADL disability.[14, 117] In a study of community-dwelling older adults over 65 years, each

increase in the number of depressive symptoms was associated with a point increase in ADL and IADL disability. Even minimal or episodic periods of high depressive symptoms are associated with functional limitations. The magnitude of the association was comparable of that of chronic medical conditions such as diabetes, congestive heart failure and myocardial infarction.[12] Taken together, these studies indicate that any level of depressive symptoms can be associated with significant functional limitation.

B.3. Association in Recovery from Disability

Depressive symptoms and ADL disability exert reciprocal risks for increased incidence, prevalence and severity of symptoms. Therefore, one might suggest a further association where the remittance of one leads to a remittance of the other. In other words, does recovery from high depressive symptoms contribute to the recovery of ADL function and vice versa?

Some research has discussed this hypothesis. Lai et al. followed the patterns of recovery from ADL disability and depression in 459 patients after stroke.[71] Depression recovery was low, only 3% after 6 months of follow-up. ADL recovery was highly associated with being not depressed. For the non-depressed group, cumulative ADL recovery at 1, 3 and 6 months was 47%, 63% and 72%, respectively. For the depressed group, cumulative ADL recovery at the 1, 3 and 6 month follow-up was 19%, 34% and 52%, respectively. In other words, depressed patients had poorer recovery patterns and took longer to reach ADL independence when they did recover, compared to non-depressed patients. In a separate study, Cronin-Stubbs et al. assessed the likelihood of recovering from ADL disability in a group of > 3, 400 community-dwelling adults 65 years and older and found that each increasing depressive symptom reduced the odds of recovery 4%.[14] Both of these studies highlight an association of better ADL recovery with fewer depressive symptoms.

B.4. Influence of Contextual Factors

Other factors potentially influencing this process are the environmental and personal factors identified by the ICF model.[1] The presence of environmental factors such as hospitalization may increase the risk for depressive symptoms or ADL disability in older adults which upon discharge may be alleviated. Personal factors such as female

gender, older age and pain may be risk factors for hospital depressive symptoms and ADL disability. In the next segment, we discuss hypotheses for how these personal factors may moderate the depression-ADL association.

C. Indirect Pathways of Association

C.1. Evidence of Mediator Pathways

The second plausible pathway for the association between depressive symptoms and ADL is indirect. In this context, depressive symptoms directly contribute to weakening of body function, which may then initiate disability. Associations between depressive symptoms, walking speed and cognition have been previously established. Decreased walking speed and lower cognitive levels are associated with higher risk of clinically-significant depression[40, 51, 54, 60, 118, 119] and arguments have been made for depression as the precedent of these limitations.[104] Subsequently, reductions in certain body functions may initiate disability in ADL and would support arguments for the role of depressive symptoms in reducing ADL independence.[104, 119]

C.2. Potential Interaction Effects

Indirect associations between variables can be tested for interaction effects through moderator analysis. An interaction effect exists when the outcome of an association between two variables differs based on the value of the moderator variable.[120] Variables that serve as risk or protective factors may also moderate the influence of depressive symptoms on ADL.

C.2.a. Marital Status

Marital status is considered a part of a person's social network or resources. Being unmarried has been found to increase the risk of depressive symptoms and ADL disability and therefore may moderate the depression-ADL association.[11, 40, 43, 44, 51-53] While specific research for this hypotheses could not be found, evidence for social support varying the impact of depression on behavior was found. Higher levels of perceived social support moderated the relationship between depression and function by minimizing ADL/ IADL disability in a group of older adults. In a study of Hispanic

older adults, higher levels of social support reduced suicidal ideation in people with high depressive symptoms.[121-123]

C.2.b. Gender

Gender is another potential moderator in the depression-ADL relationship. As discussed earlier, being female is associated with higher risk of depression and ADL disability and therefore may influence the relationship between the two.[3, 84] In a study of adults 70-79 years, gender moderated the relationship between depressive symptoms and new ADL disability; the odds for incident disability were higher in depressed females (OR: 5.4 95% CI: 1.8-16.9) than in depressed males (OR: 3.6; 95% CI: 1.1-11.7).[108] In a separate study, males with higher BMI scores were more likely than females to suffer from severe depression.[124]

C.2.c. Pain

In previous sections, the presence of pain was associated with both depressive symptoms[60, 63] and ADL disability.[102, 107, 109-111] What is unclear is the potential interaction effect between pain and depression on the outcome of ADL. To date, no published reports were found that assessed this potential interaction effect. However, pain and pain-related concepts were moderating variables in other studies that assessed functional performance and participation.[125, 126]

C.2.d. Medical Conditions

Specific previous medical conditions, such as stroke, hip fracture, cancer and myocardial infarction, are associated with high depressive symptoms.[26, 44, 54, 59, 60] These medical conditions also contribute to ADL disability. Thus, we hypothesized that an interaction effect between medical conditions and depression may change ADL outcome. While specific research assessing this moderating effect could not be found, Cohen and Rodriguez theorized about the reciprocal influence of affective disorders and physical disorders.[127]

D. Summary of Section 3

In this section, we explored the associations between depressive symptoms and ADL using the ICF model. Published reports support both direct and indirect pathways of association. Hypotheses for potential moderators in this relationship are supported by previous literature. In the next chapter, we present a review of the study design, conceptual model, specific aims, hypotheses, measures and data analysis plan.

Chapter 3: Methods

The Methods section details the overall design of the study by describing: 1) the specific aims and representative hypotheses; 2) the conceptual model guiding the hypotheses, study design, and analytical choices; 3) design and sampling procedures; 3) measures used to define study variables, and 4) analyses used for each specific aim.

A. Specific Aims

A.1. Specific Aim 1

Determine the trajectory of depressive symptoms from hospitalization to 3 months post discharge. Prevalence estimates in hospital and post-discharge, as well as change in depressive symptoms will be explored by relevant sociodemographic and clinical characteristics such as age, gender, ethnicity, pain and ADL function.

A.1.a. Representative Hypotheses:

- Hypothesis 1a: The prevalence of high depressive symptoms will decrease significantly from hospital to 3 month follow-up.
- Hypothesis 1b: Risk factors associated with hospital depressive symptoms will include being female, unmarried, and having any level of ADL disability.
- Hypothesis 1c: Positive change in depressive symptoms will be associated with positive change in ADL.

A.2. Specific Aim 2

Determine the trajectory of ADL function from hospitalization to 3 months post discharge. Prevalence estimates in hospital and post-discharge, as well as change in ADL function will be explored by relevant sociodemographic and clinical characteristics such as age, gender, ethnicity, pain and depression.

A.2. a. Representative Hypotheses:

- Hypothesis 2a: The prevalence of ADL disability will decrease significantly from hospital to 3 month follow-up.

- Hypothesis 2b: Risk factors associated with hospital ADL disability will include female gender, currently married and pain.
- Hypothesis 2c: Change in ADL will be associated with marital status, education and age.

A.3. Specific Aim 3

Examine the direct associations between hospital depressive symptoms and ADL function 3 months post-discharge controlling for relevant sociodemographic and clinical variables such as age, gender and pain.

A.3.a. Representative Hypotheses:

- Hypothesis 3a: At the 3 month follow-up, self-reported bathing, toileting and dressing disability will be associated with hospital depressive symptoms
- Hypothesis 3b: The magnitude of high depressive symptoms in hospital will have a linear effect on ADL disability 3 months post-discharge.

A.4. Specific Aim 4

Examine the interaction between hospital depressive symptoms and select personal and health characteristics on ADL status 3 months post-discharge. Personal and health characteristics will include measures such as gender, marital status and pain.

A.4.a. Representative Hypothesis:

- Hypothesis 4a: Gender, marital status, pain and number of medical conditions will moderate the relationship between depressive symptoms and ADL.

B. CONCEPTUAL MODEL

To better explain this study, the ICF framework[1] has been used to underlie the study design, hypotheses and analytical choices.

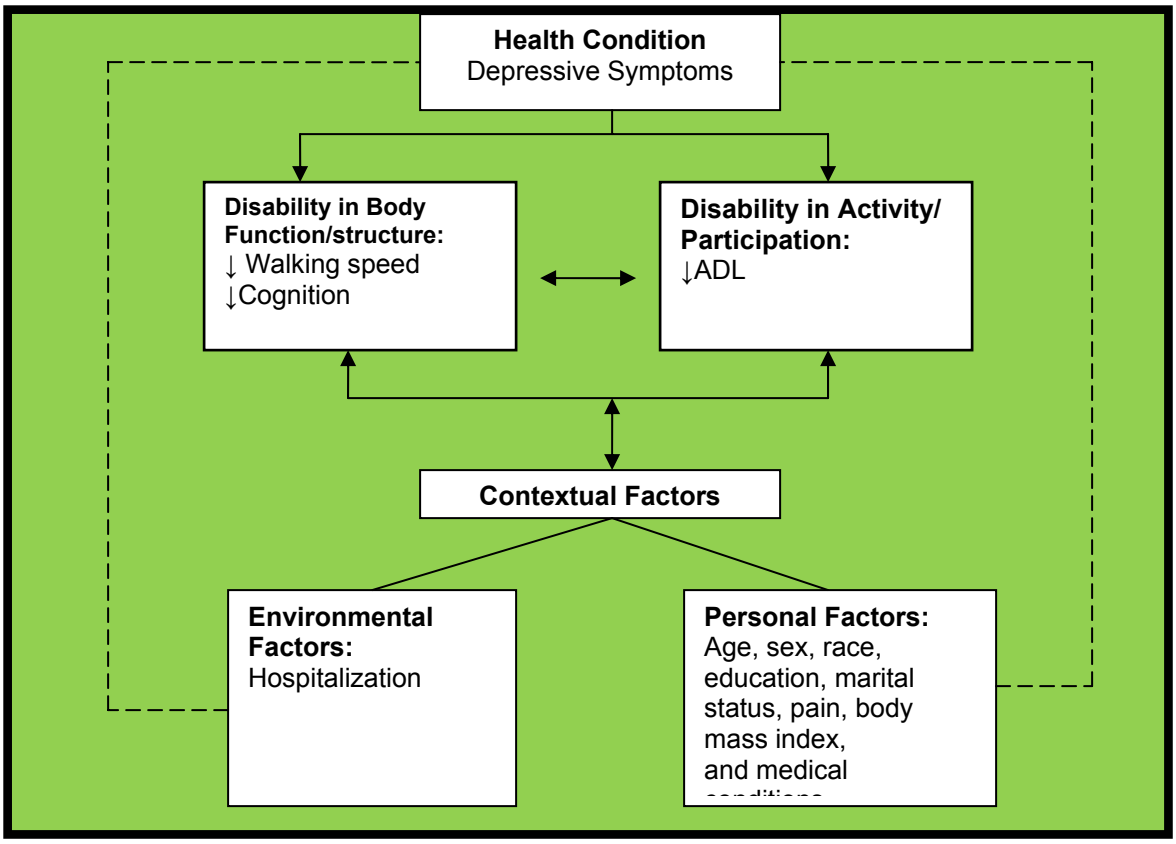


Figure 9. Conceptual model (ICF) postulating how depressive symptoms may be associated with disability and the potential influence of contextual factors. *Source*: Adapted from World Health Organization 2002, Figure 1.

The ICF model creates a framework to test hypotheses that the presence of depressive symptoms (health condition) is associated with ADL disability (activity and participation) as illustrated in Figure 9. This relationship may exist in cross-sectional analysis of concurrent states but may also persist despite alleviation of one condition. Therefore, the ICF model encompasses the hypothesis that hospital depressive symptoms are associated with hospital ADL as well as with 3 month follow-up ADL, despite potential remittance of depression. Reciprocal arrows between health condition and activity and participation allow testing of concepts where dynamic changes in one condition may lead to changes in the other condition. For example, alleviation of depressive symptoms may also be associated with alleviation of ADL disability.

The ICF model also provides the theoretical framework to evaluate the influence of contextual factors such as hospitalization on the prevalence of hospital depressive

symptoms and hospital ADL disability, while sociodemographic characteristics such as gender, marital status and age may serve to buffer against or increase risk for symptomatology in respective conditions. Finally, ICF model factors that protect or contribute to disability may play a moderating role between key variables. For example, gender is associated with depressive symptoms and with ADL disability and therefore may play a moderating role in the relationship between depression and ADL disability.

C. DESIGN AND SAMPLING

This study was designed as a longitudinal examination of the psychological status of older adults admitted to the UTMB John Sealy Hospital ACE unit. A convenience sample of 403 diverse and cognitively competent older adults consecutively admitted to the ACE unit were invited to participate in data collection occurring at two time points, in hospital and 3 months post discharge. A longitudinal design was chosen for this study to assess changes that occur in depressive symptoms and ADL disability over time and to allow assessment of the potential association between hospital depression and 3 month ADL function.

C.1. Setting

The ACE unit opened in 2000 with 20 beds following previously established ACE unit recommendations for supporting older adult function during hospitalization.[97] The ACE unit is staffed with a multidisciplinary team of physicians, nurses, occupational therapists, physical therapists, speech-language pathologist, dieticians and activity personnel.

C.2. Recruitment and Screening Procedure

Figure 10 illustrates the sequence for recruitment, screening and assessment of patients within this study and is detailed further in this section. During the enrollment period, the ACE interdisciplinary team met daily to discuss the health status and plan of care of new and current patients. During these meetings, potential study subjects were identified and interviewers were sent to complete the screen and obtain consent.

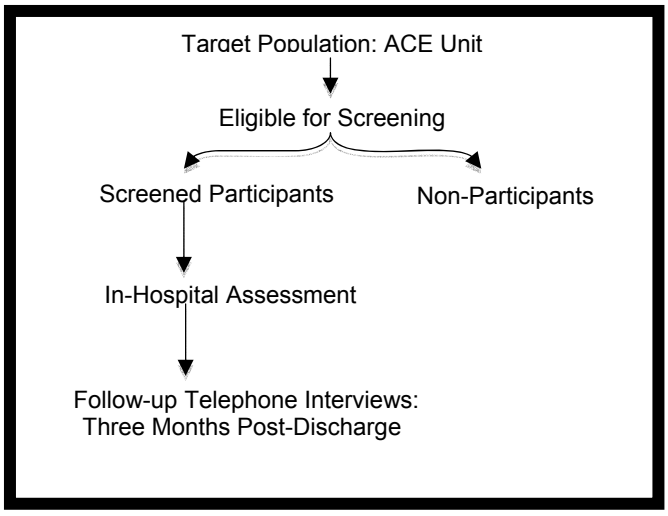


Figure 10. Flow Diagram of Patient Recruitment for the ACE Unit Study.

C.3. Inclusion Criteria

Study participants were screened for five inclusion criteria: 1) admitted within the last 24 hours with an underlying diagnosis of heart disease, pneumonia, cerebrovascular disease or cancer; 2) admitted on a week day to the ACE unit; 3) aged 65 years or older; 3) non-Hispanic white, non-Hispanic black or Hispanic of either gender; 4) cognitively appropriate (as established by nurse manager through an orientation assessment) with no proxy needed for interviewing; and 5) patient reported the ability to walk across a room prior to hospitalization.

C.4. Exclusion Criteria

Study participants were excluded for one or more of the following exclusion criteria: 1) below 65 years of age; 2) admitted to the ACE unit on a weekend; 3) patient reported inability to walk across a room prior to hospitalization; and 4) not cognitively appropriate for study.

C.5. Informed Consent

Individual subjects who met inclusion criteria were asked to participate in the study. If the subject agreed, a brief description of the study was provided by the interviewer.

The interviewer emphasized that participation was voluntary and non-participation in no way affected quality of care. If the patient indicated readiness to participate, he or she was given a copy of the informed consent form. The interviewer read the consent form to the subject and answered any questions related to the project. If the subject then consented to participate, he or she signed the consent form and was assigned a unique patient identifier number.

C.6. Participant Selection

Figure 11 outlines the process of participant selection for the cross-sectional and longitudinal analyses. Of the 403 patients who agreed to participate, ninety-three had some aspect of missing data, such as hospital ADL score (n=53), medical history (n=28) or pain (n=17), which prevented them from being included in the analysis. No significant differences existed in age, gender or race in those who participated in the study and those who were excluded due to missing data. Due to low numbers, Asians (n=3) and Native Americans (n=1) were excluded so that a tri-ethnic sample of whites, blacks and Hispanics could be analyzed. The remaining patients (N=306) were used for cross-sectional analyses based on hospital admission status data. By the 3 month follow-up, 108 participants had been lost to follow-up, leaving 198 participants with complete data for the longitudinal analyses. Reasons of loss (i.e., death, refusal or move) are unknown. No significant differences existed in age, gender or race between those included in the longitudinal analyses and those lost to follow-up.

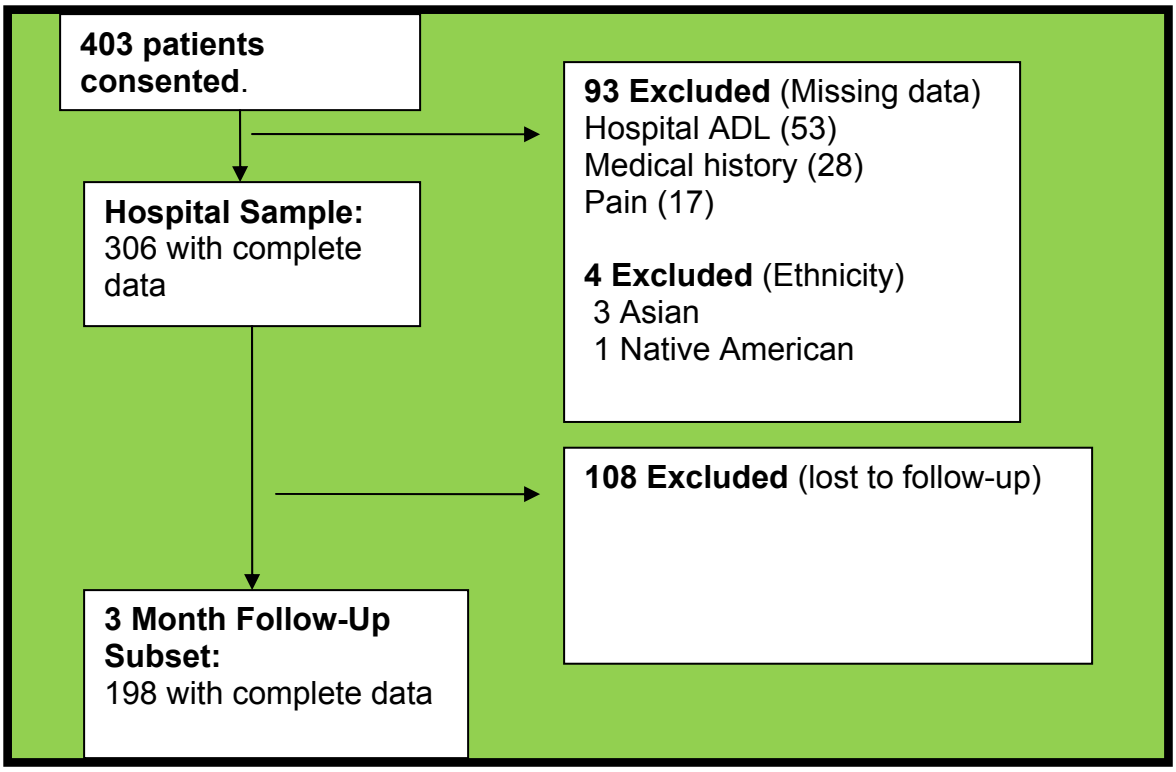


Figure 11. Flow chart of ACE unit study participants.

C.7. Ethical Considerations

This data collection method was approved through the University of Texas Medical Branch (IRB #05-345). No harmful effects were expected from the collection of this data. Patients were given the choice to proceed or discontinue the process at any time. No physical or emotional adverse effects were reported.

C.8. In-Hospital Assessments

In-hospital assessments occurred within 24 hours of admission and were initiated immediately after the patient had signed the consent form. The interview / assessment consisted of three parts: 1) a structured face-to-face interview; 2) a chart review; and 3) a functional / physical performance battery (2 meter walk, chair rise time, standing balance task, grip strength, knee extensor strength). Face-to-face interviews required about 30-40 minutes and completing the chart review required 20 minutes. A licensed physical therapist supervised the functional assessment after the completion of face to face interview. The physical performance battery took about 12 minutes to complete. Face-to-face interviews and functional assessments were halted if the patient 1) became fatigued or 2) required routine nursing care.

C.9. Follow up Interviews

Contact information including phone number and home address were collected while the patient was in hospital and along with Invision information, follow-up interviews were coordinated and scheduled. Telephone follow up interviews occurred 3 months after hospital discharge.

D. MEASURES

This study utilized a variety of sociodemographic and clinical data. For each measure in the study, the operational definition, retrieval source and, when applicable, the test psychometrics, are outlined below in Table 1. First, sociodemographic and abstracted medical data variables are described. Second, clinical variables, such as depressive symptoms and are described. Finally, the outcome variable of interest, ADL, is explained.

Table 1. Data Type, Source and Operational Definition.

Sociodemographic Characteristic	**Data source**	**Operational Definition**
Age	Person / ClinWeb	Age at admission in years
Gender	Person	Male/Female
Race	Person	Non-Hispanic white, non-Hispanic black, Hispanic
Marital Status	Person	Married vs. all others
Education	Person	Years of schooling
Address / Phone number	Person / Invision	Follow up contact information was obtained from the individual and Invision database.
Abstracted Medical Data	**Data source**	**Operational Definition**
Admitting Diagnosis	ClinWeb	Heart disease, pneumonia, cerebrovascular disease or cancer
Length of stay (LOS)	ClinWeb	Calculated in days from admission to discharge
Medical Condition Index	ClinWeb	Patient responded yes or no to presence of stroke, diabetes, hip fracture, heart attack and cancer. Answers were summed and used as a continuous or dichotomous score (0 v. ≥ 1)
Clinical Measure	**Data Source**	**Operational Definition**
Depressive Symptoms	Person	20-item Center for Epidemiologic Studies – Depression (CES-D)

		scale ranging from 0-60, where higher scores indicate increased depressive symptoms. The scale was used as a continuous and a categorical variable (< 16 v. ≥ 16 and < 20 v. ≥ 20)[20, 52] where either ≥ 16 or ≥ 20 was considered depression dependent on the analysis. In older populations: Internal consistency (.85-.91) and validity (.82)[128]
Body Mass Index	ClinWeb	Continuous measure described as weight in kilograms divided by height in meters squared.[129]
Pain	Person	11-point scale ranging from no pain (score = 0) to worst pain possible (score = 10)[130]
Outcomes	**Data Source**	**Operational Definition**
Activities of daily living (ADLs)	ClinWeb Person	Continuous (0-7) and dichotomous variable (0 vs. ≥ 1 ADL limitation) of functional status. ADLs include: bathing, using the toilet, transferring from bed to chair, walking across a small room, personal grooming, dressing, and eating.[76]

E. Data Collection

Data were collected on 403 older patients over two time points: during hospitalization on the ACE unit and 3 months post discharge via telephone interview. Patient characteristics (age, gender, race, and education and marital status) and clinical measures of health status (BMI, hospital pain, diagnoses) were considered fixed effects and collected once during the hospital interview. Depressive symptoms (hospital and follow-up status) and ADLs (hospital and follow-up status) were collected at two time points as shown in Table 2.

Table 2. Data Collection Time Points for Study Variables.

	Admission	3 Month Follow-Up
Inclusion/exclusion Criteria; consent	x	
Sociodemographic characteristics	x	
Medical Conditions	x	
Clinical measures (BMI, pain)	x	
Depression	x	X
ADLs	x	X

F. DATA ANALYSIS

The analyses for each specific aim are provided below. Data for this study were analyzed using SAS Version 9.1.

F.1. Specific Aim 1 Data Analysis

Descriptive statistics were used to 1) describe the sample and the prevalence of clinically-significant depression in hospital and at discharge; 2) develop the CESD and ADL change score; and 3) describe change in depression through continuous and categorical variables. To examine differences between groups with high and low depressive symptoms, bivariate analyses (chi square/Fisher's exact tests for categorical variables and t-tests for continuous variables) were performed. Bivariate analysis was also used to assess differences between groups with categorical CESD change. Scatter plot analysis was used to test the relationship between change in CESD and change in ADL. A modified Poisson regression model was used to assess factors associated with risk of high depressive symptoms in hospital; logistic regression was used to assess factors associated with risk of high depressive symptoms at follow-up. Factors associated with CESD change were examined through linear regression and factors associated with positive change in CESD were assessed through logistic regression. Tests for normality, outliers and multi-collinearity were done to assess that assumptions

were met for multivariate regression analysis. Visual representation of findings will be presented through charts or figures.

F.2. Specific Aim 2 Data Analysis

Descriptive statistics were used to describe the sample and 1) the prevalence of ADL disability in hospital and at discharge and 2) change in ADL status/disability through continuous and categorical variables. To examine differences between groups with and without ADL disability, bivariate analyses (chi square/Fisher's exact tests for categorical variables and t-tests for continuous variables) were performed. Bivariate analysis was also used to assess differences between groups with categorical ADL change. Logistic regression was used to assess factors associated with risk of ADL disability in hospital and at follow-up. Factors associated with ADL change were examined through linear regression. Tests for normality, outliers and multi-collinearity were done to assess that assumptions were met for multivariate regression analysis. Visual representation of findings will be presented through charts or figures.

F.3. Specific Aim 3 Data Analysis

Chi-square analysis was used to assess the bivariate relationship between hospital depressive symptoms and ADL disability categories, both in hospital and 3 months post-discharge. Linear regression using a negative binomial distribution was used to examine the multivariate association between ADL status at 3 month follow-up and depression (independent variable), after controlling for other sociodemographic and clinical variables. Furthermore, the analysis included an assessment of a potential dose-response effect of higher levels of depression resulting in higher levels of ADL limitations. A log linear ratio was calculated to assess the superiority of fit between models. Tests for normality, outliers and multi-collinearity were done to assess that assumptions were met for multivariate regression analysis. Visual representation of findings will be presented through charts or figures.

F.4. Specific Aim 4 Data Analysis

A linear regression model using a negative binomial distribution was used to analyze the potential interaction effects of gender, marital status, pain and medical conditions on the association between hospital depressive symptoms and 3 month follow-up ADL

status. Previous multi-collinearity and normality diagnostics have been run on these variables and standards were met as described in previous aims.

Chapter 4: Results

Chapter 4 summarizes the results of this ACE unit study by each Specific Aim. Within each section, the specific aim and results are provided via text, tables and graphs as appropriate.

SPECIFIC AIM 1

Determine the trajectory of depressive symptoms from hospitalization to 3 months post discharge. Prevalence estimates in hospital and post-discharge, as well as change in depressive symptoms will be explored by relevant sociodemographic and clinical characteristics such as age, gender, ethnicity, pain and ADL function.

A. Overview of Hospital Depressive Symptoms

A.1. Distribution of CESD Scores

Prior to reporting the results on prevalence of hospital depressive symptoms, we illustrate the distribution of CESD scores through the frequency histogram depicted in Figure 12. In hospital, the mean CESD score was 14.6, the median score was 13 and the mode score was 7.

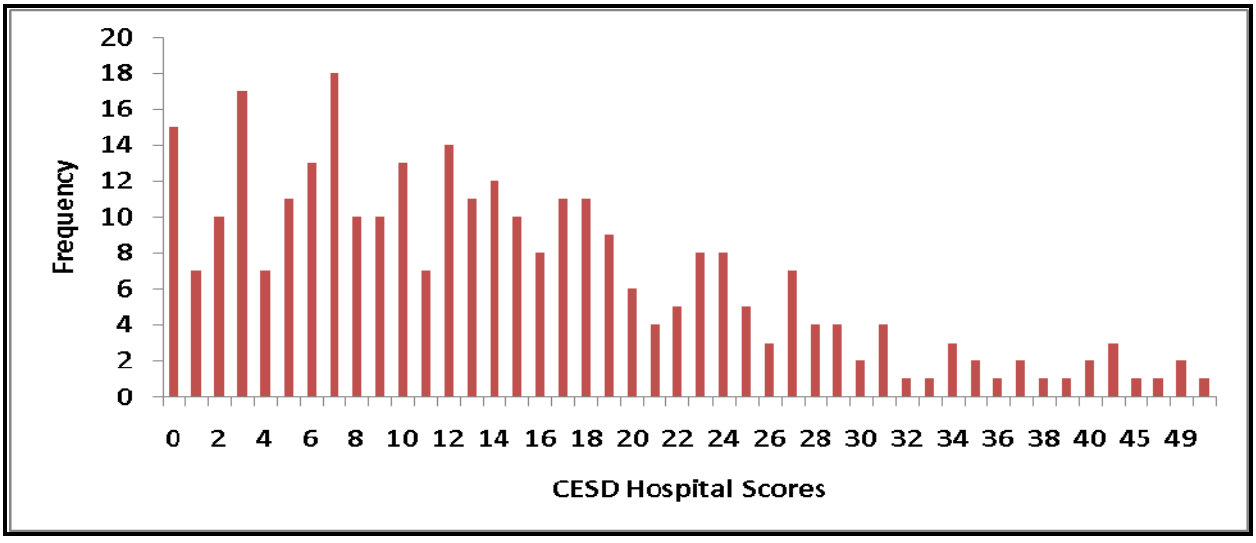
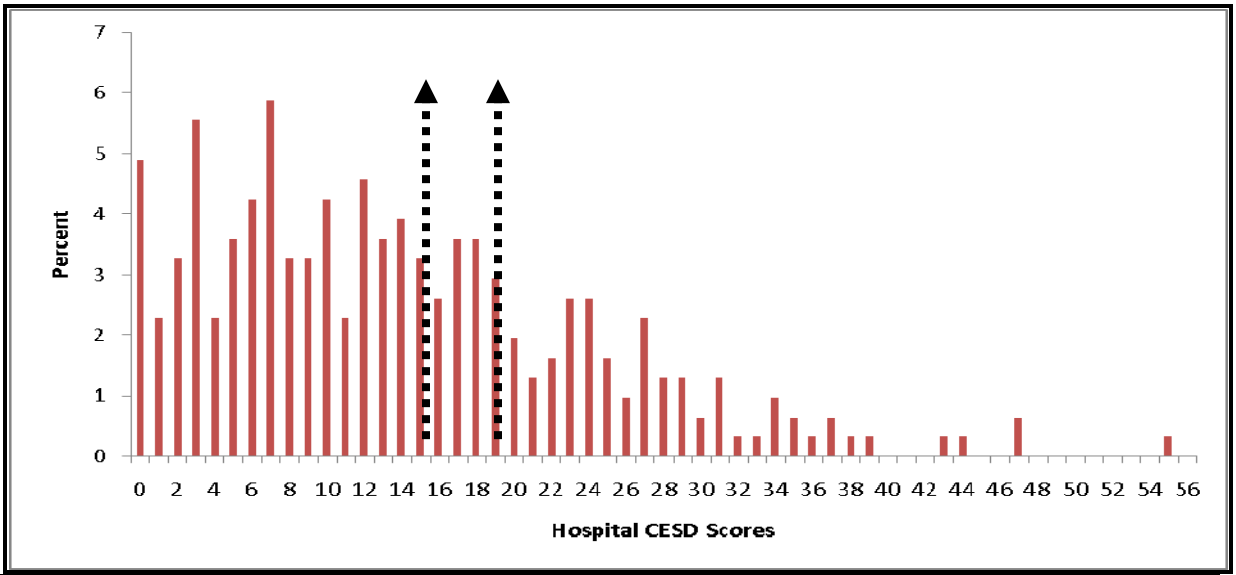


Figure 12. Frequency distribution of hospital CESD scores (N=306).

A.2. Prevalence of High Depressive Symptoms

The results for prevalence of high depressive symptoms in our sample is described with two different CESD cut-off rates, the standard ≥ 16 score used in most studies and the more stringent score of ≥ 20. When the cut-off score was ≥ 16, the prevalence of high depressive symptoms was 39.5% (121/306). When the more conservative cut-off score (≥ 20) was used, the prevalence of high depressive symptoms was 26.8% (82/306); see Figure 13.



	Count	Percent
Not depressed (< 16)	185	60.5
Depressed (≥ 16)	**121**	**39.5**
Not Depressed (< 20)	224	73.2
Depressed (≥ 20)	**82**	**26.8**

Figure 13. Prevalence of high depressive symptoms in hospital using two different CESD cut-off points (N=306).

A.3. Factors Associated with Depressive Symptoms: Bivariate

A.3.a. Sociodemographic Characteristics

Table 3 describes the sociodemographic characteristics of the sample as well as the assessment of differences between groups with high and low depressive symptoms. The mean age of the total sample was 75.6 years. No significant difference in age was

observed (p=.31) between the group with high depressive symptoms (75.8 years) and low depressive symptoms (75.4 years). More females (58.2%) than males (41.8%) were represented in this sample. Females were also more likely to have high depressive symptoms at admission (p=.01). A majority of the sample was unmarried (63.1%) and this group was also more likely to have high depressive symptoms in hospital (p<.01). By race and ethnicity, the sample was divided as follows: whites (66.3%), blacks (23.9%) and Hispanics (9.8%). No significant difference between groups with high and low depressive symptoms by race or ethnicity (p=.15)

The education status of this sample was stratified by three levels (<12 years, 12 years and >12 years). Thirty percent of the sample had < 12 years of education, 29.7% had 12 years of education and 40.2% had >12 years education. No significant differences existed between groups with high and low depressive symptoms by education status (p=.35).

Table 3. Sociodemographic characteristics of sample by depressive symptoms during hospitalization (N=306).

Sociodemographic Characteristics	Total Sample (N=306)		Low Depressive Symptoms (<16) (n=185) n (%)	High Depressive Symptoms CESD (≥ 16) (n=121) n (%)	p – value
Age (years) Mean [SD]	75.6 [7.2]		75.4 [6.6]	75.8 [8.0]	.31*
65-74	149 (48.7)		87 (47.0)	62(51.2)	
≥ 75	157 (51.3)		98 (53.0)	59 (48.8)	
Gender					.01
Male	128 (41.8)		88(47.6)	40 (33.1)	
Female	178 (58.2)		97(52.4)	81 (66.9)	
Marital Status					<.0004
Married	113 (36.9)		83 (44.9)	30 (24.8)	
Unmarried	193 (63.1)		102 (55.1)	91 (75.2)	
Ethnicity					.15
White	203 (66.3)		118 (63.8)	85 (70.2)	
Black	73 (23.9)		44 (23.8)	29 (24.0)	
Hispanic	30 (9.8)		23 (12.4)	7 (5.8)	
Education					.35
< 12 years	92 (30.1)		51 (27.6)	41 (33.9)	
= 12 years	91 (29.7)		60 (32.4)	31 (25.6)	
> 12 years	123 (40.2)		74 (40.0)	49 (40.5)	

All analyses are chi-square except those indicated with * which are student's t-test.

A.3.a.1. Sub-analysis using a Higher CESD Cut-Off Score

Additional analyses were completed using a CESD cut-off score of ≥ 20 for bivariate analyses. Being unmarried continued to be significantly associated with high depressive symptoms (p<.01), but gender (p=.26), age (p=.12), ethnicity (p=.08) and years of schooling (p=.90) were non-significant. Most of these variables were non-significant in

the initial chi-square analysis conducted with a CESD cut-off score of ≥ 16, except for gender. Thus, when the high depressive symptom cut-off score was 4 points higher, being female was no longer associated with clinically-significant depression.

A.3.b. Clinical Characteristics

Table 4 describes the distribution of the sample by clinical characteristics as well as the assessment of differences between groups with high and low depressive symptoms. The primary admission diagnosis for the sample was cardiopulmonary (40%), followed by infection (16%), gastrointestinal (15.0%), central nervous system (11.8), trauma (6.5%) and other (14.7%). No statistically significant differences existed between groups with high and low depressive symptoms by admission diagnosis (p=.29).

The mean length of stay was 4.4 days (SD: 3.2; range 0-28). The majority of patients were in the hospital for 4 or fewer days (63.7%). No significant difference existed between groups by length of stay (p=.82). Over 70% of the sample had at least one of the conditions listed in the medical history index, but no significant differences existed between groups by this variable (p=.92).

Body mass index (BMI) was trichotomized into 3 levels (< 22, 22-29.9 and $\underline{\geq}$ 30). Within the hospital sample, 19.3% were categorized as underweight (BMI < 22), 45.4% were normal weight (BMI 22-29.9) and 35.3% were obese (BMI > 30). An equal variance student's t-test performed on BMI by groups with high and low depressive symptom yielded no statistically significant difference (p=.07). Between group differences were found for pain. In hospital, 67% reported no pain, while 33% reported a pain score of at least "1" on a scale of 1-10. People without pain were more likely to report low depressive symptoms, while people with any pain were more likely to report high depressive symptoms (p=.04).

Table 4. Clinical characteristics of sample by depressive symptoms during hospitalization (N=306).

Clinical Characteristics	Total (N=306) n (%)	Low Depressive Symptoms (n=185) n (%)	High Depressive Symptoms (n=121) n (%)	p-value
Admit diagnosis				
Cardiopulmonary	110 (40.0)	59 (31.9)	51 (42.1)	.29
Gastrointestinal	46 (15.0)	32 (17.3)	14 (11.6)	
Trauma	20 (6.5)	14 (7.6)	6 (5.0)	
Central Nervous System	36 (11.8)	25 (13.5)	11 (9.1)	
Infection	49 (16.0)	30 (16.2)	19 (15.7)	
Other	45 (14.7)	25 (13.5)	20 (16.5)	
LOS				
≤ 4 days	195 (63.7)	117 (63.2)	78 (64.5)	.82
> 4 days	111 (36.3)	68 (36.8)	43 (35.5)	
Medical Condition Index				.92
0 Conditions	90(29.4)	54 (29.2)	36(29.8)	
≥ 1 Conditions	216 (70.6)	131(70.8)	85 (70.2)	
Body Mass Index				
< 22	59 (19.3)	32(17.3)	27 (22.3)	.07
22-29.9	139 (45.4)	94(50.8)	45 (37.2)	
≥ 30	108 (35.3)	59 (31.9)	49 (40.5)	
Pain				
No Pain	205 (67)	132 (71.4)	73 (60.3)	.04
Any (≥ 1)	101 (33)	53 (28.6)	50 (39.7)	

A.3.b.1. Sub-Analysis using a Higher CESD Cut-off Score

Additional analyses were completed using the CESD cut-off score of ≥ 20 for bivariate analyses. LOS remains non-significant (p=.84) but admit diagnosis was nearly statistically significant (p=.05), with a trend toward more patients with cardiopulmonary diagnosis reporting depression than those in other diagnostic group. Medical history index (p=.97) and BMI (p=.54) remained non-significant, while pain continued to be significant (p=.03). The association continued in which those without pain were more likely to report being not being depressed, while those with any pain were more likely to report being depressed.

A.4.Factors Associated with High Depressive Symptoms: Multivariate

A.4.1. Modified Poisson Regression Models

To assess risk factors associated with high depressive symptoms in hospital, we completed a modified Poisson regression analysis with results in Table 5. In Model 1, the sociodemographic variables were tested alone. Being unmarried was the only variable associated with a significantly increased risk of having high depressive symptoms (OR: 1.7; 95% CI: 1.2-2.4). In Model 2, clinical variables were added to Model 1. Again, being unmarried increased the risk of having high depressive symptoms by 70% as compared to married patients, a risk that was virtually unchanged in the fully adjusted model. Having any level of ADL limitation (compared to no limitation) increased the odds of having high depressive symptoms by 60%. No other model variables were statistically significant. Although not statistically significant, being Hispanic (compared to white) was protective against risk of being depressed (p=.06).

Table 5. Modified Poisson regression models assessing sociodemographic and clinical characteristics associated with risk of having high depressive symptoms in hospital (N=306).

		Model 1 OR (95% CI)	Model 2 OR (95% CI)
Age (≥ 75 yr vs. 65-74)		1.3 (.96-1.63)	1.2 (.97-1.60)
Female (vs. male)		1.2 (.89-1.65)	1.2 (.85-1.56)
Unmarried (vs. married)		**1.7 (1.17-2.40)**	**1.7 (1.16-2.37)**
Hispanic (vs. white)		.55 (.28-1.04)	.58 (.32-1.04)
Black (vs. white)		.90 (.65-1.23)	.98 (.73-2.43)
White		1.0	1.0
<12 yr ed (vs. 12)		1.2 (.86-1.76)	1.2 (.86 -1.69)
>12 yr ed (vs. 12)		1.1 (.79-1.57)	1.1 (.79-1.55)
12 yr ed		1.0	1.0
Length of stay (≤ 4 days vs. > 4 days)		*	1.1(.85-1.43)
Medical Condition Index (0 vs ≥ 1)		*	1.0 (.76-1.31)
Low BMI (vs. high)		*	1.1 (.81-1.52)
Normal BMI (vs. high)		*	.76 (.56-1.04)
High BMI		*	1.0
Pain (Any vs. none)		*	1.2 (.89-1.51)
ADL Limitations (Any vs. none)		*	**1.61 (1.21-2.13)**

B. Overview of Three-Month Follow-up Depressive Symptoms

B.1. Distribution of CESD Scores

The histogram in Figure 14 illustrates the distribution of CESD scores at the 3 month follow-up. The median CESD score was 4, mean: 5.9 and mode: 1.

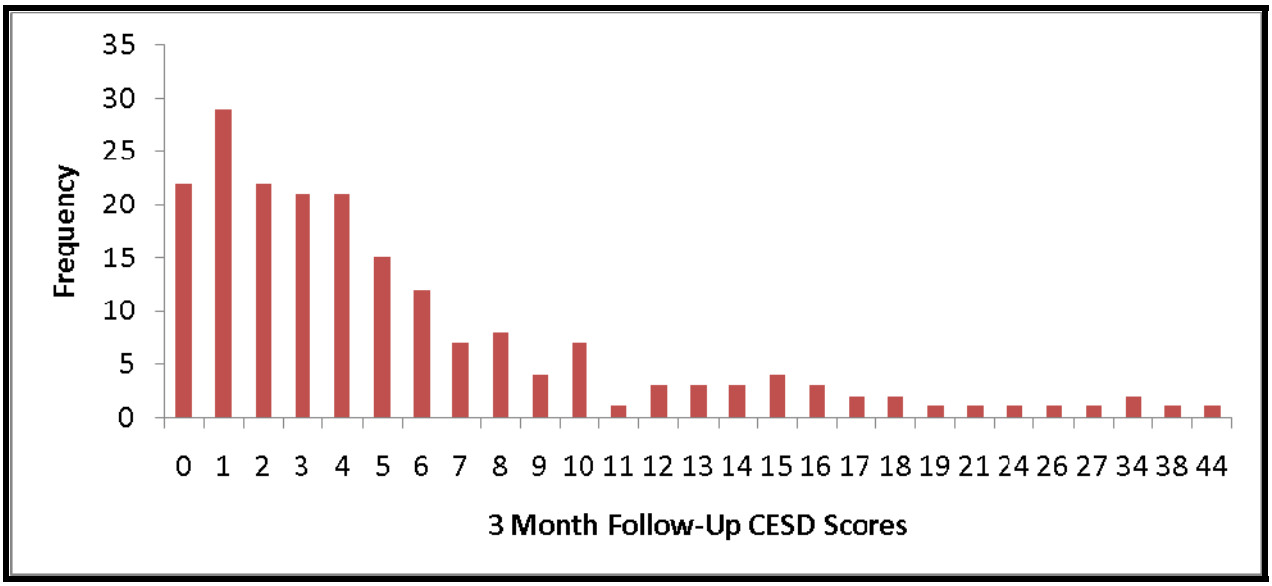
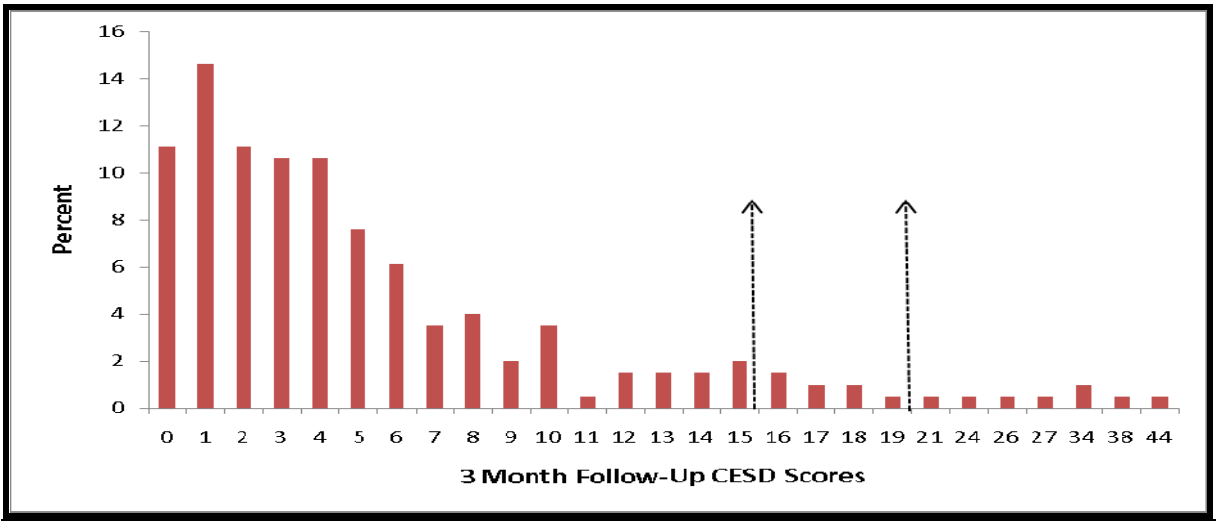


Figure 14. Frequency distribution of 3 month follow-up CESD scores (N=198).

B.2. Prevalence of High Depressive Symptoms

We again determined the prevalence of high depressive symptoms at the 3 month follow-up using 2 different cut-off scores for the CESD as shown in Figure 15. Using the ≥ 16 cut-off score, we found a prevalence of high symptoms of 8% (16/198). To replicate the admission analysis, we also used the ≥ 20 cut-off score, finding a prevalence of high symptoms of 4% (8/198). The difference between prevalence of high depressive symptoms in hospital (39.5%) and at follow-up (8%) was statistically significant ($p<.0001$).



	Count	Percent
Not depressed (< 16)	182	92.0
Depressed (≥ 16)	**16**	**8**
Not Depressed (< 20)	190	96.0
Depressed (≥ 20)	**8**	**4.0**

Figure 15. Prevalence of depression at 3 month follow-up using two different CESD cut-off points (N=198).

B. 3. Factors Associated with Depressive Symptoms: Bivariate

B.3.a. Sociodemographic Characteristics

Table 6 details the bivariate associations between groups with high and low depressive symptoms at follow-up by the sociodemographic variables of age, gender, marital status, ethnicity and education. No differences existed between follow-up groups by age (p=.47), ethnicity (p=.34), gender (.43), marital status (p=.11) or education level (p=.09) using chi-square analysis or the Fisher's Exact test as indicated. However, when t-tests were performed using the continuous depression scores stratified by marital status, significant between group differences existed, such that those who were married were less likely to have high depressive symptoms at follow-up (p=.004).

Table 6. Sociodemographic characteristics of sample by high and low depressive symptoms at the 3 month follow-up (N=198).

	Total Sample (N=198) n (%)		Low Depressive Symptoms (n=182) n (%)	High Depressive Symptoms (n=16) n (%)	p-value
Age (years) Mean [SD]	75.2 [7.5]		74.0 [7.5]	72.4 [7.8]	.47*
65-74	103 (52.0)		98 (53.8)	5 (31.3)	
≥ 75	95 (48.0)		84 (46.2)	11(68.7)	
Gender					.59
Male	80 (40.4)		75 (41.2)	5 (31.3)	
Female	118 (58.8)		107 (58.8)	11 (68.7)	
Marital Status					.11
Married	76 (38.4)		73 (40.1)	3 (18.7)	
Unmarried	122 (61.6)		109 (59.9)	13 (81.3)	
Ethnicity					.34
White	128 (64.6)		115 (63.2)	13 (81.2)	
Black	51 (25.8)		48 (26.4)	3 (18.8)	
Hispanic	19 (9.6)		19 (10.4)	0 (0)	
Education					.09
< 12 years	56 (28.3)		55 (30.2)	1 (6.3)	
= 12 years	61 (30.8)		54 (29.7)	7 (43.7)	
> 12 years	81 (40.9)		73 (40.1)	8 (50.0)	

All analyses are Fisher's Exact test except those indicated with * which are student's t-test.

B.3.a.1. Sub-Analysis using a Higher CESD Cut-off Score

Bivariate analyses were repeated using the CESD cut-off score of ≥ 20. Using Fisher's Exact tests, gender (p=.47), ethnicity (p=.62), age (p=.15), marital status (p=.71) and years of school (p=.44) were not significantly associated with follow-up depression. These results showed that, despite a change in depression cut-off, no

sociodemographic variables were associated with high depressive symptoms at follow-up. However, when a student's t-test was used to analyze continuous CESD scores using the ≥ 20 cut-off point, the difference between the married and unmarried groups continued to be significant (p=.003). The relationship held in which unmarried patients were more likely to report high depressive symptoms and the married were more likely to report low depressive symptoms.

B.3.b. Clinical Characteristics

Table 7 details the bivariate associations between groups with low and high depressive symptoms at follow-up by the clinical variables of LOS, medical history index, BMI, hospital pain, and hospital ADL status. No differences existed between groups by LOS (p=.58), medical history (p=.56) or BMI (p=.47) using chi-square analysis or the Fisher's Exact test as indicated. Hospital pain was borderline statistically significant (p=.05), describing the same relationship between hospital pain and follow-up depression as in the in hospital analysis. People without pain in the hospital were less likely to report low depressive symptoms while people with pain in the hospital were more likely to report high depressive symptoms at follow-up. A statistically significant difference did exist between groups by hospital ADL status (p=.02). Those without hospital ADL limitations were less likely to report high depressive symptoms, while those with hospital ADL limitations are more likely to report high symptoms at follow-up.

Table 7. Clinical characteristics of sample by low and high depressive symptoms at the 3 month follow-up (N=198).

	Total Sample (N=198) n(%)		Low Depressive Symptoms (N=182) n (%)	High Depressive Symptoms (N=16) n (%)	p -value
Length of Stay (days)					
≤ 4	136 (68.7)		126 (69.2)	10 (62.5)	.58
> 4	62 (31.3)		56 (30.7)	6 (37.5)	
Medical Condition Index					
0 Conditions	57 (28.8)		54 (29.7)	3(18.8)	.56*
≥ 1 Conditions	141 (71.2)		128(70.3)	13 (81.2)	
BMI					
< 22	33 (16.7)		29(15.9)	4 (25)	.47*
22-29.9	95 (48.0)		87(47.8)	8 (50)	
≥ 30	70 (35.3)		66 (36.3)	4 (25)	
Pain					
No Pain	131 (66.1)		124 (68.1)	7(43.7)	.05
Any (≥ 1)	67 (33.8)		58 (31.8)	9 (56.3)	
ADL					
No Deficits	137 (69.2)		132 (72.5)	5 (31.2)	.0006
≥ 1 Deficit	61(30.8)		50(27.5)	11 (68.8)	

All analyses are chi-square analysis except those indicated with * which are Fisher's Exact tests.

B.3.b.1. Sub-Analysis using a Higher CESD Cut-Off Score

Bivariate analyses were repeated using the CESD cut-off score of ≥ 20. Using Fisher's Exact tests, we found no significant differences between groups with low and high depressive symptoms for the variables of LOS (p=.70), medical history index (p=.69), pain (p=.44) and BMI (p=.27). Hospital ADL limitations remained significant (p=.0008). The relationship held in which those without hospital ADL deficits were more likely to report low depressive symptoms and those with hospital ADL deficits were more likely to report high depressive symptoms at follow-up.

B.4. Factors Associated with High Depressive Symptoms: Multivariate

B.4.a. Linear Regression Model

Table 8 describes the extent to which study variables were associated with the continuous CESD score at follow-up. Class statements were used for ethnicity and amount of schooling in Model 1; class statements for BMI were added to Model 2. Sociodemographic variables were tested in Model 1. Being married was significantly associated with a decrease in the follow-up CESD score, as compared to being unmarried (b= -.44; SE=.17; p=.009). In Model 2, being married continued to be associated with a lower CESD score (b= -.34; SE=.18; p=.04). The follow-up ADL score (continuous) was also associated with follow-up CESD, in which an increase in the ADL score (more disability) was associated with an increase in the follow-up CESD score (b=.17; SE=.05; p=.03). Finally, the continuous hospital CESD score was also significantly associated with the follow-up CESD score (b=.04; SE=.01; p<.001), with a higher hospital score predicting a higher follow-up score.

Table 8. Linear regression model using a negative binomial distribution to assess sociodemographic and clinical variables associated with follow-up CESD score (n=198).

	Model 1				Model 2		
	b	SE	p		b	SE	p
Age (≥ 75 yrs vs. 65-74)	.20	.16	.22		.04	.17	.81
Male (v. female)	-.19	.17	.24		-.12	.17	.49
Married (v. not married)	**-.44**	**.17**	**.009**		**-.34**	**.18**	**.04**
Hispanic (v. White)	-.39	.30	.19		-.03	.29	.29
Black (v. White)	-.07	.19	.69		.04	.19	.82
White	0.0	*	*		0.0	*	*
< 12 yr ed (v. > 12)	.04	.20	.86		-.03	.19	.86
12 yr ed (v. > 12)	.02	.19	.92		-.03	.42	.84
> 12	0.0	*	*		0.0	*	*
BMI (< 22 vs. ≥ 30)		*			.21	.26	.40
(22-29.9 v. ≥ 30)		*			.02	.18	.89
(≥ 30)		*			0.0	*	*
Hospital Pain (Any v. none)		*			.07	.17	.72
Hospital CESD (continuous)		*			**.71**	**.04**	**<.0001**
Medical Condition Index (Any v. None)		*			-.04	.16	.78
LOS (continuous)		*			.01	.02	.33
Continuous ADL Score (Follow-up)		*			**.17**	**.05**	**.03**

C. Overview of the Trajectory of Depressive Symptoms

C.1. Change in Depressive Symptoms: Categorical

Change in depressive symptoms was analyzed by the categorical variables, low and high depressive symptoms. Four categories for the course of depressive symptoms were possible by the 3 month follow-up. Two categories represented a course of depressive symptoms in which no change occurred (high to high symptoms and low to low symptoms) and two categories represented change in the course of depressive symptoms (low to high and high to low symptoms).

Table 9 describes the level of depressive symptoms at the 3 month follow-up interview. Of the 198 patients analyzed at follow-up, 36.9% (73/198) reported high depressive symptoms in hospital. At follow-up, 82.2% (60/73) reported low depressive symptoms and 17.8% (13/73) reported high symptoms. Conversely, in hospital, 63.1% (125/198) of patients reported low depressive symptoms. Of those, 2.4% (3/125) reported high symptoms at follow-up and 97.6% (122/198) reported low symptoms.

Table 9. Change in depressive symptoms at the 3 month follow-up (N=198).

Hospital Depressive Symptoms	Follow-Up Depressive Symptoms		
	High Depressive Symptoms	Low Depressive Symptoms	Total
High Depressive Symptoms	13	60	73
Low Depressive Symptoms	3	122	125
Total	16	182	198

C.2. Change in Depressive Symptoms: Continuous CESD score

Change in depressive symptoms was assessed categorically in the last section. Now the results of change in the continuous CESD score are presented by creating a continuous CESD change variable. The follow-up CESD score was subtracted from the hospital CESD score to produce the continuous CESD change variable. A positive

score indicates fewer depressive symptoms at follow-up compared to in hospital, while a negative score indicates more depressive symptoms reported at the 3 month follow-up. Distribution of the CESD change variable is illustrated in Figure 16. The mean CESD change score was 8 (SD: 9.7; range -15-40).

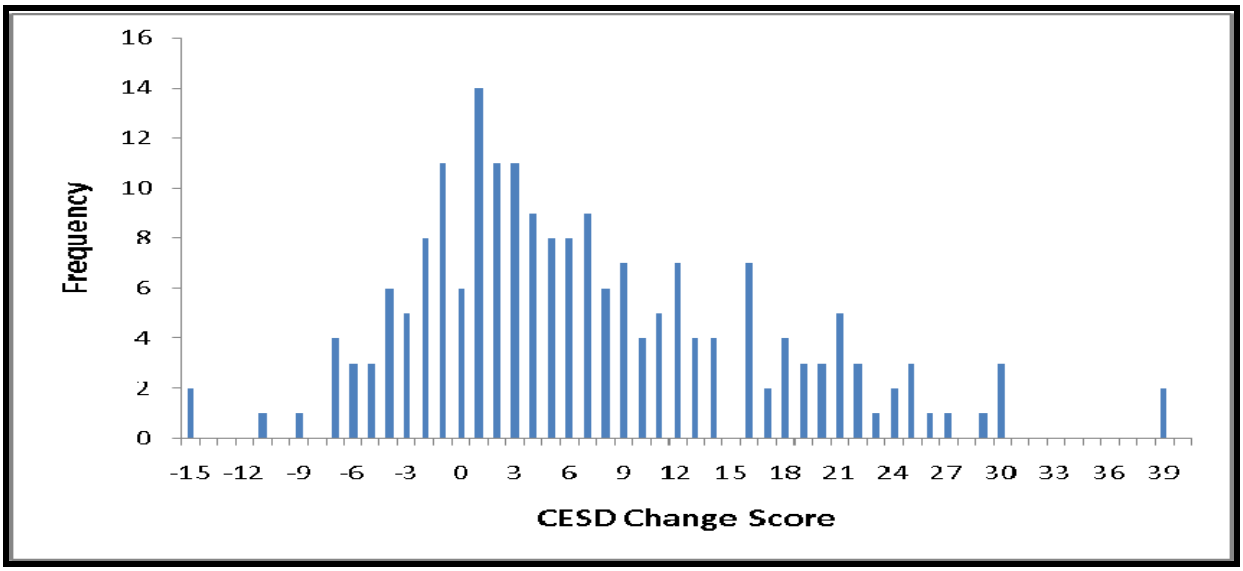


Figure 16. Frequency distribution of the CESD change score (N=198).

C.5. Factors Associated with Change in CESD Score: Bivariate

To assess differences in change in CESD score by sociodemographic and clinical variables, a new categorical variable was developed which divided CESD change into the 3 potential pathways: no change in score (n=11), worsening of symptoms (n=33) and improvement in symptoms (n=154). For this analysis, a dichotomous ADL outcome score was also developed for the outcomes of same or improved ADL (n=178) or worsened ADL (n=20). Fisher's exact test analyses were performed to assess for between group differences in sociodemographic and clinical variables and has been described in Table 10. Variables associated with change in CESD score were LOS (p=.04) and change in ADL (p=.01). Interpreted, those with a LOS higher than the mean (> 4 days) were more likely to have the same CESD score at the 3 month follow-up compared to those with a LOS ≤ 4 days and those with a worsened ADL score were more likely to have higher depressive symptoms at follow-up.

Table 10. Sociodemographic and clinical characteristics associated with change in CESD (N=198).

	3 Month Follow –Up Sample (N=198) n (%)		Higher Depressive Symptoms (n=33) n (%)	Lower Depressive Symptoms (n=154) n (%)	No Change in Depressive Symptoms (n=11) n (%)	p-value
Age (in years)						
65-74	103(52.0)		13 (39.4)	82 (53.3)	8 (72.7)	.14
≥ 75	95 (48.0)		20 (60.6)	72 (46.7)	3 (27.3)	
Gender						
Male	80 (40.4)		13 (39.4)	61 (39.6)	6 (45.6)	.63
Female	118 (59.6)		20 (60.6)	93 (60.4)	5 (54.5)	
Marital Status						
Married	76 (38.4)		12 (36.4)	57 (37.0)	7 (63.6)	.23
Unmarried	122 (61.6)		21 (63.6)	97 (63.0)	4 (36.4)	
Ethnicity						
White	128 (64.7)		22 (66.7)	102 (66.2)	4 (36.4)	.21
Black	51 (25.7)		9 (27.3)	36 (23.4)	6 (54.5)	
Hispanic	19 (9.6)		2 (6.0)	16 (10.4)	1 (9.1)	
Education (in years)						
>12	56 (28.3)		7 (21.2)	47 (30.5)	2 (18.2)	.12
=12	61 (30.8)		16 (48.5)	43 (27.9)	2 (18.2)	
>12	81 (40.9)		10 (30.3)	64 (41.6)	7 (63.6)	
BMI						
< 22	33 (16.7)		6 (18.2)	26 (16.9)	1 (9.1)	.79
22-22.9	95 (48.0)		16 (48.5)	75(48.7)	4 (36.4)	
≥ 30	70 (35.3)		11 (33.3)	53 (34.4)	6 (54.5)	
Medical Condition Index	57 (28.8)		7 (21.2)	48 (31.2)	2 (18.2)	.46
0 Conditions	141 (71.2)		26 (78.8)	106 (68.8)	9 (81.8)	
≥ 1 Condition						
Pain						
None	131 (66.2)		23 (69.7)	100 (64.9)	8 (72.7)	.81
Any (1-10)	67 (33.8)		10 (30.3)	54 (35.1)	3 (27.3)	
Length of Stay						
≤ 4	136 (68.7)		21 (63.6)	111 (72.1)	4 (36.4)	.04
> 4	62(31.3)		12 (36.4)	43 (27.9)	7 (63.4)	
Change in ADL						
Same or improved	178 (89.9)		25 (75.8)	143 (92.9)	10 (90.9)	.01
Worse	20 (10.1)		8 (25.2)	11 (7.2)	1 (9.1)	

C.5. a. Simple Linear Regression: CESD Change Score and ADL Change Score

Further exploration of the relationship between change in ADL and change in depressive symptoms was performed. A continuous ADL change score was created by subtracting the follow-up ADL score from the hospital ADL score. A positive ADL change score indicated improvement in ADL function, whereas a negative ADL change score indicated a worsening of ADL function at follow-up. To assess the univariate relationship between change in ADL score and change in CESD score, a simple linear

regression was performed and illustrated in Figure 17. A positive relationship was identified which suggested that as the ADL change score increased, the CESD score change also increased. (p=.02)

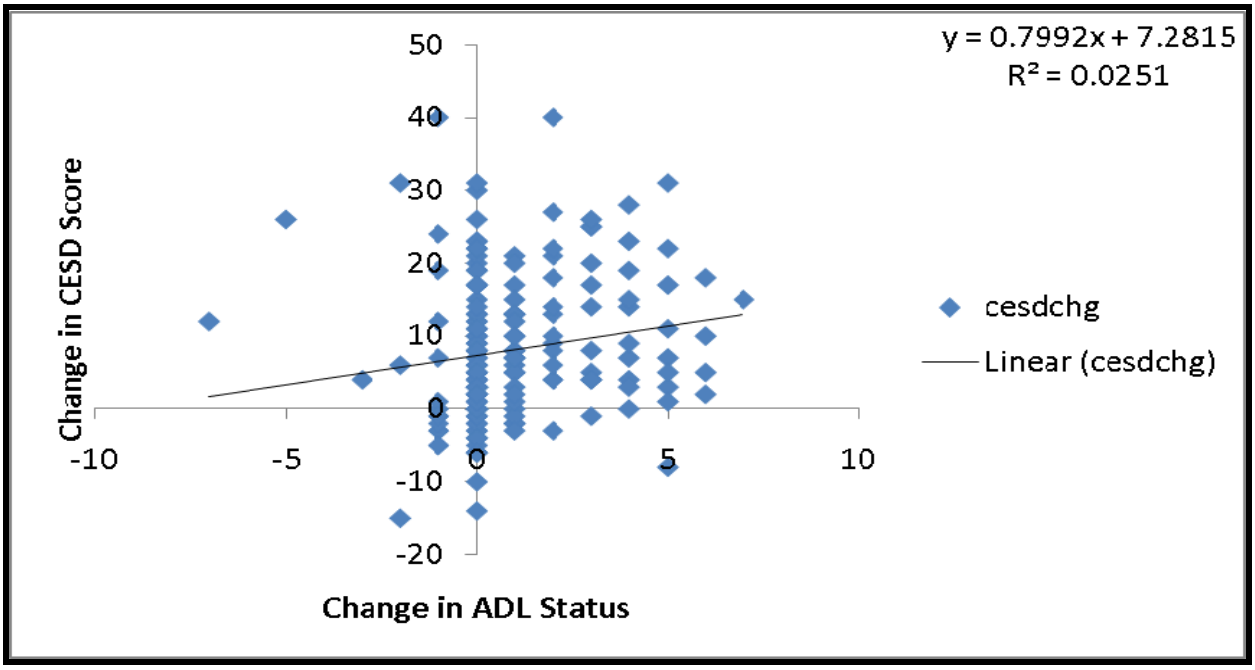


Figure 17. Scatter plot illustrating the relationship between change in hospital CESD score and change in ADL status (n=198).

C.6. Factors Associated with Change in CESD Score: Multivariate

C.6.a. Background for Analysis

A linear regression model was chosen to assess factors that predict change in the continuous CESD score. Prior to this analysis, multi-collinearity diagnostics were performed. Acceptable limits were set and met for the condition index (<20). The test for normality was not met (Shapiro-Wilk p-value <.0001); despite removal of several outliers, the normality assumption necessary for linear regression was not achieved. Therefore, linear regression analysis was performed followed by logistic regression analysis of a new dichotomous outcome. The previous categorical CESD change, which was divided into 3 categories, no change, improvement of depressive symptoms and worsening of depressive symptoms, was modified. Patients reporting no change were dropped from the analysis as lack of change could capture those who were depressed

and non-depressed at the two time points and such patients were not appropriate to combine with either group, leaving 189 patients for the logistic regression sample size.

C.6.b. Linear Regression Models

Table 11 describes the extent to which study variables predict change in the continuous CESD change score. Class statements were used for ethnicity, school and BMI. In model 1, sociodemographics were tested for significance in predicting change in CESD score. While none of the associations were statistically significant, a trend emerged in which the older age group (≥ 75 years) was associated with a lower change score compared to the younger age group (b= -3.3; SE=1.4; p=.05). In the fully adjusted model, age was not significant and the only variable significant for predicting CESD change at the 3 month follow-up was hospital CESD score (b=.71; SE=.05; p<.0001). ADL change score (b= -1.68, SE=.96; p=.08) and marital status (b=1.7; SE=.99; p=.08) were nearly significant. Interpreted, a non-significant trend appeared where a worsening ADL score was associated with a lower CESD change score and being married was associated with a higher CESD change score.

Table 11. Linear regression model assessing sociodemographic and clinical variables that predict change in CESD (n=198).

	Model 1				Model 2		
	b	SE	p		b	SE	p
Age ≥ 75 years (v. 65-74)	-3.3	1.4	.05		-1.44	.98	.14
Male (v. female)	-1.5	1.5	.34		.36	1.0	.72
Married (v. not married)	1.3	1.6	.42		1.8	.99	.08
Hispanic (v. White)	-3.0	2.6	.24		.57	1.64	.72
Black (v. White)	-1.1	1.7	.52		-.38	1.1	.74
White	0.0	*	*		0.0	*	*
< 12 years education (v. >12)	-1.5	1.8	.42		-.27	1.1	.81
12 years education (v. >12)	-2.8	1.7	.10		-.64	1.1	.56
>12	0.0	*	*		0.0	*	*
BMI (< 22 vs. ≥ 30)		*			-1.67	1.45	.25
(22-29.9 v. ≥ 30)		*			.31	1.0	.76
≥ 30)		*			0.0	*	
Hospital Pain (Any v. none)		*			-.77	.95	.42
Hospital CESD (continuous)		*			**.71**	**.04**	**<.0001**
Medical Condition Index (Any v. None)		*			-.12	.99	.90
LOS (continuous)		*			-.17	.13	.21
ADL Change (Worse vs. Improved or Same)		*			-1.68	.96	.08

C.6.c. Logistic Regression Models

Logistic regression models were used to assess factors associated with the likelihood of having positive change in CESD score at the 3 month follow-up. To begin, CESD change was divided into 3 categories: no change (n=11), improvement of depressive symptoms (n=154) and worsening of depressive symptoms (n=33). Patients reporting no change were dropped from the analysis as lack of change captured those who had either high or low depressive symptoms at the two time points and therefore were not appropriate to combine with either group, leaving 189 patients for the logistic regression models. Findings are shown in Table 12. In model 1, change in ADL was tested alone. Results show that those with a positive change in ADL were 2.8 times more likely to be categorized with a positive change in CESD score.

In model 2, sociodemographic variables were added to positive change in ADL. Again, being categorized with a positive change in ADL nearly quadrupled the odds of being categorized into a positive CESD change category over those with a negative change in ADL. Also, having < 12 or > 12 years of education tripled the odds of having a positive change score compared to patients with 12 years of education.

In model 3, clinical variables were added to previously established models. With new covariates in the model, patients with a positive change in ADL were 2.7 times more likely to have a positive CESD change score. Patients with less than 12 years of education and those with more than 12 years of education continued to be more likely to have a positive change score, 2.8 and 2.7 times respectively, than those with exactly 12 years of education. Last, a one point increase in hospital CESD score resulted in 13% higher odds of having a positive change score.

Table 12. Logistic regression models assessing sociodemographic and clinical characteristics associated with having a positive change in CESD score (v. negative change) (N=189).

	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)
Improved ADL Change Score (v. worse score)	**2.8 (1.14 -6.80)**	**3.9 (1.47-10.53)**	**2.7 (1.07-6.74)**
Age ≥ 75 years (v. 65-74)	*	.44 (.19-1.03)	.54 (.23-1.28)
Male gender (v. female)	*	1.4 (.57 – 3.33)	1.69 (.72-3.92)
Married (v. unmarried)	*	.89 (.36 - 2.18)	.97 (.42-2.24)
Hispanic (v. white)	*	1.7 (.32-9.34)	2.6(.58-11.45)
Black (v. white)	*	.96 (.37-2.48)	1.16(.44-3.06)
White	*	1.0	1.0
< 12 years education (v. = 12)	*	**3.1 (1.07-8.92)**	**2.8 (1.01-7.70)**
> 12 years education (v. =12)	*	**3.3 (1.25-9.0)**	**2.7 (1.02-7.08)**
=12 years of education	*	1.0	1.0
Medical Condition Index (Any vs. None)	*	*	.78 (.31-1.94)
LOS (> 4 v. ≤ 4)	*	*	.70 (.29-1.67)
Pain (≥ 1 v. 0)	*	*	1.07 (.46-2.50)
CESD Score (Continuous)	*	*	**1.13(1.06-1.19)**

SPECIFIC AIM 2

Determine the trajectory of ADL function from hospitalization to 3 months post discharge. Prevalence estimates in hospital and post-discharge, as well as change in ADL function will be explored by relevant sociodemographic and clinical characteristics such as age, gender, ethnicity, pain and depression.

A. Overview of Hospital ADL Status

A. 1. Prevalence of ADL Disability

Figure 18 illustrates the ADL status of the 306 patients analyzed at admission. Over 54% of the sample reported at least one limitation while 45% reported no limitations. Of the 167 patients with ADL limitations, 52% (87/167) reported ≥ 3 limitations and 48% (80/167) reported 1-2 ADL limitations. The mean ADL score was 1.6, which can be interpreted as nearly 2 ADL limitations per patient on average (SD: 2.2; range 0-7).

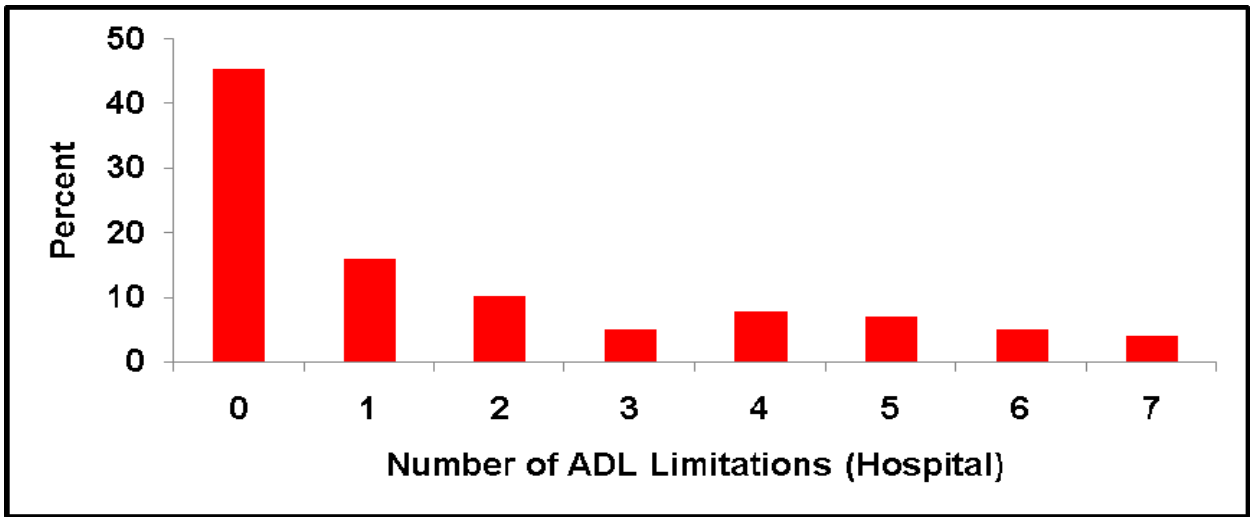


Figure 18. Percent reporting ADL limitations in hospital (N=306).

A.2. Prevalence of ADL Disability by ADL Category

To further assess prevalence of disability, each individual ADL category was analyzed for prevalence of disability within categories as shown in Figure 19. More patients reported needing assistance with bathing than any other ADL, with 39.2% reporting some level of disability. Toileting was the second most occurring disability at 25.2%, followed by dressing (20.6%), grooming (13.1%) and eating (7.5%).

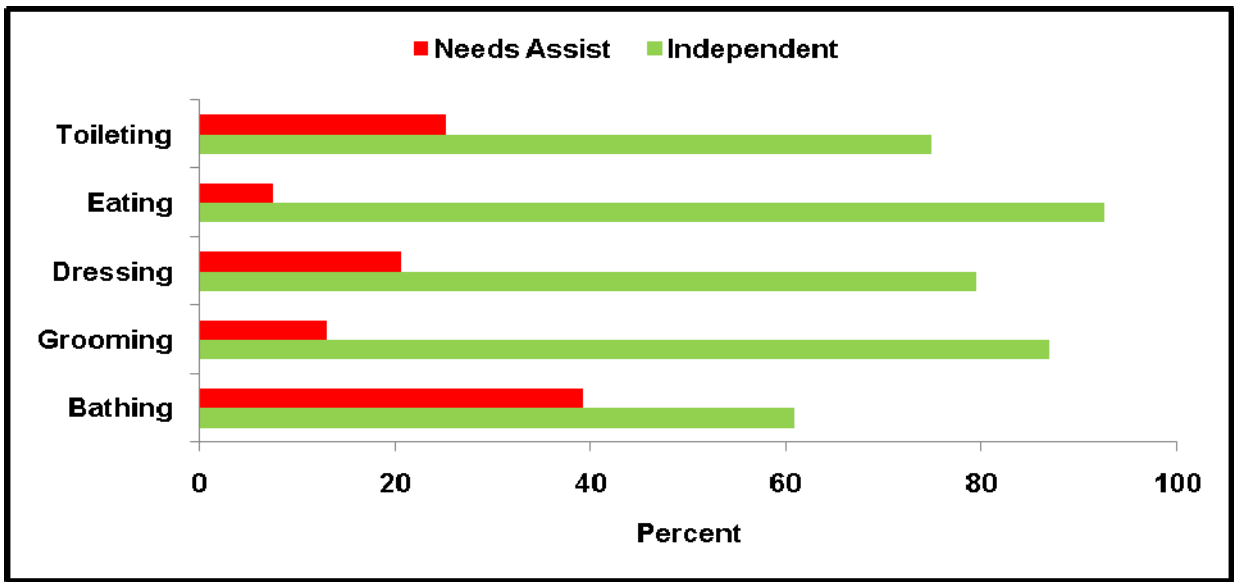


Figure 19. Prevalence of ADL disability by ADL category.

A.3. Factors associated with ADL Status: Bivariate

Chi-square analyses were performed to examine between group differences in patients with at least one ADL limitation and those with no limitations by sociodemographic and clinical characteristics (see Table 13). In hospital, no sociodemographic variable was significantly associated with ADL at the $p < .05$ level. However trends existed that were borderline significant and mention noting. Adults ≥ 74 years were more likely to have at least one ADL limitation as compared to those < 74 years, with younger patients more likely to report no ADL limitations (p=.09). Likewise, patients who reported no pain in hospital were more likely to report no ADL limitations (p=.05). Finally, those with low depressive symptoms were more likely to report no ADL limitations, while those with high depressive symptoms were more likely to report ≥ 1 ADL limitation (p=.0002).

Table 13. Sociodemographic and clinical variables associated with hospital ADL status (N=306).

Sociodemographic and Clinical Characteristics	Total Sample (N=306) n (%)	Hospital ADL Status: No Limitations (n=139) n (%)	Hospital ADL Status: ≥ 1 Limitation (n=167) n (%)	p-value
Age (years)				
65-74	149 (48.7)	75 (53.9)	74 (44.3)	.09
≥ 75	157 (51.3)	64 (46.1)	93(55.7)	
Gender				
Male	128(41.8)	64(46.0)	64 (38.3)	.17
Female	178 (58.2)	75(54.0)	103(61.7)	
Race				
White	203(66.3)	92 (66.2)	111 (66.4)	.50
Black	73 (23.9)	36 (25.9)	37 (22.2)	
Hispanic	30 (9.8)	11(7.9)	19 (11.4)	
Marital Status				
Married	113 (36.9)	58(41.7)	55 (32.9)	.11
Unmarried	193 (63.1)	81 (58.3)	112 (67.1)	
Education (yrs)				
< 12	92 (30.1)	38 (27.3)	54 (32.34)	.16
12	91 (29.7)	37 (26.6)	54(32.34)	
> 12	123 (40.2)	64 (46.1)	59 (35.33)	
BMI				
< 22	59 (19.3)	27(19.4)	32(19.2)	.97
22-29.9	139 (45.4)	64 (46.0)	75(44.9)	
≥ 30	108 (35.3)	48 (34.6)	60 (35.9)	
Pain				
None	205 (67.0)	101(72.7)	104 (62.3)	.05
Any (≥ 1)	101 (33.0)	38 (27.3)	46 (37.7)	
Depressive Symptoms				
Low	185 (60.5)	129 (68.6)	56 (47.5)	.0002
High	121 (39.5)	59 (31.4)	62 (52.5)	

A.4. Factors Associated with ADL Status: Multivariate

A.4. a. Logistic Regression Models

To assess risk factors associated with having ADL limitations in hospital, we constructed a logistic regression analysis with results shown in Table 14. In Model 1, sociodemographic variables were tested alone. Being younger (65-74 v. ≥75 years) was significantly associated with a decreased risk of having at least one ADL limitation (OR: .52; 95% CI: .30-.90). In Model 2, clinical variables were added to Model 1. Again, those

younger had a 62% decreased risk of being categorized with at least one ADL limitation than older patients. Furthermore, patients who were depressed were 2.5 times more likely to have an ADL limitation than those who were not depressed. All other model variables were statistically non-significant.

Table 14. Logistic regression models assessing sociodemographic and clinical characteristics associated with having at least one ADL limitation in hospital (vs. no limitations). (N=198).

	Model 1 OR (95% CI)	Model 2 OR (95% CI)
Age 65-74 (v. ≥ 75) (yrs)	**.52 (.30-.90)**	**.39 (.21-.69)**
Female (vs. male)	1.4 (.80-2.60)	1.4 (.77-2.65)
Married (v. unmarried)	1.1 (.57-1.9)	1.2 (.65-2.33)
Hispanic (vs. white)	1.2 (.45-3.0)	1.5 (.54-3.95)
Black (vs. white)	.78 (.41-1.5)	.83 (.42-1.66)
White	1.0	1.0
< 12 years education (vs. 12)	1.1 (.56-2.3)	.98 (.48 -2.03)
> 12 years education (vs. 12)	.69 (.35-1.4)	.69 (.35-1.36)
12 years education	1.0	1.0
Length of stay (≤ 4 days vs. > 4 days)	*	.75 (.43-1.33)
Medical Condition Index (None v. Any)	*	.79 (.44-1.46)
Low BMI (vs. high)	*	.57 (.25-1.30)
Normal BMI (vs. high)	*	.78 (.41-1.49)
High BMI	*	1.0
Pain (Any vs. none)	*	1.7 (.94-3.09)
High Depressive Symptoms (v. low)	*	**2.6 (1.45-4.63)**

B. Overview of Three-Month Follow-up ADL Status

B.1. Prevalence of ADL Disability

By the 3 month follow-up, the number of those reporting ADL disability was significantly reduced (p<.0001). The percent of the sample reporting no ADL limitation was 69.2%, while 30.8% report at least 1 ADL limitation a shown in Figure 20. Of the 61 patients reporting at least one ADL limitation, 66% (40/61) reported 1-2 limitations and 34% (21/61) reported ≥ 3 limitations in ADL. In all categories of ADL limitation, the frequency of reported limitations at follow-up was decreased. The mean ADL score was .76 (SD: 1.5; range 0-7).

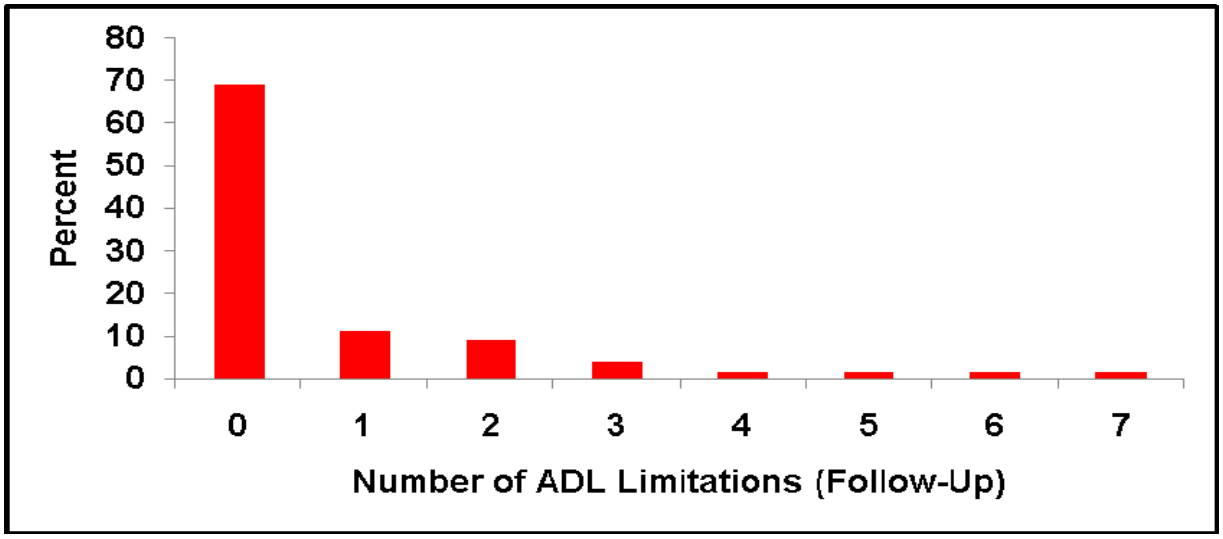


Figure 20. Percent reporting ADL limitations at 3 month follow-up (n=198).

B.2. Prevalence of ADL Disability by ADL Category

Figure 21 illustrates the prevalence of ADL disability by ADL category at the 3 month follow-up. Bathing was the most frequently reported disability (19.7%), followed by dressing (13.6%), toileting (9.1%), grooming (5.6%) and, finally, eating (2.5%). Over 80% of the sample was independent in all categories of ADL.

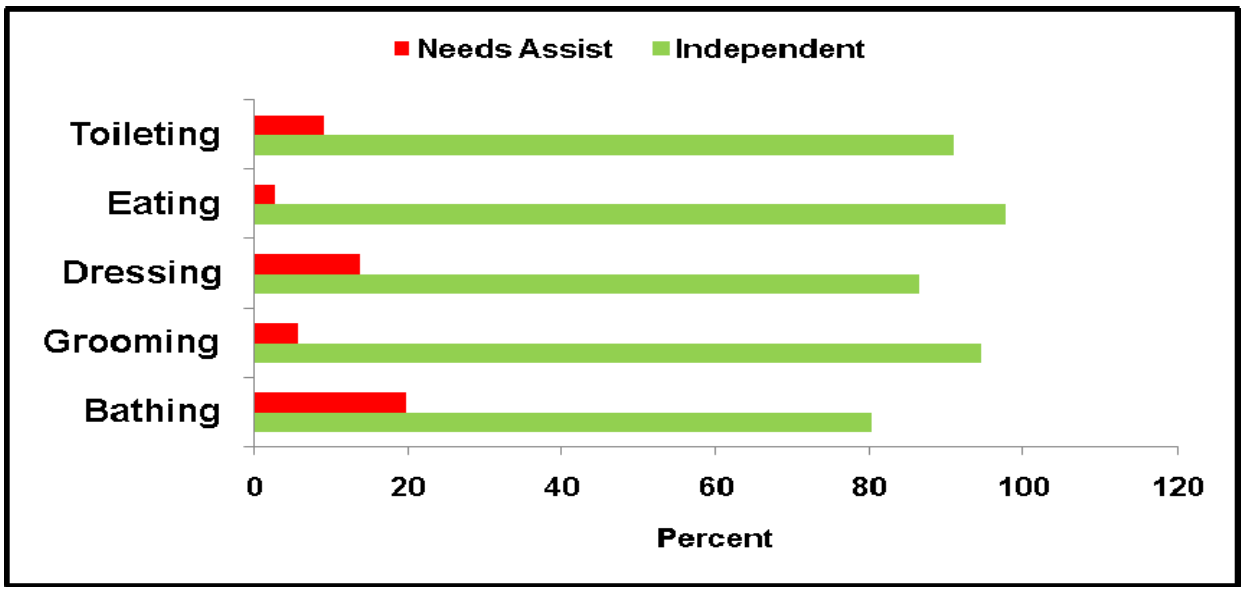


Figure 21. Prevalence of ADL disability by ADL category.

B.3. Factors Associated with ADL Status: Bivariate

Analyses were performed to assess the associations between 3 month follow-up ADL status and sociodemographic and clinical variables; see Table 15. Three months post discharge, age was significantly associated with ADL status (p=.04), revealing the same relationship in which those ≥ 75 years was more likely to report an ADL limitation than those 65-75 years and the younger group was more likely to report no ADL limitations. Gender (p=.07) was nearly statistically significant, with a trend toward females being more likely to report at least one ADL limitation. Hospital pain status (p=.0007) was now significantly associated with follow-up ADL; those with no pain in hospital were more likely to report no ADL limitations at follow-up. Hospital depression was associated with follow-up ADL status (p <.0001), with those reporting no depression in hospital more likely to have no ADL limitations post discharge and those reporting depression in hospital more likely to report follow-up ADL limitations.

Table 15. Sociodemographic and clinical characteristics associated with follow-up ADL (n=198).

Sociodemographic and Clinical Characteristics	Total Sample (N=198) n(%)	3 Month Follow-Up ADL Status		
		No Limitations (n=137) n (%)	≥ 1 Limitations (n=61) n (%)	p-value
Age (yrs)				
65-74	103(52.0)	78 (56.9)	25 (41.0)	**.04**
≥ 75	95 (48.0)	59 (43.1)	36 (59.0)	
Gender				
Male	80 (40.4)	61 (44.5)	19 (31.2)	.07
Female	118 (58.8)	76 (55.5)	42 (68.8)	
Ethnicity				
White	128 (64.6)	88 (64.2)	40 (65.6)	.63*
Black	51 (25.8)	34 (24.8)	17 (27.9)	
Hispanic	19 (9.6)	15 (11.0)	4 (6.5)	
Marital Status				
Married	76 (38.4)	55 (40.2)	21 (34.4)	.44
Unmarried	122 (61.6)	82(59.8)	40 (65.6)	
Education (yrs)				
< 12	56 (28.3)	35 (25.6)	21 (34.4)	.42
12	61 (30.8)	43 (31.4)	18 (29.5)	
> 12	81 (40.9)	59 (43.0)	22(36.1)	
BMI				
< 22	33 (16.7)	20 (14.6)	13 (21.3)	.49
22-29.9	95 (48.0)	68 (49.6)	27 (44.3)	
≥ 30	70 (35.3)	49 (35.8)	21 (34.4)	
Pain				
None	137 (69.2)	99 (72.3)	32 (52.5)	**.0007**
Any (≥ 1)	61 (30.8)	38 (27.7)	29 (47.5)	
Depressive Symptoms				
Low	125 (63.1)	112 (70.4)	13 (33.3)	**<.0001**
High	73 (36.9)	47 (29.6)	26 (66.7)	

All analyses are chi-square except where indicated by * which represents Fisher's exact test.

B.4. Factors Associated with ADL Disability: Multivariate

B.4.a. Logistic Regression Models

To assess risk factors associated with having ADL limitations in hospital, a logistic regression analysis was completed with results shown in Table 16. In Model 1, the sociodemographic variables were tested alone. Males were 67% less likely to have an ADL limitation at follow-up when compared to females (OR: .33; 95% CI: .14-.77). In

Model 2, relevant clinical characteristics were added to the model. Males continued to show less risk for ADL limitation at follow-up by 75% (OR: .25; 95% CI:.09-.65). Other factors in the model that showed an increased risk for ADL disability included: being married (OR: 2.7; 95%CI: 1.1-6.64), having a high school education or less (compared to > 12 years) (OR: 3.3; 95% CI: 1.2-8.9), the presence of pain in the hospital (OR: 4.4; 95% CI: 1.9-10.0) and having high hospital depressive symptoms (OR: 5.7; 2.4-13.5).

Table 16. Logistic regression models assessing sociodemographic and clinical characteristics associated with the risk of having at least one ADL limitation at the 3 month follow-up.

	Model 1 OR (95% CI)	Model 2 OR (95% CI)
Age 65-74 years (v. ≥ 75)	1.1 (.52-2.2)	.89 (.39-2.1)
Male (v. female)	**.32 (.14-.78)**	**.25 (.09-.65)**
Married (v. unmarried)	1.5 (.70-3.4)	**2.7 (1.08-6.64)**
Hispanic (v. white)	.66 (.17-2.6)	.68 (.16-2.9)
Black (v. white)	.76 (.32-1.8)	1.19 (.47-3.06)
White	1.0	1.0
<12 yr ed (vs. > 12)	1.9 (.79-4.7)	**3.3 (1.22-8.96)**
=12 yr ed (vs. > 12)	1.3 (.52-3.0)	1.3 (.51-3.56)
!2 yr ed	1.0	1.0
Low BMI (v. high)	*	.67 (.84-8.0)
Normal BMI (v. high)	*	1.3 (.54-3.18)
High BMI	*	1.0
Hospital pain (Any vs. none)	*	**4.4 (1.9-10.0)**
High hospital depressive symptoms (v. low)	*	**5.7 (2.4-13.5)**

C. Overview of the Trajectory of ADL

C. 1. Change in Prevalence of ADL Disability

Change in ADL was first analyzed by a dichotomous outcome: no ADL limitations and ≥ 1 ADL limitation. Four categories for the course of ADL status were possible by the 3 month follow-up. Two no change patterns were possible where patients in hospital with no ADL limitations remained limitation free at follow-up and those with limitations in hospital continued to have limitations at follow-up. Hence, 2 change patterns were possible when those with ADL limitations in hospital reported no limitations at follow-up and those with no limitations in hospital reported limitations at the 3 month follow-up.

Table 17 outlines the course of ADL status from hospital to follow-up (n=198). Of the 36% (72/198) of the follow-up sample that reported hospital limitations, 43% (31/72) continued to report limitations at follow-up and 57% reported no limitations 3 months post-discharge. On the other hand, of the 64% (126/198) of patients reporting no limitations in hospital, 93.6% (118/126) reported no follow-up limitations and 6.4% (8/126) reported continued limitations in ADL function 3 months post-discharge.

Table 17. Course of ADL status from hospital to 3 month follow-up (N=198).

Admission ADL Status	3 Month Follow-UP ADL Status		
	Limitations	No Limitations	Total
Limitations	31	41	72
No Limitations	8	118	126
Total	39	159	198

C.1.a. Sub-Analysis: Change in Prevalence of ADL Disability across 3 Time Points

Due to missing data, previous ADL status was not included in the study to preclude loss of participants (missing prior ADL =76). However, a sub-analysis was conducted to gain information on the pattern of ADL loss and recovery throughout the study. Previous ADL was assessed by asking patients how they performed ADLs prior to hospitalization.

At follow-up, 144 had complete data for previous, hospital and follow-up ADL. Prior to hospitalization 78.5% reported no limitations in any ADL; 21.5% had some limitation in ADLs. During hospitalization, 66.7% reported no difficulty in ADLs and 33.3% reported some difficulty, as shown in Figure 22. At the 3 month follow-up, 84% reported no difficulty, indicating that 16% had some difficulty. This result demonstrates an overall trend for increased difficulty with ADLs in hospital (compared to previous difficulty with ADLs) and decreased ADL difficulty by 3 months post discharge (compared to previous and hospital ADLs).

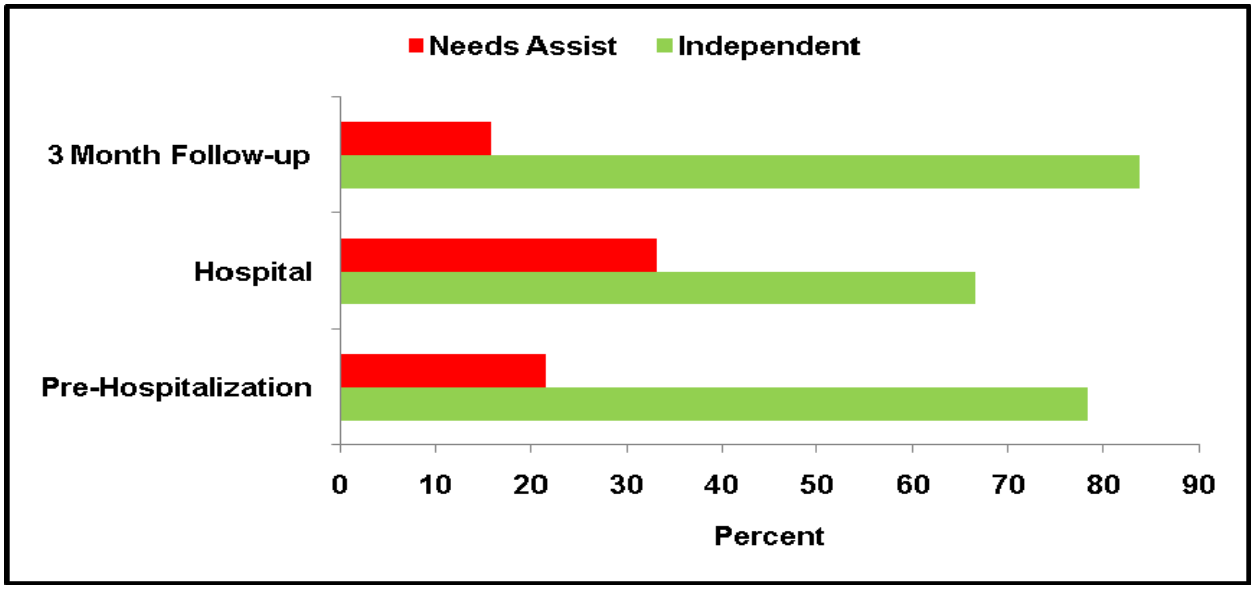


Figure 22. Prevalence of ADL disability across 3 time points (N=144).

C.1. b. Sub-Analysis: Change in Prevalence of ADL Disability by ADL Category

To inspect this relationship more closely, we assessed each subcategory of ADL by percentage reporting difficulty pre-hospitalization, during hospitalization and at 3 months post discharge, with results represented in the graph in Figure 23. More patients reported difficulty with bathing at all three time points compared to the other ADL categories. Twenty percent reported difficulty in bathing prior to hospitalization, increasing to 34.7% of the sample in hospital. The number reporting difficulty at follow-up fell below pre-hospitalization levels (17.4%).

Patients reported toileting as the second most difficult ADL to perform; abilities followed the same trajectory of worsening in hospital followed by improvement after discharge. The number of patients reporting grooming and eating disability also increased during hospitalization, but not to the extent of bathing and toileting; these also appeared to resolve after discharge. Dressing followed a slightly different course for reported disability. Prior to hospitalization, 9.0% of patients reported disability in dressing, increasing to 21.5% during hospitalization. Upon 3 month reassessment, dressing was the only ADL that did not improve over previous ADL levels, and in fact worsened by 2.1%. Taken together, these results indicate that specific ADL subcategories showed patterns of worsening during hospitalization and subsequent improvement by the 3 month follow-up assessment.

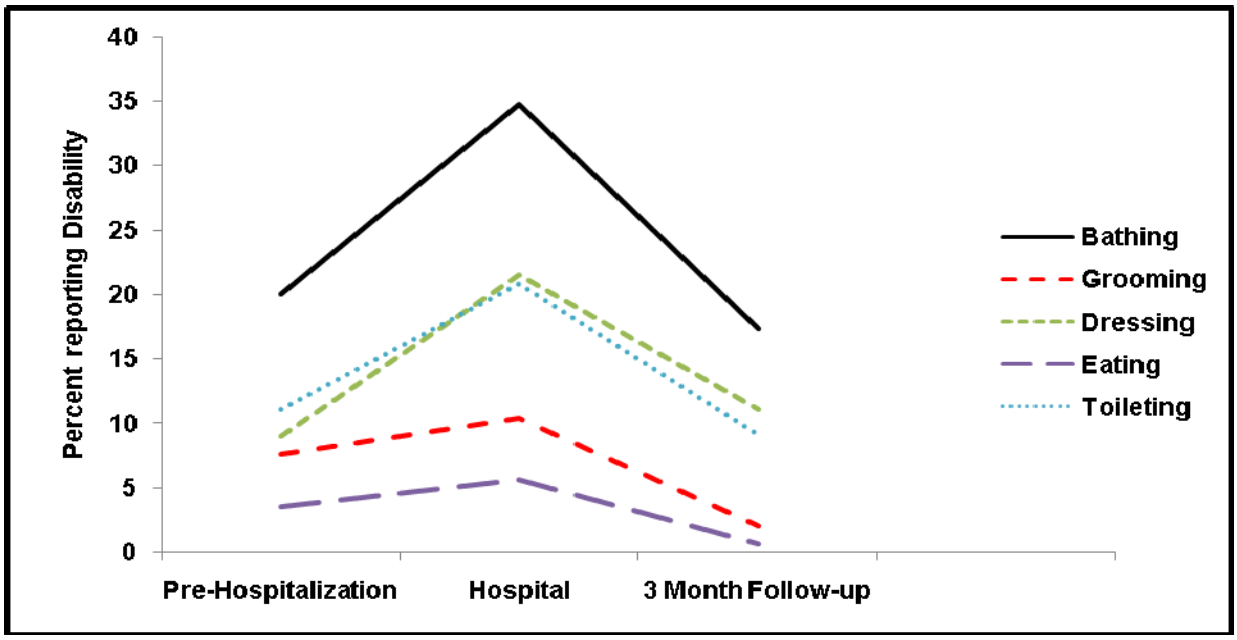


Figure 23. Percent reporting ADL disability by ADL category at three time points (N=144).

C.2. Factors Associated with Change in ADL Score: Bivariate

To assess sociodemographic and clinical characteristics associated with change in ADL score, a new categorical variable was developed which divided ADL change into the 3 potential pathways: no change in score (n=103), worsening of symptoms (n=20) and improvement in symptoms (n=75). For this analysis, a categorical CESD change

score was also developed for the outcomes of improved depressive symptoms (n=154), worsened depressive symptoms (n=33) or no change in symptoms (n=11).

Chi-square analysis or Fisher's exact test analyses were performed to assess between group differences in ADL change categories by sociodemographic and clinical characteristics; see Table 18. Variables associated with change in ADL score were age (p=.03) and change in CESD score (p=.01). Interpreted, patients aged ≥ 75 years were more likely to have a negative change in ADL score while the younger group was more likely to have no change. In terms of change in CESD score, those with fewer depressive symptoms at follow-up were more likely to have a positive change in ADL score or no change in ADL score.

Table 18. Sociodemographic and clinical characteristics associated with change in ADL (N=198).

Sociodemographic and Clinical Characteristics	3 Month Follow –Up Sample (N=198) n (%)	Negative Change in ADL (n=20) n (%)	Positive Change in ADL (n=75) n (%)	No Change in ADL Status (n=103) n (%)	p-value
Age (years)					
65-74	103(52.0)	8 (40.0)	32 (42.7)	63(61.2)	**.03**
≥ 75	95 (48.0)	12 (60.0)	43 (57.3)	40 (38.8)	
Gender					
Male	80 (40.4)	9 (45.0)	24 (32.0)	47(45.6)	.17
Female	118 (59.6)	11(55.0)	51 (68.0)	56(54.4)	
Marital Status					
Married	76 (38.4)	8(40.0)	29 (38.7)	39(37.9)	.98
Unmarried	122 (61.6)	12 (60.0)	46(61.3)	64 (62.1)	
Race					
White	128 (64.7)	22 (66.7)	102 (66.2)	4 (36.4)	.21
Black	51 (25.7)	9 (27.3)	36 (23.4)	6 (54.5)	
Hispanic	19 (9.6)	2 (6.0)	16 (10.4)	1 (9.1)	
Education (years)					
>12	56 (28.3)	6(30.0)	21(28.0)	29(28.2)	.89
=12	61 (30.8)	5 (25.0)	26(34.7)	30 (29.1)	
>12	81 (40.9)	9 (45.0)	28 (37.3)	44 (42.7)	
BMI					
< 22	33 (16.7)	5(25.0)	12 (16.0)	16 (15.5)	.79
22-22.9	95 (48.0)	9 (45.0)	34 (45.3)	52 (50.5)	
≥ 30	70 (35.3)	6 (30.0)	29 (37.7)	35 (40.0)	
Medical Condition Index					
0 Conditions	57 (28.8)	6(30.0)	20 (26.7)	31 (30.1)	.87
≥ 1 Conditions	141 (71.2)	14 (70.0)	55 (73.3)	72 (69.9)	
Hospital Pain					
None	131 (66.2)	12 (60.0)	50 (66.7)	69 (70.0)	.82
Any (1-10)	67 (33.8)	8 (40.0)	25 (33.3)	34 (33.0)	
Length of Stay (days)					
≤ 4	136 (68.7)	11 (55.0)	51 (68.0)	74 (71.8)	.33
> 4	62(31.3)	9 (45.0)	24 (32.0)	29 (28.2)	
Change in Depressive Symptoms					
Worsened	33(16.7)	8 (40.0)	7 (9.3)	18 (17.5)	**.01***
Improved	154(77.8)	11 (55.0)	66 (88.0)	77 (74.8)	
No change	11 (5.6)	1 (5.0)	2 (2.7)	8 (7.8)	

All analyses are chi-square except where indicated by * which represents Fisher's exact test.

C.3. Factors Associated with Change in ADL Score: Multivariate

C.3.a. Linear Regression Models

Table 19 describes the extent to which study variables predict change in the continuous ADL change score. Class statements were used for race, school and BMI when analyzed in the model. In model 1, sociodemographics were tested alone. Gender was statistically significant (b= -.65; SE=.30; p=.03). In the fully adjusted model, gender (b=-.59; SE=.31; p=.05) and CESD change (b=1.0: SE=.37; p=.006) were significantly associated with change in ADL score. Age (b=-.63; SE=.29; p=.09) showed a trend toward significance. Interpretation of these finding suggest that males and patients ≥ 75 years are more likely to have a lower ADL change score, whereas patients with the same or positive change in CESD (compared to negative change) have higher change scores.

Table 19. Linear regression model assessing sociodemographic and clinical variables that predict change in ADL (N=198).

	Model 1				Model 2		
	b	SE	p		b	SE	p
Age (≥ 74 vs. 65-74 years)	.38	.28	.17		-.63	.29	.09
Male (v. female)	-.65	.30	**.03**		-.63	.30	**.04**
Married (v. not married)	.29	.30	.33		.28	.31	.36
Hispanic (v. White)	-.32	.49	.51		-.23	.52	.65
Black (v. White)	.08	.33	.79		.06	.35	.86
White	0.0	*	*		0.0	*	*
< 12 yr ed (v. > 12)	-.09	.35	.78		-.13	.36	.71
12 yr ed (v. > 12)	.18	.33	.59		.16	.34	.62
>12	0.0	*	*		0.0	*	*
BMI (<22 vs. ≥ 30)		*			-.14	.45	.75
(22-29.9 v. ≥ 30)		*			-.07	.32	.83
(≥ 30)		*			0.0	*	
Hospital Pain (Any v. none)		*			-.03	.29	.89
Same or improved depressive symptoms (v. worsened)		*			1.01	.37	**.006**
Medical Condition Index (Any v. None)		*			.25	.31	.41
LOS (≤ 4 v. > 4)		*			-.18	.30	.55

SPECIFIC AIM 3

Examine the direct associations between hospital depressive symptoms and ADL function 3 months post-discharge controlling for relevant sociodemographic and clinical variables such as age, gender and pain.

A. Association between Depressive Symptoms and ADL Function: Bivariate

A.1. Hospital Depressive Symptoms and Hospital ADL Status

Figure 24 illustrates the association between hospital ADL status and hospital CESD score categories. CESD scores were trichotomized into <16 (low depressive symptoms), 16-22 (includes most published cut-off points for presence of depression and is used here to indicate mild depressive symptoms) and ≥ 23 (indicates moderate to severe depressive symptoms). In hospital, patients with low depressive symptoms have the lowest percentage (46.5%) reporting at least one ADL limitation. In the middle CESD category (16-22), 68.5% reported at least one ADL limitation, followed by the last CESD category (≥ 23) in which 65.7% reported at least one ADL limitation. The association between hospital ADL and hospital depressive symptoms was significant (p=.002); those with low depressive symptoms were more likely to report no ADL limitations and those with any level of high depressive symptoms were more likely to report ≥ 1 ADL limitation.

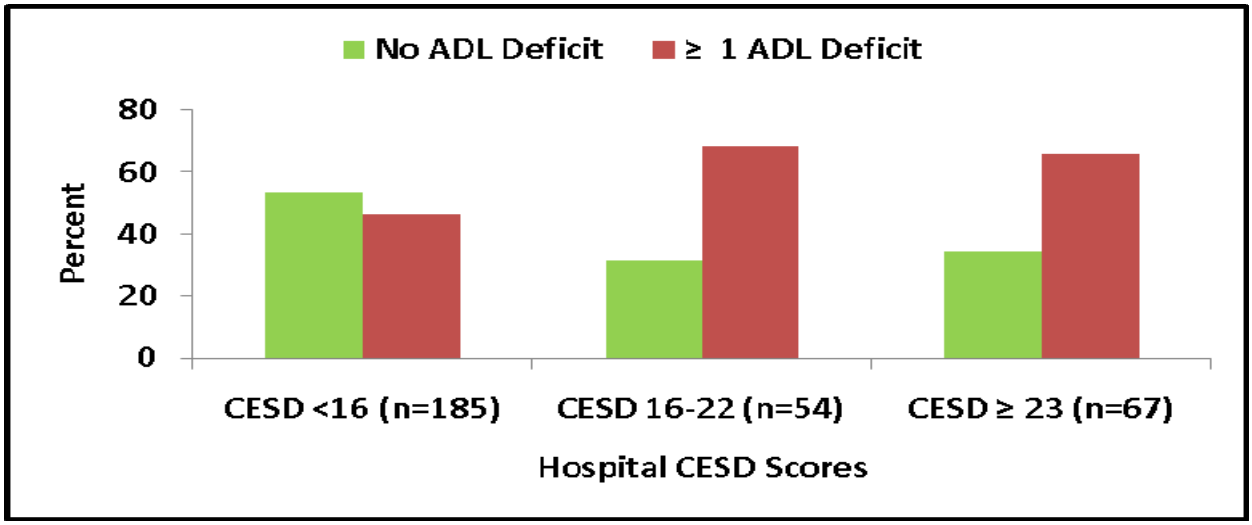


Figure 24. Hospital ADL status by hospital CESD scores (N=306).

A.2. Hospital Depressive Symptoms and 3 Month Follow-up ADL Status

Figure 25 illustrates the association between 3 month follow-up ADL status and hospital CESD score categories. In this analysis, those with low depressive symptoms (CESD <16) in hospital had the highest percentage of people reporting no ADL deficit (77.6%) and the lowest percentage reporting any ADL limitations (22.4%) at the 3 month follow-up. Of those patients in the middle category (CESD score 16-22), 60% reported no limitations and 40% reported some limitations. This pattern continued in the high CESD score category, where the percent of people reporting no limitations was lower (51.2%) and the percent of ADL limitation higher (48.8%) than for other groups. This relationship was significant (p <.003) and appears to reflect a linear association between follow-up ADL function and hospital CESD scores.

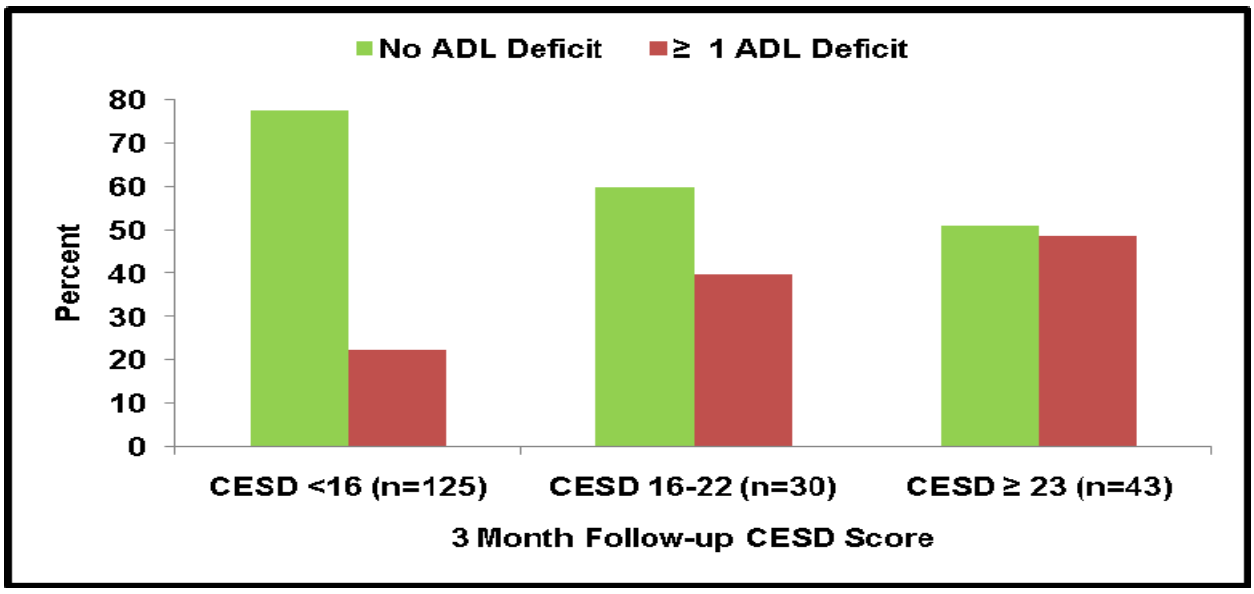


Figure 25. Follow-up ADL status by hospital CESD scores (n=198).

A.2. a. Hospital Depressive Symptoms and Categories of Follow-up ADL

The bivariate associations between categories of follow-up ADL performance and hospital depressive symptoms were assessed through chi-square analysis as outlined in Table 20. Within the ADL subcategory of bathing, patients with low depressive symptoms in hospital were more likely to have no follow-up bathing difficulties; conversely, those with high depressive symptoms were more likely to have bathing deficits at follow-up (p<.005). The relationship between depressive symptoms and

specific ADL limitations followed the same significant trends for dressing (p=.003) and toileting (p=.001), but were not significant for grooming (p=.10) or eating (p=.36). These findings indicate that high depressive symptoms in hospital were specifically associated with limitations in certain categories of follow-up ADL, but not all.

Table 20. Associations between categories of 3 month follow-up ADL and hospital depressive symptoms (N=198).

	Total Sample (N=198) n (%)		**Low Depressive Symptoms** (n=125) n (%)		**High Depressive Symptoms** (n=73) n (%)	P value
Bathing						
Independent	159 (80.3)		108 (86.4)		51 (69.9)	**<.005**
Needs assist	39 (19.7)		17 (13.6)		22 (30.1)	
Grooming						
Independent	187 (94.4)		121 (96.8)		66 (90.4)	.10*
Needs assist	11 (5.6)		4 (3.2)		7 (9.6)	
Dressing						
Independent	171 (86.4)		115 (92.0)		56 (76.1)	**.003**
Needs assist	27 (13.6)		10 (16.2)		17 (23.3)	
Eating						
Independent	193 (97.5)		123 (98.4)		70 (95.9)	.36*
Needs assist	5 (2.5)		2 (1.6)		3 (4.1)	
Toileting						
Independent	180 (90.9)		120 (96.0)		60 (82.2)	**.001**
Needs assist	18 (9.1)		5 (4.0)		13 (17.8)	

All analyses are chi-square except where indicated by * which represents Fisher's exact test.

B. Association between Depressive Symptoms and ADL Status: Multivariate

B.1. Background for analysis

Two different regression models were used to determine which best describes the relationship between hospital depressive symptoms and 3 month follow-up ADL. First, a linear regression model using the continuous follow-up ADL score (dependent variable) and the continuous CESD score (independent variable) was constructed. Next, a linear regression model was made, using the continuous follow-up ADL score (dependent variable) and categorical CESD scores (<16, 16-22 and ≥ 23) to assess for a linear trend in ADL function associated with severity of depressive symptoms. A log likelihood ratio was developed from each models' log likelihood score to determine if one model was a better fit for this association. Prior to this analysis, multi-collinearity diagnostics

were performed. Acceptable limits were set and met for the condition index (<20), leverage (.5) and studentized residuals (≤ 3). As the ADL sum score is highly skewed to the left, a negative binomial distribution was used to determine significance in the regression models. Class statements were used in both models for race, school and, when applicable, BMI and depression.

B.2. Linear Regression Model using the Continuous CESD Score

As described above, a linear regression model using a negative binomial distribution was used to assess the relationship between follow-up ADL (dependent variable) and the continuous CESD score in hospital (independent variable), controlling for other sociodemographic and clinical variables. Table 21 outlines the results. In model one, the continuous CESD score was significantly associated with follow-up ADL (b=.07; SE: .02; p<.0001). In model 2, sociodemographic characteristics were added to the model and class statements for race and education were added to the analysis. Continuous CESD score remained the only significant variable in the model (p=.07; SE=.02; p <.0001). While no other variables reached statistical significance as defined by p<.05, female gender was nearly significant (p=.07). Clinical variables were added in the last model and class statements for BMI were added to those used in Model 2. The continuous CESD score remained highly significant (b=.05; SE=.01; p<.0001). Having < 12 years of education (vs. 12 years) was also statistically significant (b=.67; SE=.31; p=.03). BMI and medical history were not associated with follow-up ADL; hospital pain was nearly significant (p=.07). The hospital ADL sum score was strongly associated with follow-up ADL (b=.30; SE=.06; p<.0001).

Table 21. Linear regression models assessing the association between follow-up ADL status and hospital depression controlling for sociodemographic and clinical variables (N=198).

	Model 1			Model 2			Model 3		
	b	SE	p	b	SE	p	b	SE	p
CESD (continuous)	**.07**	**.02**	**<.0001**	**.07**	**.02**	**<.0001**	**.05**	**.01**	**<.0001**
Age (65-73 v. ≥ 74 years)		*		.25	.30	.40	.15	.29	.61
Female (v. male)		*		-.56	.31	.07	.05	.31	.88
Married (v. not)		*		.43	.31	.16	.22	.29	.45
Hispanic (v. White)		*		.29	.54	.58	-.26	.53	.63
Black (v. White)		*		.01	.37	.98	.03	.33	.91
White		*		0.0	0.0	*	0.0	0.0	*
< 12 yr ed (v. > 12)		*		.60	.33	.06	**.67**	**.31**	**.03**
12 yr ed (v. > 12)		*		.47	.37	.20	.29	.34	.40
> 12		*		0.0	0.0	*	0.0	0.0	*
BMI (< 22 vs. ≥ 30)		*			*		.39	.42	.36
(22-29.9 v. ≥ 30)		*			*		.12	.32	.70
(≥ 30)		*			*		0.0	0.0	*
Pain (Any v. none)		*			*		.08	.04	.07
Medical Condition Index (Any v. None)		*			*		-.0006	.30	.99
Hospital ADL Sum Score (continuous)		*			*		**.30**	**.06**	**<.0001**

B.3. Linear Regression Model using Categorical CESD Scores

As described earlier, a second linear regression model using a negative binomial distribution was used to assess the relationship between follow-up ADL (dependent variable) and categorical CESD scores in hospital (independent variable); a contrast statement was coded in the analysis to further assess for a linear trend in ADL function associated with severity of depressive symptoms. In model one, CESD categorical scores were tested without controlling for other variables. A CESD score of 16-22 (vs. low depressive symptoms) was significantly associated with follow-up ADL (b=.93; SE=.40; p=.02). A CESD score of ≥ 23 (vs. low depressive symptoms) was also significant (b=1.2; SE=.34; p=.0008).

The results for the linear regression model are outlined in Table 23. In model 2, sociodemographic characteristics were added to the model and class statements for ethnicity and education were added to the analysis. CESD scores 16-22 (vs. low depressive symptoms) remained significant (b=1.3; SE:.41; p=.002) and CESD scores ≥ 23 (vs. low depressive symptoms) also remained significant (b=1.4; SE: .41; p=.0001). In model 2, gender was the only sociodemographic variable to reach statistical significance (b=-.72; SE=.32; p=.02). Clinical variables were then added in Model 3 and class statements for BMI were added to those used in Model 2. A CESD score of 16-22 (vs. low depressive symptoms) remained significant (b=.81; SE=.36; p=.03) as did a CESD score of ≥ 23 (vs. low depressive symptoms) (b=1.07; SE: .32; p=.0008). Having < 12 years of education (compared to 12 years) was now significant (b=.63; SE=.30; p=.04). Of the clinical characteristics, hospital pain (b=.09; SE=.04; p=.04) and hospital ADL score (b=.30; SE=.06; p<.0001) were statistically associated with follow-up ADL.

Table 22. Regression models with linear contrast statement assessing the association between follow-up ADL status and categorical hospital CESD scores controlling for sociodemographic and clinical variables (N=198).

	Model 1			Model 2			Model 3		
	b	SE	p	b	SE	p	b	SE	p
CESD Score ≥ 23 (v. < 16)	**1.15**	**.34**	**.0008**	**1.38**	**.36**	**.0001**	**1.07**	**.32**	**.0008**
CESD Score 16-22 (v. < 16)	**.93**	**.40**	**.02**	**1.27**	**.41**	**.002**	**.81**	**.36**	**.03**
CESD Score (< 16)	**0.0**	**0.0**	*	**0.0**	**0.0**	*	**0.0**	**0.0**	*
Age (65-73 v. ≥ 74 years)		*		.25	.30	.40	.11	.28	.69
Female (v. male)		*		-.72	.32	.02	.05	.31	.89
Married (v. not)		*		.53	.31	.09	.30	.29	.31
Hispanic (v. White)		*		.57	.54	.29	-.04	.54	.93
Black (v. White)		*		.01	.36	.96	.09	.33	.78
White		*		0.0	0.0	*	0.0	0.0	*
< 12 years education (v. > 12)		*		.49	.32	.09	**.63**	**.30**	**.04**
12 years education (v. > 12)		*		.49	.37	.18	.25	.34	.47
> 12 years education		*		0.0	0.0	*	0.0	0.0	*
BMI (< 22 vs. ≥ 30)		*			*		.45	.42	.28
(22-29.9 v. ≥ 30)		*			*		.20	.31	.53
(≥ 30)		*			*		0.0	0.0	*
Pain (Any v. none)		*			*		**.09**	**.04**	**.04**
Medical Condition Index (Any v. None)		*			*		.005	.30	.98
Hospital ADL Sum Score (continuous)		*			*		**.30**	**.06**	**<.0001**

To better understand the clinical implications of this model, we examined the exponential of the statistically significant estimates and confidence intervals and sought to interpret them as odds ratios and confidence intervals, with results in Table 24. Compared to patients with no depression, patients with CESD scores ≥ 23 were 2.9 times more likely to have an additional ADL limitation. Patients with a CESD score of 16-22 were 2.2 times more likely than those with no depression to have an additional ADL limitation. Of note here, the 95% confidence intervals for CESD scores ≥ 23 (1.56-

5.43) and CESD scores 16-22 (1.09-4.52) overlap, suggesting that while these categorical groups are different from the low depressive symptoms group, they are not necessarily different from one another. Patients reporting any level of pain while in the hospital have a 9% higher chance of having an additional ADL limitation compared to those with no pain; those with a hospital ADL limitation are 34% more likely to have an additional ADL limitation compared to those reporting no hospital ADL limitations.

Table 23. Odds ratio and confidence intervals estimating the linear association between follow-up ADL and hospital CESD scores.

	Odds Ratio (95% CI)
CESD Scores (≥ 23 v. < 16)	2.9 (1.56-5.43)
CESD Scores (16-22 v. < 16)	2.2 (1.09-4.52)
CESD Score (< 16)	1.0
Pain (Any v. none)	1.09 (1.01-1.53)
Hospital ADL Score (Continuous)	1.35 (1.20-1.53)

B.4. Comparison of Fit between the Two Models

Two different models assessing the association between hospital depressive symptoms and follow-up ADL status have been analyzed. In one model, the CESD score is used as a continuous variable and in the second model, categories of increasing CESD scores have been examined to assess a linear association between categorical CESD scores and follow-up ADL. To assess the goodness of fit, the log likelihood ratio has been examined to assess whether or not a significant difference exists between the two models' ability to assess this relationship. In model 1 (continuous CESD), the log likelihood is -98.9771 and in model 2 (categorical CESD scores), the log likelihood is -98.5431. In this case, the log likelihood ratio follows a chi-square distribution with 1 degree of freedom; therefore, for the models to be significantly different, the chi-square value would have to be > 3.84. The equation (2 x model 1 log likelihood)/ (2x model 2 log likelihood) was used to develop the ratio value. The log

likelihood ratio = .99 which is < 3.84; therefore, there is no significant difference between the two models and neither is superior in terms of goodness of fit.

SPECIFIC AIM 4

Examine the interaction between hospital depression and select personal and health characteristics on ADL status 3 months post-discharge. Personal and health characteristics will include measures such as gender, marital status and pain.

A. Linear Regression Models

Table 25 describes the results of the linear regression analysis using interaction terms. In model 1, all potential interaction terms were used and none were statistically significant in a fully-adjusted model. In Model 2, the least significant interaction term (continuous CESD x marital status) was removed and the remaining interaction terms were retained, yet none proved significant. Two interaction terms (continuous CESD x marital status and continuous CESD x gender) were removed from model 3 to assess the final two interaction terms (continuous CESD x medical history and continuous CESD x pain) and neither was significant. Finally, in model 4, the last interaction term (continuous CESD x pain) was assessed alone in a fully adjusted model and was found to be statistically non-significant. Throughout all 4 models, hospital CESD scores, pain and ADL were significantly associated with 3 month follow-up ADL, as well as < 12 years of education (compared to > 12 years) as demonstrated in earlier models. However, in this sample, no interaction effects were noted between depression and the potential moderators: pain, gender, marital status or number of medical conditions.

Table 24. Linear regression model results assessing interaction effects with hospital depressive symptoms on the depression-ADL association (N=198).

	Model 1 p-values	Model 2 p-values	Model 3 p-values	Model 4 p-values
CESD*Marital Status	.45	-	-	-
CESD*Gender	.23	.21	-	-
CESD*Medical Condition Index	.17	.20	.24	-
CESD*Pain	.13	.11	.18	.13

Each model adjusted for age, gender, race, school*, marital status, pain*, medical history, LOS, hospital ADL*, hospital depression score* and BMI. Those designated with * were significant at the p<.05 level in all models.

Chapter 5: Discussion

This chapter provides interpretation of study findings. The specific aims and results are reviewed and critically analyzed for relevance within current literature and clinical practice. Conclusions and future directions for research with older hospitalized adults are presented.

A. PURPOSE

The primary objectives of this study were to investigate the change in depression and ADL function from in hospital to 3 month follow-up, the relationship between hospital depression and 3 month follow-up ADL and potential moderators of this relationship in a sample of older adults on an Acute Care for Elders unit.

B. SPECIFIC AIM 1 DISCUSSION

The intent of Specific Aim 1 was to determine the trajectory of depressive symptoms from hospitalization to 3 months post discharge. Prevalence estimates in hospital and post-discharge, as well as change in depressive symptoms, were explored by relevant sociodemographic and clinical characteristics. Results are as follows.

B.1. Prevalence of High Depressive Symptoms: Hospital

When the presence of depressive symptoms is determined using a CESD cut-off point of ≥ 16, 39.5% of subjects reported high symptoms; using the CESD cut-off point of ≥ 20, 26.8% reported high symptoms. With either threshold, clinically-significant depression was higher in our sample than in community-based samples (8-16%)[3] and in range with other studies of hospitalized older adults (3-51%) on non-ACE units.[33, 37] These results are disappointing as an ACE unit is structured to minimize the severity of hospital depressive symptoms.[97] That said, we do not know the extent to which our patients took advantage of the unique attributes of an ACE unit, nor do we know which attributes contribute the most to minimizing depressive symptoms as shown in other studies.[99, 100] Do specific variables such as beds in the room for family contribute more than other variables, such as family dining areas? And do patients with low depressive symptoms utilize these options more than patients with high depressive symptoms?

Answers to these questions will inform us on the behavior of patients and families looking to maximize the benefit of a short-term hospital admission.

B.2. Factors Associated with High Depressive Symptoms

Bivariate and multivariate models were used to examine the sociodemographic and clinical characteristics associated with high depressive symptoms in hospital and at 3 months follow-up. *In hospital*, unadjusted analyses reveal that female gender, being unmarried and the presence of pain or ADL disability are significantly associated with high depressive symptoms; in multivariable analyses, being unmarried and having one ADL disability retain statistical significance. At the *3 month follow-up*, unadjusted analyses reveal that being unmarried, having follow-up ADL disability and the presence of hospital pain (borderline significant) was associated with high depressive symptoms. In multivariate analyses, being unmarried and having ADL disability were significant correlates of high depressive symptoms at follow-up. These findings show a strong association between high depressive symptoms, marital status and ADL, congruent with other studies that report the same associations.[11, 40, 42, 52] Older adults who are unmarried or have ADL disability are at risk for high depressive symptoms; research targeting specific interventions for these populations is warranted.

B.3. Trajectory of Depressive Symptoms

At the 3 month follow-up, the prevalence of high depressive symptoms was determined using the 2 cut-off points used in the hospital analysis. Using the CESD ≥ 16 cut-off point, 8% reported high depressive symptoms; using the CESD ≥ 20 cut-off point, only 4% reported such symptoms. Clinically-significant depression significantly decreased from admission to three month follow-up. Of those with high symptoms in hospital, over 80% reported low symptoms at follow-up, revealing a high recovery rate in this population. So while our prevalence in hospital was in range with other studies, our recovery rate exceeded published findings of 40-66%.[34, 73, 131] What contributed to our high recovery rate? ACE unit milieu variables (environmental modifications and interdisciplinary team management) or discharge management are potential mediators. Questioning patients who had high depressive symptoms in hospital about factors that assisted them with recovery through qualitative methods would inform this research.

B.5. Factors Associated with Positive Change in Depressive Symptoms

Bivariate and multivariate models were used to examine the sociodemographic and clinical characteristics associated with positive change in depressive symptoms. In the multivariate analysis, <12 or > 12 years of education (compared to 12 years) and positive improvement in ADL status were associated with increased odds of having a positive change in CESD score.

We found no studies that assessed factors associated with change in depressive symptoms. However, Koenig et al. studied factors associated with time to recovery of mild and major depression in patients with pulmonary disease.[73] Improvement in mild depression was associated with higher social support, black race and less severe disease.[73] Improvement in major depression was associated with less severe depression and less use of anti-depressants. We did not collect data on current or previous use of anti-depressants or previous history of depression; analysis of these factors may enhance our findings. Also, it would be interesting to examine unmeasured factors such as amount of social support after discharge or resolution of the medical issues causing hospitalization.

C. SPECIFIC AIM 2 DISCUSSION

The intent of Specific Aim 2 was to determine the trajectory of ADL function from hospitalization to 3 months post discharge. Prevalence estimates in hospital and post-discharge, as well as change in ADL function, were explored by relevant sociodemographic and clinical characteristics such as age, gender, ethnicity, pain and depressive symptoms.

C.1. Prevalence of ADL Disability: Hospital

In hospital, 38.6% of the sample reported ≥ 1 ADL limitation while 61.4% reported no limitations; of those reporting limitations, over half reported ≥ 3 limitations. In terms of specific ADLs, patients reported highest disability in bathing (39%) and lowest in eating (7.5%). Overall, these results are similar to other studies assessing ADL status in hospitalized patients. In a study of 572 patients over 70 years on an acute care ward,

50% reported at least one limitation in ADL in the admission interview.[117] An Italian study of hospitalized patients over 65 years revealed that 20% of those aged 65-74 years reported 1-3 limitations and 9% reported 4-6 limitations on admission; in the group 75+years, 31% reported 1-3 limitations and 24% reported 4-6 limitations on admission.[33] Similarly, bathing is the most reported disability in ADL.[91] Factors associated with declines in specific ADLs such as bathing have not been examined, but research is needed to identify these risks and establish preventative/restorative programs.

C.2. Factors Associated with ADL Status

Bivariate and multivariate models were used to examine the sociodemographic and clinical characteristics associated with ADL status in hospital and at the 3 month follow-up. *In hospital*, unadjusted analyses reveal that pain (borderline significant at p=.05) and high depressive symptoms are associated with ADL disability. In multivariate analyses, older age (≥ 75 years) and high depressive symptoms were associated with ADL disability in hospital. At the *3 month follow-up*, pain and high depressive symptoms in hospital were associated with ADL disability in unadjusted analyses; being female, married, having less education (< 12 vs. > 12), pain and high depressive symptoms in hospital were associated with follow-up ADL disability in multivariate models. At both times points, ADL disability was associated with pain and depressive symptoms in hospital.

Studies that examined hospital pain as a predictor of follow-up ADL disability could not be found, but a closer examination of this relationship is warranted. Does this finding suggest that pain remains under-controlled at follow-up or did the presence of hospital pain minimize the effect of interventions, for either the illness or rehabilitation therapy? Of note, older age was hypothesized to predict ADL disability as shown in other research.[89] We found that being older increased the odds of ADL disability in hospital but not at follow-up, which may suggest the vulnerability of this group to acute medical illness or sudden hospitalization. The relationship between depressive symptoms and ADL disability will be discussed in the results of Specific Aim 3.

C.3. Trajectory of ADL Disability

The course of change in ADL status is best understood if pre-hospitalization ADL is considered. Prior to hospitalization, 21.5% of the patients reported some ADL disability, compared to in hospital (33.3%) and post-discharge (16%). Of patients with pre-hospital ADL limitations, > 48% resolved all limitations by follow-up, while 52% continued to report disability. These findings suggest that ADL status improved post-discharge in over half the sample and pre-hospitalization ADL levels of independence were exceeded for nearly half of those with pre-existing disability. This pattern was consistent in specific ADL categories, such as bathing and toileting, where prevalence of disability at follow-up was lower than pre-hospitalization reports. Other studies of hospitalized older adults have shown both improvement in ADL over time and lack of recovery of ADL skills lost while in hospital.[91, 117] Research of the contribution of ACE unit structure or services to recovery of ADL disability is warranted to understand the benefits of an ACE admission.

C.5. Factors Associated with Change in ADL

Bivariate and multivariate models were used to examine the sociodemographic and clinical characteristics associated with change in ADL scores. In unadjusted analyses, age and change in depressive symptoms were significantly correlated with categorical change in ADL. In multivariate analysis, males and patients ≥ 75 years had a lower ADL change score (less change), whereas those with either the same or improved CESD score had a higher ADL change score. Lower ADL change scores in men may reflect less initial disability, yet in patients over 75 years, they may represent slower or more limited recovery than that in younger counterparts. Other research examining factors associated with ADL recovery have found similar associations with younger age and fewer depressive symptoms, while higher cognition and greater mobility have also been associated with ADL status improvement.[8, 112] These findings support the reciprocal association between change in ADL and change in depressive symptoms and create additional research questions related to intervention.

D. SPECIFIC AIM 3 DISCUSSION

The intent of Specific Aim 3 was to examine the direct associations between hospital depression and ADL function 3 months post-discharge after controlling for relevant sociodemographic and clinical variables such as age, gender and pain.

Results are as follows.

D.1. Association between Depressive Symptoms and ADL Status in Hospital

Bivariate analyses were used to examine the association between categorical hospital depressive symptoms (CESD scores: < 16, 16-22, ≥ 23) and hospital ADL function (independence v. any level of disability). Higher levels of depressive symptoms were predicted to be associated with higher levels of reported disability. As predicted, patients who reported low depressive symptoms were more likely to report ADL independence when compared to patients with high depressive symptoms. However, in patients with a high level of symptoms (CESD 16-22 and > 23), ADL disability did not increase with an increase in depressive symptoms. In fact, patients who scored 16-22 on the CESD category reported the most disability (68.5%) compared to those in the higher CESD category (65.7%).

Statistical power issues aside, this result may indicate a trend in two directions. One, a ceiling effect for the association between hospital depression and hospital ADL disability may exist. Second, the group with milder depressive symptoms is not being treated for depression, and is therefore more likely to suffer from limitations than those with more obvious depressive symptoms who receive intervention. We did not collect data on use of anti-depressants, so we cannot confirm this point. However, it represents an interesting area for future research.

D.2. Association between Hospital Depressive Symptoms and ADL Post-Discharge

Bivariate and multivariate analyses were performed to examine the hypothesis that, as depressive symptoms increase in hospital, the risk of post- discharge ADL disability also increases. In bivariate analyses, CESD scores were divided into categories (< 16, 16-22, ≥ 23) and then analyzed by ADL status (independence vs. disability). As predicted, people with the lowest CESD scores had the lowest percent of people reporting ADL limitations and the highest percentage reporting no ADL limitations. As

the CESD score increased, the prevalence of ADL disability increased in a step-wise manner. This association was tested in multivariate models in two different ways: with a continuous CESD score and with categorical CESD scores. In both models, an increase in depressive symptoms in hospital was associated with an increase in ADL disability post-discharge. The risk of ADL limitations was nearly three times greater for those with a CESD score ≥ 23 (compared to <16) and 2.2 times greater in those with a CESD score 16-22 (compared to <16).

These findings confirm longitudinal studies that looked at this association and generate research ideas related to improving ADL outcomes in hospitalized older adults.[14, 117] For example, would interventions to decrease depressive symptoms impact post-hospitalization ADL status or, conversely, would rehabilitation focused on ADL recovery and prevention of disability improve depressive outcomes? Understanding the cost-effectiveness and patient satisfaction with both interventions would further inform this research.

D.3. Association between Hospital Depressive Symptoms and Subcategories of ADL Post-Discharge

As an extension of the previous question, we hypothesized that specific ADL deficits at follow-up (bathing, dressing and toileting) would be associated with hospital depressive symptoms. Bathing, dressing and toileting require independence with surface transferring and more complex motor movements such as sit to stand and weight shifting. These ADLs also require a higher level of cognition, such as problem solving new techniques within different environments. Complex motor movements and cognitive tasks occur to a lesser extent in rote ADLs such as eating or grooming. Because depressive symptoms are associated with changes in motor function and cognition,[40, 51, 54, 60, 118, 119] bathing, toileting and dressing were hypothesized to be associated with high depressive symptoms. In fact, patients who reported independence with these ADLs were more likely to report low depressive symptoms and those reporting needing any assistance were more likely to report high depressive symptoms.

No other studies of the association between specific ADL disability and depressive symptoms were found. Additional examination of the extent and costs of post discharge ADL disability would further extend this knowledge base.

E. SPECIFIC AIM 4 DISCUSSION

The intent of Specific Aim 4 was to examine the interaction between hospital depressive symptoms and select personal and health characteristics on ADL status 3 months post-discharge. Personal and health characteristics included gender, marital status, pain and number of medical conditions. Results are as follows.

E.1. Moderator Analysis

Our results indicate that, for this sample, none of the hypothesized moderators significantly affected the relationship between hospital depressive symptoms and follow-up ADL status as predicted. Univariate and multivariate testing of interactions yielded non-significant results.

E.1.a. Gender

In previous studies, gender was shown to influence the depression-disability association. Bruce et al. followed 1,100 adults aged 70-79 years for nearly 3 years and found that those with high depressive symptoms at baseline were more likely to have incident ADL limitations, an effect which was greater in women than men.[108] In a separate study of 260 people with chronic pain, depression was positively associated with higher levels of pain and disability. Gender did not predict disability but did moderate the relationship such that women with higher levels of depression had higher levels of disability.[132] These studies suggest that gender can influence the impact of emotional symptoms, thus moderating outcomes in function. In our study, gender did not significantly alter the relationship between depressive symptoms and ADL function. Perhaps those at high risk for disability had protective factors in place which were unmeasured or required more complex analyses to identify associations.

E.1.b. Marital Status

In our study, marital status was associated with both depressive symptoms and ADL status, but did not significantly influence the depression-ADL association. No specific studies were found that previously tested this relationship. However, being married is considered part of a person's social support system; therefore research of social support was used to support this hypothesis. In a study of 305 community-dwelling patients 60 years old and older, the presence of social support (assistance with

instrumental activities of daily living and satisfaction with support) moderated some of the ADL disability in those with major and minor depression.[121] In obvious contrast to this study, we measured marital status, not the construct of social support; secondly, we measured depressive symptoms, not clinical diagnoses of depression. As with gender, examining unmeasured protective factors or conducting more complex analyses may improve our understanding of the influence of marital status on the depression-ADL association.

E.1.c. Pain

Previous literature assessing the moderating role of pain in the depression-ADL association could not be found. Pain was hypothesized as a potential moderator because it has been associated with higher depressive symptoms and ADL disability in previous research.[60, 63, 102, 107] In our study, hospital pain was associated with ADL disability at both time points, but not with depressive symptoms at either time point. The lack of association between pain and depressive symptoms may have minimized the interaction effect. Furthermore, we collected data on hospital pain but not post-discharge pain. This research could be extended by considering whether post-discharge pain acts as a moderator of the depression-ADL association.

E.1.d. Medical Conditions

No previous research was found that assessed the moderating role of medical conditions, or presence of specific medical conditions in the depression-ADL association. However, this pathway was hypothesized due to the previous associations between medical history, depressive symptoms and ADL status.[14, 33, 34, 51, 102-104] In our study, the presence of medical conditions were measured as a sum index measure of 5 conditions (stroke, cancer, hip fracture, heart attack and diabetes). Analyses were conducted using a dichotomous measure of “0” conditions vs. ≥ 1 condition. This index was not associated with depressive symptoms or ADL disability at either time point and not shown to moderate the depression-ADL association. Reasons for these findings are likely multi-faceted. One, this index may not capture those diagnoses most related to depressive symptoms and ADL disability in our sample. Two, the strength of the association between medical history and the depression-ADL association may increase

with the number of medical conditions. For example, if the index was dichotomized to analyze 4-5 conditions vs. <4, the results may be different. Third, unmeasured protective factors may influence the effect or more complex analysis is required to determine the association.

F. SUMMARY

This data is taken from a pilot study assessing the psychological health of hospitalized older adults admitted to an ACE unit. A large minority reported high depressive symptoms in hospital and over half reported ADL disability. Across both assessment periods, risk factors for having high depressive symptoms were being unmarried and having any level of ADL disability. Conversely, risk factors for ADL disability were pain and depressive symptoms. At 3 months post discharge, the recovery rate from depression and incident ADL disability was high. Positive change in depression was significantly associated with positive change in ADL status. Increasing severity of hospital depression was associated with increased odds of ADL disability at the 3 month follow-up. Neither gender, marital status, pain nor medical history moderated this relationship.

G. STUDY STRENGTHS

This study had a number of strengths. First, we examined depressive symptoms and ADL status within a sample of whites, blacks and Hispanics during and after hospitalization, which is important given the expected increase in age and ethnicity of the U.S. population in the near future. Second, this study contributes to the literature on the psychological and functional outcomes of patients admitted to an ACE unit. Third, these findings help inform the national debate on the discretionary distribution of health care resources, particularly during hospitalization.

H. STUDY LIMITATIONS

Missing data was a significant issue and contributed to loss of participants and variables included in the final analysis. Reduction in participants may have contributed to lack of power to determine statistical significance. Important covariates such as pre-hospitalization status, previous history of depression and use of anti-depressive

medications at discharge were not available or incomplete for analysis; they may have helped illuminate study outcomes. The sociodemographic characteristics of people in this study may not represent all elderly, hospitalized samples and therefore cannot be generalized to all populations.

I. FUTURE DIRECTIONS FOR RESEARCH

Three months after discharge, an association between hospital depression and follow-up ADL is significant. How long would this relationship exist if followed for 6 months to one year? Clinically, can differences be clarified such as greater need for formal health services, or reliance on informal support network assistance such as friends/family? Determining social and financial costs associated with this relationship may underscore the importance of early management.

Second, it would be interesting to track the trajectory of basic cognitive and physical function (memory, upper body strength, transfer ability) over time to assess the timing of incident functional limitations, depressive symptoms, and ADL disability. Clarifying the course and factors associated with incident disability can inform research to develop prevention and intervention programs for hospitalized older adults.

Third, how much does the ACE unit milieu contribute to prevalence or change in depressive symptoms or ADL disability? Potential protective factors provided by an ACE unit admission need to be defined, patient use of these factors measured and associations between outcomes and use examined. If associations exist, can these protective factors be “prescribed” by the team on admission, to minimize further degradation of psychological and functional health?

Finally, research focused on is a natural extension of this work. Would non-pharmacological or pharmacological intervention reduce depressive symptoms? Medication, psychotherapy and cognitive behavioral therapies are known to decrease depressive symptoms in older adults.[133-135] Could these interventions moderate the influence of high depressive symptoms on functional outcomes after hospitalization? Additionally, what impact do specific ACE unit services have on post-discharge ADL outcomes? Examining the impact of in-hospital rehabilitation therapies, acquisition of durable medical equipment prior to discharge or extensive family training would inform research in post-hospitalization ADL outcomes.

In summary, this research provides descriptive and predictive information about the psychological and functional health of older adults during and after hospitalization. These findings, in conjunction with other studies, can inform the development of clinical interventions to minimize patient suffering, improve functional outcomes and reduce healthcare costs.

APPENDIX A: Common Depressive Symptom Measures used in Epidemiology Studies.

		Purpose / Population	Type of rating	Cut-off Points for Case Depression	Sensitivity (Se)/ Specificity (Sp)
Hamilton Rating Scale (HRS)[16]		Used to quantify results of psychiatric interview in patients with depressive illness.	Examiner rated	30 + Severe depression 16-18 Clinically significant depressive symptoms	Stroke (≥11pts) 73% (Se) /100% (Sp) Alzheimer's (≥14 pts) 45% (Se)/ 96% (Sp) Parkinson's (≥17 pts)[17] 60% (Se)/ 99% (Sp)
Geriatric Depression Scale(GDS)[18]		Measure number of depressive symptoms in elderly	30-item self- report	11 for clinically relevant depression	Older adults GDS-15; cut-off (≥5)[136] 91% (Se)/72% (Sp)
Beck Depression Inventory (BDI)[19]		Measure number and severity of affective, cognitive and somatic features of depression	21-item self-report	18-21 to distinguish medically ill patients with severe depression.[137] 10: lowers sensitivity to detect less severe forms[138]	Cut-off score (≥5) on Psychological Subscale (Items 5-21) 70% (Se)/84% (Sp) Scores are for detecting major depression in hospitalized older adults.[138]
Center for Epidemiologic Studies-Depression Scale (CES-D)[20]		Measure the severity of depressive symptoms in clinical and community epidemiology samples	20 item self-report	≥ 16 for clinically relevant depression in adults[20, 139] ≥ 20 has been used in hospitalized older adults [140]	Older Adult Studies Cut-off (≥ 16) 74% (Se)/70% (Sp)[139] Cut-off (≥ 20) 93% (Se) /73% (Sp)[140]

APPENDIX B: Fifteen Year Review of Studies Assessing Prevalence of High Depressive Symptoms in Hospitalized Older Adults (1994-2009).

Author (Year)	Site/Sample	Instrument (Cut-off Score)	Prevalence
Retornaz et al. 2008[29]	ACE unit (n=186); ≥ 65 and older with cancer	GDS-4 (mini-form) ≥ 1	46.3%
Hammond et al. 2008[30]	Acute cardiac unit (n=155); ≥60	GDS-15 (≥ 5)	34%
Cully et al. 2005[31]	ARC (n=509); ≥ 60 years	GDS (≥ 11)	Stroke patients (31.8%) Non-stroke patients (31.5%)
Onishi et al. 2004[32]	Geriatric ward of Japanese university hospital (n=198); ≥ 65	GDS-15 (short form) >6	39.3%
Marengoni et al. 2004[33]	Acute geriatric ward-Italy; ≥ 65	GDS (≥11) GDS (≥20)	Patients 65-74 GDS (11-20) 31% GDS (≥20) 3.6% Patients ≥ 75 GDS (11-20) 35.8% GDS (≥20) 5.5%
Barefoot et al. 2003[34]	Acute care unit (n=196); adults	BDI (≥ 10)	37%
Bula et al. 2001[9]	Internal medicine unit of university medical center (n=401) 75-99 yrs	GDS-15 (≥ 6)	22.4%
Pouget et al. 2000[35]	Internal medicine unit (n=401); ≥ 75	GDS-15 (≥ 6)	22.4%
Lieberman et al. 1999[36]	Geriatric ARC (n=276); adults	GDS (≥ 10)	41%

Koenig et al. 1998[37]	Community hospital acute care unit (n=291) Medical center acute unit (n=542); ≥ 55 yrs	CES-D (≥ 16)	Community hospital (51.2%) Medical center (36.9%)
Diamond et al. (1995)[38]	Geriatric ARC (n=51); older adults	GDS (≥ 10)	31%
Dunham & Sager (1994)[39]	Acute medical unit (n=197)	GDS (≥ 11)	23.9%

ACE= Acute Care for Elders; ARC= Acute Rehabilitation Center; GDS= Geriatric Depression Scale; CESD= Center for Epidemiological Studies Depression Scale.

APPENDIX C: Fifteen Year Review of Studies Assessing the Course of Change in Depressive Symptoms in Hospitalized Older Adults (1994-2009).

Author/Year		Sample/ (Follow-up)	Depression Measurement	Change	Correlates of Follow-Up Depression
Hammond et al. 2008[30]		155 hospitalized adults ≥ 60 (one month post-discharge)	GDS-15 (cut-off ≥ 5)	Prevalence: Initial 34% Follow-up 17%	Rehospitalization, length of stay ≥ 4 days, lack of social support.
Barefoot et al. 2003[34]		196 inpatients s/p myocardial infarction (2 weeks)	HRSD	Prevalence Initial: 28% Follow-up: 17%	Decreased age Baseline HRSD score Whites
Lai et al. 2002[71]		Inpatients post stroke Admit (N=398) 1 month (N=395 3 months (N=372) 6 months (N=352)	GDS-15 (≥6 cut-off)	Prevalence Admit: 33% Follow-up 1 month: 35% 3 months: 34% 6 months :30%	NA
Lieberman et al. 1999[36]		275 inpatients after stroke or hip fracture (admit and then 2 days prior to discharge	GDS >10	Prevalence Initial: 41% Reports significant decrease but does not give prevalence for Discharge.	NA

HRSD= Hamilton Rating Scale for Depression; GDS= Geriatric Depression Scale.

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Biosketch

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Education

1998-2000	University of Indianapolis M.H.S. in Occupational Therapy Indianapolis, Indiana
1985-1990	University of Oklahoma Health Sciences Center B.S. in Occupational Therapy Oklahoma City, Oklahoma

Clinical Practice

I have been a practicing occupational therapist since 1990, specializing in adult clients that have upper extremity orthopedic and neurologic injuries. Practice settings have included hospitals, outpatient clinics, skilled nursing facilities and client homes.

Academic Practice

Since 2000, I have taught occupational therapy and physical therapy students within professional entry-level graduate programs. Teaching areas of focus have included evaluation and intervention of clients with neurologic and orthopedic issues and occupational therapy theory.

Post-Professional Education

In 2001, I developed a continuing education company called Master Clinician Seminars, with a focus on providing evidence-based continuing education to rehabilitation professionals. Full day seminars on topics related to the evaluation and intervention of people with stroke, brain injury and dementia were provided for occupational, physical and speech therapists.

Personal Statement

With twenty years of collective experience in clinical and academic practice, and having met the requirements for coursework for this PhD., I feel I am prepared to conceptualize, conduct, analyze and disseminate research for the advancement of my profession and to contribute to a larger body of evidence within the field of disability science.