Curriculum Vitae for Rebecca Ann Placko Brotemarkle, PhD, RN
rbrot001@son.umaryland.edu

Education:

2006-2013	Doctor of Philosophy, University of Maryland Baltimore, Baltimore, Maryland, 21201
2004-2006	Post Graduate Study in Informatics, University of Maryland Baltimore, Baltimore, Maryland, 21201
2001-2004	Master of Science in Nursing/Master of Business Administration, Johns Hopkins University, Baltimore, Maryland 21205
1986-1990	Graduate Study in Gerontology Clinical Specialist Program, University of Maryland at Baltimore, Baltimore, Maryland, 21201
1985-1986	Bachelor of Science in Nursing, University of Maryland Baltimore County, Catonsville, Maryland, 21250
1984-1985	Associate Degree in Nursing, Essex Community College, Essex, Maryland, 21237
1983-1984	Associate Degree in Biological Studies, Essex Community College, Essex, Maryland, 21237
1982-1983	Associate Degree in General Studies, Essex Community College, Essex, Maryland, 21237
1973-1974	Undergraduate Study, Goucher College, Towson, Maryland, 21204

Professional Experience:

2007-Present	Clinical Instructor/Assistant Professor, University of Maryland School of Nursing, Baltimore, Maryland, 21201
2011-Present	Utilization Review Nurse (part-time) and
2013-Present	Director of Research and Professional Practice (part-time), MedStar Good Samaritan Hospital, Baltimore, Maryland, 21239
2010-2011	Case Manager/Utilization Review Nurse (part-time), Howard County General Hospital, Columbia, Maryland, 21044
2008-2010	Clinic Nurse (part-time), Health Care for the Homeless, Baltimore, Maryland, 21201
2002-2008	Advanced Practice Case Manager, Johns Hopkins HealthCare, LLC, Glen Burnie, Maryland, 21060
2004-2007	Staff Nurse (part-time), Veterans Administration Health Care System, Baltimore, Maryland, 21201
2001-2002	Staff Nurse, Johns Hopkins Hospital, Baltimore, Maryland 21287
2001-2002	Staff Nurse (part-time), Gilchrist Center – Hospice of Baltimore, Towson, Maryland, 21204

1997-2002	Case Manager/Program Manager/Director, Health Education Resource Organization (HERO), Baltimore, Maryland, 21201
1997-1999	RN Home Care Case Manager, Bay Area Health Care/Visiting Nurse Association, Baltimore, Maryland, 21244
1991-1997	RN Home Care Case Manager, Staff Builders, Inc., Halethorpe, Maryland, 21227
1990-1991	Staff Nurse, ICU Weekend Option, Sinai Hospital, Baltimore, Maryland, 21215
1985-1991	Staff Nurse, Francis Scott Key Medical Center (now Johns Hopkins Bayview Medical Center), Baltimore, Maryland, 21224

Scholarships:

2006-2008	Merit Scholarship, University of Maryland School of Nursing, Baltimore, Maryland
1986	Sigma Theta Tau Scholarship
1985-1986	Maryland House of Delegates Scholarship
1985	Auxiliary to the Baltimore County Medical Association Nursing Scholarship
1984-1985	American Lung Association Nursing Scholarship

Honors and Awards:

2008	Graduate Poster Award, Association of Nurses in AIDS Care
1986	RN Award for Scholarly Achievement, University of Maryland School of Nursing
1986	Elizabeth Collins Lee Award, University of Maryland School of Nursing
1986	Summa Cum Laude, University of Maryland Baltimore County
1984	James A. Newpher Award, Graduating Student with Highest Academic Achievement, Essex Community College
1984	Outstanding Student in Biology Award, Essex Community College
1982-1985	Deans's Highest Honors List, Essex Community College

Certifications:

2006-Present	CCM (Certified Case Manager)
1998-Present	ACRN (AIDS Certified RN)
1990	CCRN (Critical Care RN)
1989	ACLS (Advanced Cardiac Life Support)
1987	RN,C in Gerontology
1982-Present	BLS (Basic Life Support – Healthcare Provider)

Peer-Reviewed Publications:

Nahm, E.S., Resnick, B., DeGrezia,M. & **Brotemarkle, R.** (2009). Use of Discussion Boards in a Theory-Based Health Web Site for Older Adults. *Nursing Research, 58,* 419-426.

Keiswetter, S. & **Brotemarkle, R. A.** (2010). Culturally Competent Care for HIV-Infected Transgender Persons in the Inpatient Hospital Setting: The Role of the Clinical Nurse Leader. *Journal of the Association of Nurses in AIDS Care, 21* (3), 272-277.

Brotemarkle, R.A., Resnick, B., Morton, P. & Wells, C. (in review). Pain in Older Trauma Patients During Therapy.

Presentations:

Brotemarkle, R.A. (2011,2012, 2013). "Advanced HIV Case Management, Case Management Models, Case Finding and Case Load Management" Workshop, Infectious Disease and Environmental Health Administration, DHMH, Baltimore, MD

Brotemarkle, R.A. (2010). "HIV 101" Second Annual Chesapeake ANAC Conference, Baltimore, MD

Brotemarkle, R.A. (2010). "Inpatient and Outpatient HIV Case Management: Experiences From the Front Lines" Panel Presentation for Diagnosis, Care and Management of Persons with HIV/AIDS Course, JHU & IJHN, Baltimore, MD

Brotemarkle, R.A. & Smith Barbara.(2009) "Relationships between body composition, food intake, and laboratory values in HIV-positive persons participating in a physical activity and nutrition study" Poster Presentation, Association of Nurses in AIDS Care Conference, Tucson, AZ

Brotemarkle, R.A. (2006). "Partnering for Patients: HIV Case Management and the Behavioral Health Dept." Poster Presentation, Case Management Society of America, Dallas, Texas

Brotemarkle, R.A. (2006)."Navigating the Course of HIV Disease" Case Management Society of America Presentation, Baltimore, MD

Brotemarkle, R.A. (2004). "Community Contracts in Managed Care for HIV/AIDS" Poster Presentation, Case Management Society of America, Nashville, Tennessee

Brotemarkle, R.A. (2002, 2003)."Case Management: The Big Picture" Presentation, Johns Hopkins University, Baltimore, MD

Brotemarkle, R.A. (2002)."Homelessness and Adherence to HIV Medications" Presentation District of Columbia Student Nurses Association HIV Conference, Washington, D.C.

Brotemarkle, R.A. (1999). “HIV/AIDS Today” Panel Presentation, University of Maryland Baltimore County for World AIDS Day, Baltimore, MD

Brotemarkle, R.A. (1999).“Housing as Health Care” Presentation, United States Conference on AIDS, Denver, Colorado

Brotemarkle, R.A. (1999).“Project HOPE” Presentation, United States Conference on AIDS, Denver, Colorado

Abstract

Factors Associated with Length of Stay and Discharge Disposition in

Older TraumaPatients

Rebecca Ann Placko Brotemarkle, Doctor of Philosophy, 2013

Dissertation Directed by: Dr. Barbara Resnick, Professor, School of Nursing

Background: Trauma patients over the age of 65 are living longer and staying active at older ages. Older trauma patients tend to have longer lengths of stay (LOS) and to be discharged more often to rehabilitation and skilled nursing facilities. Understanding the factors that influence LOS and discharge disposition is needed to guide interventions focused on decreasing LOS and assuring that patients are discharged to the least restrictive setting.

Purpose: The purpose of this study was to explore the impact of patient and system related factors on LOS and discharge disposition for older adults hospitalized for traumatic injury.

Methods: This was a secondary data analysis using descriptive data from rehabilitation notes during inpatient encounters. Data analysis was done using structural equation modeling and logistic regression.

Results: 132 patients were randomly selected from 1387 patients admitted to a level 1 trauma center. The majority were Caucasian (83.9%, n = 111), 46.9% (n = 62) were males with an average age of 78.3 (S.D. = 9.7) years. On average participants had 2.29 (S.D. = 1.96) comorbidities and approximately two thirds (65.9%, n = 87) were rated as having severe injuries. The average length of stay was 4.3 (S.D. = 4.0) days with 57.6%

(n = 76) of patients discharged to a facility. The model had a fair fit to the data and demonstrated that younger patients who had more comorbidities, were likely to have more pain. Older patients with more comorbidities, higher injury severity, more days from admission to evaluation, and lower pain were more likely to have a longer LOS which explained 37% of the variance in LOS. Based on logistic regression analysis, having longer LOS (O.R. = .049, 95% CI .008 - .301, p=.001) and more pain (O.R. = .531, 95% CI .310 - .908, p=.021) were associated with decreased likelihood of returning home versus being discharged to a facility.

Conclusion: Increased focus on pain and pain management, consideration of comorbidities, and decreasing time from admission to initial evaluation by rehabilitation therapists among older trauma patients may help to decrease LOS and facilitate discharge to the least restrictive setting.

Factors Associated with Length of Stay and Discharge Disposition in Older Trauma Patients

by

Rebecca Ann Placko Brotemarkle

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Dedication

This dissertation is dedicated to my father, Robert Peter Placko, who served as my role model. He ignited my spark of inquiry and taught me that research can be the adventure of a lifetime.

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Table of Contents

List of Tables

List of Figures

CHAPTER ONE: Significance and Aims

Introduction

Between 1900 and 1994, the number of adults in the United States over the age of 65 increased from three million to 33 million (U.S. Census Bureau, 2010). By the year 2050, the number is expected to at least double to 80 million (U.S. Census Bureau, 2010). Older adults represent 13.9% of the U.S. population (U.S. Census Bureau, 2010) but 33% of trauma patients (National Trauma Data Bank, 2012). Compared to younger adults, older trauma patients are more likely to be female with falls as the primary mechanism of injury (NTDB, 2010). As life expectancy increases and older adults remain active longer, injuries in this population are more likely to occur.

Trauma is the medical term for a group of injuries caused by violence or serious accidents and includes amputations; penetrating injuries to the head, neck, or torso; falls; certain vehicle accidents, rollovers, or ejection; multiple bone fractures; other serious damage to the head, spine, or vital organs. Because varying mechanisms of injury can impact various parts of the body, trauma in the elderly can present with great variation. The most frequent non-fatal, unintentional injuries in patients over age 65 are falls (64.2%), followed by being struck by or against an object (7.1%), overexertion (5.3%), and injuries suffered by being occupants in motor vehicles (5.1%) (National Center for Injury Prevention and Control, 2009a). Common injuries include fractures, contusions, lacerations, burns, crush injuries, blunt trauma, and penetrating. Injuries are frequently described by body region affected, including head, lower extremities, upper extremities, thorax, abdomen, pelvis, and spine; in some cases, multi-trauma occur with several regions affected (Soles & Tornetta, 2011a). Because of the large number of these possible injuries and the regions of injury, the study of trauma in the elderly is difficult, especially when the heterogeneity—genetic make-up, comorbid conditions, physical ability, and cognitive status—of the older adult population is considered.

After a traumatic event, older adults experience increased morbidity and mortality, are admitted to intensive care units (ICU) less frequently, and have longer lengths of stay than do younger individuals (McKevitt et al., 2003; Mosenthal et al., 2004; Taylor, Tracy, Meyer, Pasquale, & Napolitano, 2002). After a traumatic event and hospitalization, older adults were found to have accelerated functional decline (Buurman et al., 2011; Huang, Chang, Liu, Lin, & Chen, 2013; Mudge, O'Rourke, & Denaro, 2010; Shapiro, Partridge, Jenouri, Micalone, & Gifford, 2001) and loss of ability to perform an average of one activity of daily living (ADL) in the year following the traumatic event (Kelley-Quon et al., 2010). In general, elderly trauma patients have a decreased capacity to deal with serious injury and associated complex physiological disruption. For example, older adults have slower healing of bone and tissue and so take longer to recover (Jacoby, Ackerson, & Richmond, 2006; Soles & Tornetta, 2011a). This decreased capacity puts them at greater risk of having a longer hospital stay and using more resources, such as nursing care and medical supplies (Peschman, Neideen, & Brasel, 2011; Susman et al., 2002). In addition, an older adult who has experienced a traumatic injury is less likely to return home and is more likely to need the services provided at rehabilitation and long-term care facilities (Clark, Hannan, & Wu, 2010; Inaba, Goecke, Sharkey, & Brenneman, 2003; Lim, Hoffmann, & Brasel, 2007; Richmond, Thompson, Kauder, Robinson, & Strumpf, 2006; Sacks, Hill, & Rogers, 2011). The goal of trauma care is to stabilize the patient physiologically and then provide care and rehabilitation services to help the patient reach a functional level as close as possible to the pre-injury state.

Purpose and Hypotheses of the Study

The main purpose of this study is to examine in a group of 65+ post trauma adults, after controlling for demographic and health-related factors, the impact of comorbidity, time to initial evaluation by either the physical, occupational or speech therapy, and pain experienced during the therapy session on LOS and discharge disposition. Specifically, it is hypothesized that, controlling for age, gender, race/ethnicity, injury severity, and admitting diagnosis, individuals with more comorbid conditions, a longer period of time until first therapy evaluation, and more pain during therapy will have longer LOS and be less likely to be discharged to home. In addition, it is hypothesized that

1. The demographic variables of gender, age, and race/ethnicity are directly related to length of stay and indirectly related to length of stay through pain
2. The health-related variables of comorbidities, injury severity, and admitting diagnosis (head injury or fracture) are directly related to length of stay and indirectly related to length of stay through pain and days from admission to evaluation
3. Pain measured before, during, and after therapy is directly related to length of stay
4. Number of days from admission to evaluation is directly related to length of stay and to pain.
5. Comorbidities, pain, LOS, demographic variables (gender, age, and race/ethnicity), and health-related variables (injury severity and admitting diagnosis) are related to discharge disposition.

Identification of the factors associated with length of stay and discharge location is critical in order to work towards decreasing high cost acute-care and facilitating transfer to the least restrictive setting. This research study focuses on the dependent variables of length of stay (LOS) and discharge disposition.

Length of stay is the number of days from hospital admission to discharge. Hospitals often focus on LOS as a way of controlling cost of care. One reason is that each day in the hospital requires such fixed resources as nursing care, supplies, electricity, and others for patient care. Another reason is that insurance companies will reimburse hospitals only for care that is provided when a patient is an appropriate admission and then continues to require a specific level of care. Specifically, patients need to meet severity criteria that support the level of care for hospitalization and the need for continued care based on the intensity of service provided (Mitus, 2008). Determining LOS is a complex decision affected by such factors as insurance status, demographic factors of the patient, severity of illness, the number and type of comorbid conditions, patient functional status, social factors, and environmental issues.

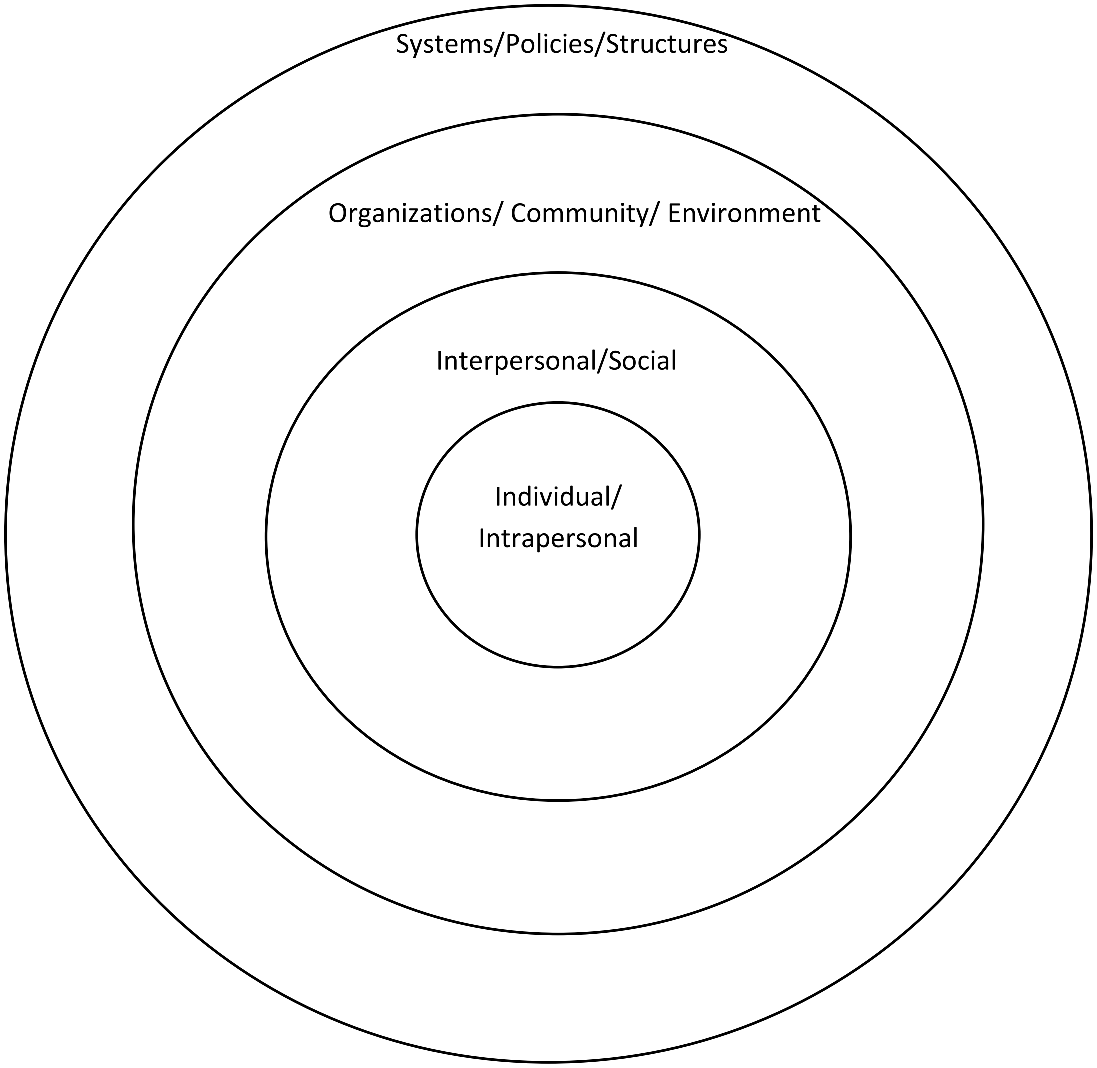
Discharge disposition is the location to which a patient goes when s/he is released from acute care: home, home with home care services, inpatient rehabilitation, long-term hospitalization, skilled nursing facilities, nursing homes, and hospice. Generally, most patients want to return to the setting from which they came (Bayer & Harper, 2000; Rantz et al., 2011; Sabia, 2008) unless they need additional services. In that case, it is best to match the available settings to the needs of the patient using discharge planning principles. Several factors can influence discharge disposition, including insurance/third party coverage, patient's functional level, safety, preference, and the appropriateness of returning to the original site (Lin, Cheng, Shih, Chu, & Tjung, 2012; Mason, Auerbach, & LaPorte, 2009; Shepperd et al., 2010). In addition, the recommendations of healthcare professionals and services available at the various sites also help determine where a patient goes (D. U. Jette, Grover, & Keck, 2003a; Lin et al., 2012; Shepperd et al., 2010).

While research and guidelines have shown that there are various factors—demographics, injury severity, and system factors—that influence discharge disposition and length of stay, only a small part of discharge disposition and length of stay has been examined. This study examines such additional factors as the effects of uncontrolled pain, comorbidities, and the length of time before a therapy evaluation is completed.

Conceptual Framework

Social-Ecological Model. The Social-Ecological Model (SEM) (see Figure 1) is used to provide a broad conceptualization of the factors that influence length of stay and discharge disposition. (Bronfenbrenner, 1977; Green, Richard, & Potvin, 1996; Gregson et al., 2001; McLeroy, Bibeau, Steckler, & Glanz, 1988; National Center for Injury Prevention and Control, 2009b). The SEM is the model suggested by the Centers for Disease Control and Prevention (CDC) in its injury research agenda and is applicable to circumstances surrounding traumatic injury (National Center for Injury Prevention and Control, 2009b). The description that follows is a composite of the various models described by Bronfenbrenner (1977), Green et al. (1996), Gregson et al. (2001), McLeroy et al. (1988), and the CDC (2009b).

Figure 1. Social-Ecological Model



(Bronfenbrenner, 1977; Green et al., 1996; Gregson et al., 2001; McLeroy et al., 1988; National Center for Injury Prevention and Control, 2009b).

The SEM describes an individual who lives within spheres of increasing size that are nested inside each other. The individual is in the center surrounded by an interpersonal/social level, an organization/community/environment level, and a system/policy/structural level. The individual level, also known as the intrapersonal level, represents those factors that are part of the individual, generally demographic variables. Included in this level are age, gender, race/ethnicity, and health status, which includes functional status, diagnoses, and symptoms (Bronfenbrenner, 1977; Green et al., 1996; Gregson et al., 2001; McLeroy et al., 1988; National Center for Injury Prevention and Control, 2009b). The next level is the interpersonal level, which represents the people with whom and the social environment in which the individual interacts on a frequent, sometimes daily, basis. Included in this level are immediate family members, close friends, and co-workers (Bronfenbrenner, 1977; Green et al., 1996; Gregson et al., 2001; McLeroy et al., 1988; National Center for Injury Prevention and Control, 2009b). Within a healthcare setting, this level is represented by care providers such as nurses, therapists, and physicians.

The organization/community/environment level encompasses the interpersonal and individual levels as the physical space increases in size and includes the physical environment for the patient and the way in which that environment facilitates or inhibits recovery. Also at this level, the neighborhood in which the patient lives is a focus and includes services and resources readily available to the patient, such as neighbors, healthcare resources, stores, churches, and schools. Healthcare settings might include ancillary services, staffing ratios, availability of weekend therapy, and such factors in the physical environment as furniture height, adequate therapy facilities, and access to primary care providers, specialists, and rehabilitation therapy. Finally, the policy level contains those forces which shape the other levels, such as state and federal government and the laws, regulations, and policies developed at those levels (Bronfenbrenner, 1977; Green et al., 1996; Gregson et al., 2001; McLeroy et al., 1988; National Center for Injury Prevention and Control, 2009b). The policy level also includes such considerations as Medicare or other insurer eligibility guidelines for rehabilitation services post-acute care.

In this study, the variables that influence discharge disposition and length of stay are examined, guided by the various levels of the SEM. At the intrapersonal/individual level, the characteristics of the patient are examined—age, gender, race/ethnicity, and health status as defined by primary diagnosis, comorbid diagnoses, and the symptoms a person experiences, such as pain. In addition, the preparation manuscripts of the review of comorbidity measurement and the descriptive study on pain in older trauma patients fit in the intrapersonal level. For this study, within the interpersonal sphere are caregivers within the hospital setting—speech language pathologists, occupational and physical therapists and the number of days from admission to initial therapy evaluation. The organization/community level represents the environment—in this case, the hospital—that has some proximity to the individual and influences the immediate resources available to that individual. For this study, the environment includes the LOS and discharge disposition. The policy level may influence the number of days a patient can stay in the hospital and where a patient goes after discharge based on insurance and cost of care.

Factors Known to Influence Length of Stay and Discharge Disposition

Age. Age is known to affect length of stay and discharge disposition; usually patients more than 65 years old have longer lengths of stay and more discharges to rehabilitation facilities or nursing homes (Clark et al., 2010; Conti, Friolet, Eckert, & Merlani, 2011; Johansen, Evans, Bartlett, & Stone, 1998; Peschman et al., 2011; Sacks et al., 2011). In some studies, 65+ trauma patients are further categorized as 65-74, 75-85, and 85+ (Fallon et al., 2006). Surprisingly, 85+ patients are found to have shorter lengths of stay but are discharged to facilities more often than those who are 65-84 (Bennett, Scarborough, & Vaslef, 2010a; McClaran, Berglas, & Franco, 1996).

Gender. Gender is also predictive of certain outcomes of traumatic events in the lives of older adults (Lim et al., 2007; Richmond, Kauder, Strumpf, & Meredith, 2002), including mortality, length of stay, and discharge to facilities. Women generally outlive men, which may contribute to the higher proportion of older women seen at trauma centers. Female patients are more likely to be discharged to a sub-acute facility (Cuthbert et al., 2011; Evans et al., 2012); however, gender has not been found to have an influence on LOS (Ottochian et al., 2009; Starnes, Hadjizacharia, Chan, & Demetriades, 2011).

Race/Ethnicity. Several studies find that race/ethnicity are factors in discharge disposition, length of stay, and mortality in older patients after trauma (Haider et al., 2008a; Lim et al., 2007). There are mixed data regarding the effect of race on discharge disposition: non-white patients are more likely to be discharged to home (B. R. Englum et al., 2011; Shafi et al., 2007); to a facility (Millham & Jain, 2009); or sometimes race does not make a difference (Marquez de la Plata et al., 2007). Non-whites seem to have shorter lengths of stay following a traumatic event (Millham & Jain, 2009).

Comorbidities. Since early studies of trauma in older patients, pre-existing illness has been recognized as a factor in outcomes (Sacco et al., 1993). Other later studies

(Chan, Moran, Clarke, Martin, & Solomon, 2009; Frontera, Egorova, et al., 2011; McMahon, Schwab, & Kauder, 1996; Soles & Tornetta, 2011) support the presence of comorbidities as factors that can produce more severe outcomes in adults who have experienced trauma, such as mortality, unsatisfactory discharge disposition, and length of stay. Comorbidities have been measured in various ways: the number of comorbidities a patient has, the severity of pre-existing illnesses, or use of administrative data in algorithms (Dominick, Dudley, Coffman, & Bosworth, 2005; Jain, Guller, Pietrobon, Bond, & Higgins, 2005; Quan et al., 2005; Roche, Wenn, Sahota, & Moran, 2005).

Injury Severity. Injury severity is one of the major predictors of outcomes: higher severity produces higher mortality, longer lengths of stay, and more discharges to nursing homes and rehabilitation facilities (Broos, D'Hoore, Vanderschot, Rommens, & Stappaerts, 1993; Gabbe et al., 2005; Malec, Mandrekar, Brown, & Moessner, 2009). Many methods for measuring injury severity have been developed based on these major categories: physiological (Revised Trauma Scale, Blood pressure, Glasgow Coma Scale), acute physiology combined with chronic health issues (APACHE II), organ failure (Sequential Organ Failure Assessment), inflammatory response (Systemic Inflammatory Response Syndrome Score), anatomic scores (Injury Severity Score, Abbreviated Injury Score, ICD-based Injury Severity Score), and a combination—combining the Revised Trauma Score with the Injury Severity Score and with age (Pohlman et al., 2010).

Insurance. Insurance status has been shown to affect where a patient goes after hospitalization and LOS in an acute-care setting (Cuthbert et al., 2011; B. Englum et al., 2010; Lane-Fall, Iwashyna, Cooke, Benson, & Kahn, 2012; Sacks et al., 2011). Insurance influences discharge disposition in that insurance pays for post-hospitalization services.

Medicare covers up to 100 days of skilled nursing care such as rehabilitation, intravenous medications, or wound-care in a post-acute care setting if there is a consecutive three day stay in the acute hospital setting as an admitted inpatient (Aragon et al., 2012; Centers for Medicare and Medicaid Services, 2007; Mor, Intrator, Feng, & Grabowski, 2010). These factors influence overall length of stay for older trauma patients who might have been discharged sooner. Certain services or settings may not be covered benefits and may be available to patients only if they pay out-of-pocket. In addition, insurance pays for a specific number of days in the hospital only so long as there is medical necessity, severity of illness, and intensity of service (Orland, 2011). In this study population, Medicare was available to all patients because they were 65+ years of age.

Acute Pain. Acute pain in older adults may lead to an interruption of therapy, prolonged rehabilitation treatment, and increased cost of care (Arinzon, Gepstein, Shabat, & Berner, 2007; Mehta, Siegler, Henderson, & Reid, 2010). A patient who is not able to participate in extensive physical therapy may be placed in a sub-acute rehabilitation or nursing facility rather than in acute rehabilitation or at home. Pain has been identified as a factor that can contribute to patients' inability to participate in therapy because of fear of pain with movement (Söderlund & Asenlöf, 2010). Specifically, adequate pain management is one factor that leads to early mobilization after hip surgery, treatment for hip fracture, which is a common traumatic event among older adults (Wellman, Murphy, Gulcynski, & Murphy, 2011). Pain management during therapy is particularly important since if pain is not managed, it can interfere with rehabilitation (38.6% of patients) and may even cause discontinuation of therapy (18.5% of patients) (Padua et al., 2012).

Therapy: Physical, Occupational, Speech. The physiologic changes that accompany aging are believed to exacerbate the negative impact of immobility (Corcoran, 1991; Creditor, 1993; Graf, 2006; Jacoby et al., 2006). In contrast, physical activity has been shown to be beneficial to the recovery process (Markey & Brown, 2002; Morris, 2007; Mudge, Giebel, & Cutler, 2008; Suesada, Martins, & Carvalho, 2007). Some of the benefits seen in those who have increased activity during acute care are increased strength (Truong, Fan, Brower, & Needham, 2009) and improved function in activities of daily living (C. J. Brown, Friedkin, & Inouye, 2004; Mudge et al., 2008; Padula, Hughes, & Baumhover, 2009). Secondary benefits to early mobilization in the hospital include decreased length of stay (Kamel, Iqbal, Mogallapu, Maas, & Hoffmann, 2003; Morris, 2007; Padula et al., 2009; Truong et al., 2009) and fewer discharges to other institutions (C. J. Brown et al., 2004).

Several studies show early and aggressive therapy following trauma, mechanical ventilation, and/or surgery improves outcomes (Morandi, Brummel, & Ely, 2011; Wellman et al., 2011). Exposure of critically ill adults to physical therapy and occupational therapy has been shown to improve muscle strength, flexibility, respiratory capacity, and general function (O'Connor & Walsham, 2009; Stockley, Morrison, Rooney, & Hughes, 2012). In addition, programs that encourage early mobility among older post-trauma adults or among those who are acutely ill improve function and decrease length of stay (Morandi et al., 2011; Wellman et al., 2011); therefore, exposing older post-trauma adults to therapy and other types of interventions geared toward increasing physical activity is critical to the recovery process.

Unfortunately, for hospitalized older adults, therapy may not be prescribed or initiated for various reasons: the perception that patients will not benefit from therapy, the patient's unwillingness to participate, increased pain with movement, and insurance issues (Alami et al., 2011; Gorman et al., 2010; Grill, Huber, Gloor-Juzi, & Stucki, 2010; A. M. Jette & Latham, 2010). Additional barriers to mobilizing patients in the acute-care setting include safety concerns, sedation, cost barriers, and time restraints (Morris, 2007).

Specific Aims and Overview of Chapters

The specific aims of this dissertation are to

1. explore the concept of comorbidity and ways to measure it (Chapter Two/Manuscript 1)
2. describe pain in older trauma patients during therapy and identify the factors that affect pain (Chapter Three/Manuscript Two)
3. test a comprehensive model of factors associated with length of stay and discharge disposition in older trauma patients (Chapter Four/Manuscript Three).

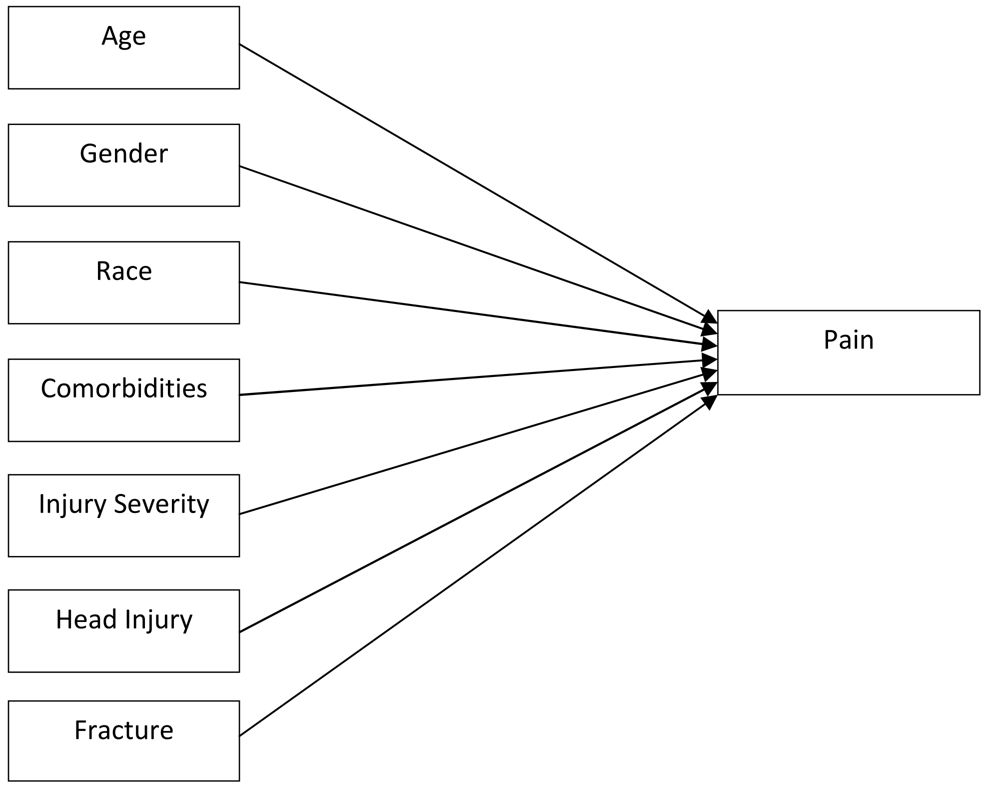
Measurement of Comorbidity. To better understand and consider the conceptualization and measurement of comorbidities in evaluation of trauma patients, a review paper (Chapter Two/Manuscript One) on ways to measure comorbidities was developed. Comorbidity is the presence of one or more diseases that are in addition to the primary diagnosis for which a patient is admitted to the hospital. There are several ways to measure comorbidities that can be used with an older trauma population: a simple count of the number of comorbidities, the Charlson Comorbidity Index, the Elixhauser method, the Geriatric Index of Comorbidity, the High Risk Diagnoses in the Elderly Scale, and the Mortality Risk for Trauma Comorbidity Index.

The sum of the number of comorbidities is the simplest and most often used method for measuring comorbidities. The widely used Charlson Comorbidity Index moves beyond a simple count to include weighting of 19 diseases associated with mortality. The Elixhauser method uses administrative data to rate the severity for 30 different conditions and has been used with many populations but not specifically with an older trauma population. The Geriatric Index of Comorbidity classifies patients into four classes of increasing comorbidity based on information from two areas—the number of diseases and the severity of diseases—and is based on information gathered from medical records. In the High Risk Diagnoses in the Elderly Scale, ten diagnoses found to be high risk diagnoses for mortality in this population are weighted on a scale of one to six based on the magnitude of risk for one-year mortality. The Mortality Risk for Trauma Comorbidity Index uses six different chronic conditions that are weighted based on mortality risk and was developed in a population that was not an older population.

In summary, the main findings of this review are that no specific measure of comorbidity exists for the older trauma population and that there is no single method of collecting comorbidity data that is recommended over others. What is recommended, however, is that the measure used should match the targeted population and the type of data available (Brotemarkle, Resnick, Morton, & Wells, submitted manuscript). Since there is no specific measure for the older trauma population, a simple count of comorbid conditions is used in model testing.

Assessment of Pain in Older Trauma Patients. Chapter Three/Manuscript Two will focus on an in-depth evaluation of pain in older trauma patients during therapy and the many factors that influence pain. Specifically, the focus of this Chapter/Manuscript is on describing pain in older trauma patients before, during, and after physical and occupational therapy using data that were collected for a primary study, the Shock Trauma Therapy Study. The most frequent method by the therapists for measuring pain is the Verbal Rating Scale (scale of zero to ten to rate pain intensity), followed by the Checklist of Nonverbal Pain Indicators (list of six behaviors that indicate the presence of pain, not intensity), and then the Verbal Descriptor Scale (list of six verbal categories from 'no pain' to 'worst imaginable pain'). Pain is not reported in approximately one-fourth of the patients, which may be due to the fact that the patients had no pain or that the assessment of pain was not complete. Approximately one-third of the patients who had pain reported severe pain (7-10 of 10), and another third reported moderate pain (4-6 of 10). Pain is lowest before the therapy session and highest during the session. Severe pain is most frequently reported in those who are non-white and female. Testing the impact of age, gender, race/ethnicity, number of comorbidities, and admitting diagnosis—whether admitting diagnoses involved a fracture or a head injury—on pain (Figure 2), number of comorbidities, and being admitted for a fracture are the only factors that significantly influence pain (Brotemarkle, Resnick, Morton, & Wells, submitted manuscript). In light of the variability and importance of pain during therapy and to optimally conceptualize pain, a pain measurement model was developed to consider pain before, during, and after a therapy session. All paths in the measurement model of pain are significant, and the pain measurement model was used in the full structural equation model tested.

Figure 2. Model for Chapter Three/Manuscript Two)



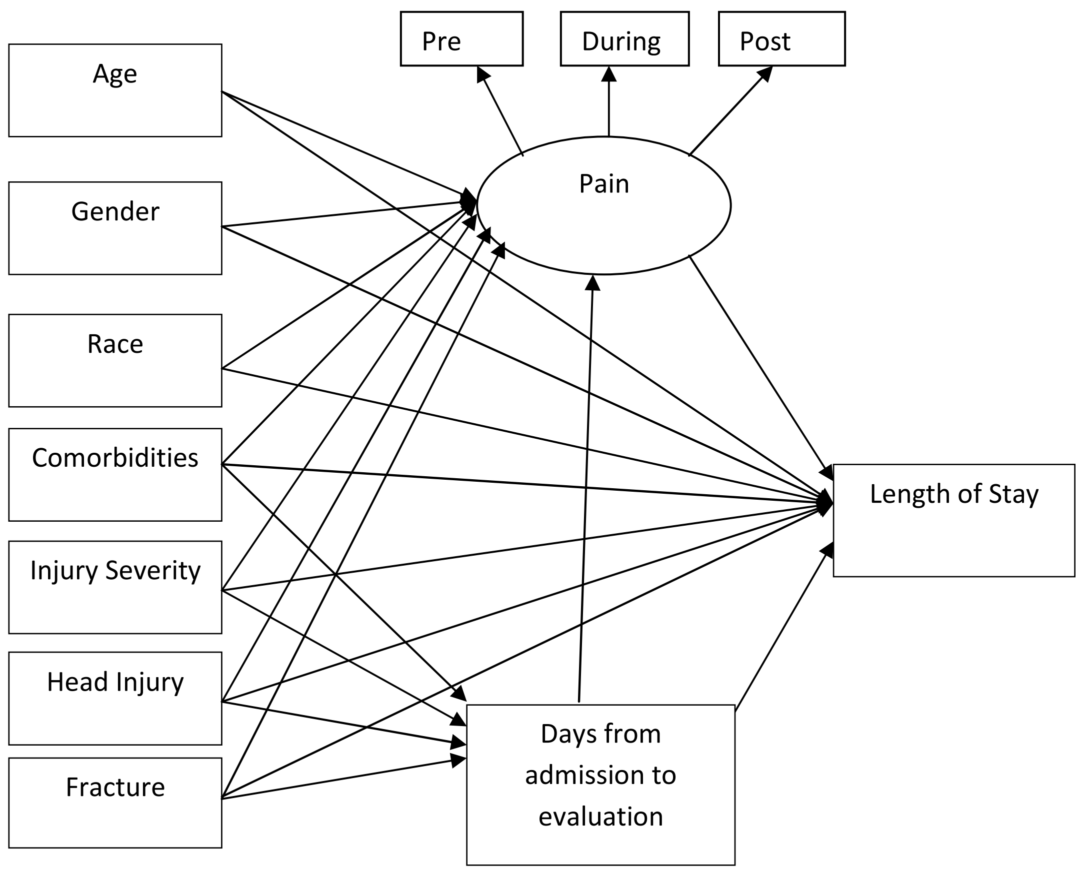
Factors that Impact LOS and Discharge Disposition. Building on the two Manuscripts, a model of factors associated with LOS and discharge disposition was developed based on empirical research and the Social Ecological Model. To test the impact of comorbidities, pain, and length of time from admission to first therapy evaluation on LOS, model testing was done (Figure 3). This model was tested using structural equation modeling. Of the 24 hypothesized paths, 15 were significant in explaining 40% of the variance in LOS. Age, comorbidities, pain, and days until first therapy evaluation were directly related to LOS.

In addition, patient age, injury severity, and admitting diagnosis were directly related to pain and indirectly related to length of stay through pain. Comorbidities and injury severity were directly related to the number of days from admission to evaluation and indirectly to length of stay through days from admission to evaluation. Unexpectedly, pain was not positively associated with LOS; instead, there was a negative relationship between pain and LOS.

Controlling for demographic and health-related variables, it was hypothesized that comorbidities, pain, LOS, and days from admission to therapy evaluation were related to discharge disposition. It was expected that patients with more comorbidities, more pain, longer LOS, and more time from admission to therapy evaluation were more likely to be discharged to a rehabilitation or long-term care setting.

Logistic regression was used to determine significant relationships among discharge disposition and comorbidities, pain, LOS, time from admission to therapy evaluation, the demographic variables, and the health-related variables. Specifically, it was observed that the more pain older trauma patients experience and the longer their

Figure 3. Model for Chapter Four/Manuscript Three



LOS, the more likely they were to be discharged to a rehabilitation or long-term care facility.

Definition of Terms

Age. *Age* was defined as the age in years of the participant at the time of hospitalization for the traumatic event.

Gender. *Gender* was defined as the self-identified gender of the participant as recorded in the medical record.

Race/Ethnicity. *Race/Ethnicity* was defined as the self-identified race and/or ethnicity of the participant as recorded in the medical record.

Comorbidities. *Comorbidities* was defined as the existence of pre-existing illness unrelated to the index disease or the admitting diagnosis (Feinstein, 1970; Gijsen et al., 2001; Hall, 2006; Valderas, Starfield, Sibbald, Salisbury, & Roland, 2009). For the purpose of this study, *comorbidities* was defined as the sum of pre-existing conditions as indicated in the medical record. These conditions included arthritis, cardiac disease, cancer, stroke, dementia, diabetes, hypertension, history of fall, psychiatric diagnoses, and seizure.

Injury Severity. *Injury severity* was defined as the degree of injury experienced by the study participants and is based on the body location, number of injuries, and degree of injury sustained. For the purpose of this study, the injury severity was determined by the rule that if a patient had more than one trauma diagnosis, had shock or a head injury with coma, the injuries were considered to be severe; otherwise, the injuries were considered to be mild/moderate. This method combined the physiological and anatomical methods of scoring injury severity (Oyetunji et al., 2010).

Acute Pain. *Pain* was defined as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" (International Association for the Study of Pain, 2011). Pain is a subjective experience and is whatever the person says it is (McCaffery, 1968; Pasero, Paice, & McCaffery, 1999). *Acute pain* is defined as pain generally associated with tissue damage and is time-limited (McCaffery & Pasero, 1999). Pain is a fluid experience that can change over time. For this study, those with pain experienced it throughout the rehab session, and the intensity of pain often changed based on activity level. Also, for the purpose of this study, pain was conceptualized using the intensity of pain before, during, and after a therapy session. Pain was measured using a verbal rating scale of zero to represent no pain and ten to represent the worst imaginable pain.

Therapy. For this study, three different types of therapy were provided to the participants—physical, occupational, and speech. "*Physical therapists* are healthcare professionals who maintain, restore, and improve movement, activity, and health enabling individuals of all ages to have optimal functioning and quality of life, while ensuring patient safety and applying evidence to provide efficient and effective care" (American Physical Therapy Association, 2011, p. 2). *Occupational therapy* is defined as therapy that "addresses the physical, cognitive, psychosocial, sensory-perceptual, and other aspects of performance in a variety of contexts and environments to support engagement in occupations that affect physical and mental health, well-being, and quality of life" (Association of Occupational Therapists of America, 2007, p. 3). *A speech-language pathologist* is defined as a "professional who engages in clinical services, prevention, advocacy, education, administration, and research in the areas of communication and swallowing across the lifespan from infancy through geriatrics" (American Speech-Language-Hearing Association, 2007). A therapy session was defined as the period of time during which a patient was seen by a therapist and therapy was provided. A participant could have received one or more sessions of either physical therapy, occupational therapy, or speech therapy or all three. For the purposes of this study, the days from admission to the hospital until the initial evaluation by either physical therapy, occupational, or speech therapy were used in the analysis. The days from admission to initial evaluation were counted by including the day of admission and subsequent days, but not including the actual day the patient was seen by therapy.

Length of Stay. Length of stay was the number of days a participant is in the acute care hospital. For this study, if a participant was discharged on the same day as admission, it was counted as one day. Length of stay in days was determined by counting the admission day and subsequent days, but not counting the day of discharge.

Discharge Disposition. Discharge disposition is the location to which a participant goes following hospital discharge. The possible choices are home, home with home health services, rehabilitation facility, long-term facility, nursing home, or hospice. For this study, discharge disposition was coded as a dichotomous variable—home or not home.

Assumptions of the Study

The following assumptions were made

1. Information in the electronic medical record is accurately recorded
2. Participants understood the questions asked about their experience of pain before, during, and after therapy

3. Pain intensity can be measured by the instruments used by the therapists

Significance of the Study

This study provides important information about older trauma patients, particularly the impact on LOS and discharge disposition made by pain, comorbidities, and time from admission to therapy-evaluation. Despite the growing number of older adults who sustain traumatic events, little work has been done in this area. Older trauma patients, compared with younger patients, have longer hospital stays (Peschman et al., 2011; Susman et al., 2002) and are more likely to have delayed discharges (S. N. Thomas, McGwin, & Rue, 2005). The longer patients stay in the hospital, the more likely they are to develop such complications as nosocomial infections (Dilworth & Pyenson, 2004; Glance, Stone, Mukamel, & Dick, 2011) and to lose their functional ability (Morris, 2007; Mudge et al., 2010; Padula et al., 2009). Thus, LOS has major cost implications at the state and national levels.

In addition to having an increased LOS, older adults are more likely to be discharged to rehabilitation facilities or long-term care sites (David E. Clark et al., 2010; Sacks et al., 2011) even though discharge to home is often preferred by older adults and is the discharge planning goal (Bayer & Harper, 2000; Rantz et al., 2011; Sabia, 2008). Interventions that facilitate discharge to the least restrictive setting may help to decrease cost (Buntin, Colla, Deb, Sood, & Escarce, 2010; Conti et al., 2011; Cook et al., 2013) and may also optimize quality of life (Stolee, Lim, Wilson, & Glenny, 2012; L. Watkins, Hall, & Kring, 2012). Also, longer LOS is associated with discharge to a facility (A. Y. Chen et al., 2012; Cuthbert et al., 2011), which can increase overall cost.

Finding ways to decrease acute care LOS and facilitate discharge to home is consistent with the current healthcare focus on decreasing costs while providing optimal care. Understanding the factors that influence LOS and discharge disposition may provide guidance for interventions to decrease LOS and optimize discharges to the least restrictive and lower-cost settings.

Pain during therapy and longer LOS were associated with discharge to a non-home setting. Unfortunately, it was noted that often during the therapy session, very little was done to manage pain. The most frequent action reported was continuing the therapy, followed by timing with medications, notifying the physician or nurse, and positioning the patient for comfort (Brotemarkle et al., submitted paper). Several possibilities exist for improvement in pain-management including the use of additional modalities, such as heat, ice, electrotherapy, and massage. These methods are known to be used successfully by therapists (Christo, Li, Gibson, Fine, & Hameed, 2011; Wan, 2011). In addition, communication between providers, especially therapy and nursing, to make sure patients are available, pre-medicated, and ready for therapy sessions may improve the time and outcomes of therapy. Pain-management education for providers and patients is another potential intervention to enhance participation in therapy sessions.

Limitations

This study was a secondary-data analysis and thus was not designed to answer the primary research questions. Several factors that may influence LOS and discharge disposition were not included: pain-management interventions used (i.e., medication ordered and/or given), detailed information about what happened during therapy sessions, and whether or not there was carry-over or involvement of the nurses in therapy-related activities. The study was also limited in that it was descriptive in nature; the sample size was relatively small, which may mean the study was underpowered for some of the analyses; the data were collected at a single site, which influences generalizability. The study sample was comprised of older adults (65+ years) but may not be representative of the older population in regard to race/ethnicity. Although a higher number of women than men had been expected, a situation which has been found in previous studies of older trauma patients (ranging from 58.9% -76.7% female) (Aitken, Burmeister, Lang, Chaboyer, & Richmond, 2010; Arora et al., 2009; Clement, Tennant, & Muwanga, 2010). the number of male and female participants was nearly the same,

Summary

The purpose of this study was to examine the factors that contributed to length of stay and discharge disposition in post-trauma older adults. This Chapter described the background, significance, and purpose of this secondary data analysis. The Social-Ecological Model guided the variable selection and interpretation of the results. In addition, an overview of Chapters Two, Three, and Four was provided.

CHAPTER TWO:

Measurement of Comorbidity in the Geriatric Trauma Population: A Review of Methods[1]

Introduction

Definition of comorbidity. Comorbidity is defined by Feinstein (1970, p. 455) as "Any distinct additional entity that has existed or may occur during the clinical course of a patient who has the index disease under study, where the index disease is the reason for hospitalization and distinct entities are comorbid conditions." Others have used similar definitions for comorbidity with an index disease and then additional conditions that may be related or unrelated to the index disease (Gijsen et al., 2001; Hall, 2006; Valderas et al., 2009). Comorbidity alone or with an index disease has certain causes and consequences, and the index disease and comorbidities can share the same risk factors (de Groot, Beckerman, Lankhorst, & Bouter, 2003; Gijsen et al., 2001). Some authors have preferred to use the term *multimorbidity,* defined as the co-occurrence of any two or more chronic or acute medical conditions (Batstra, Bos, & Neeleman, 2002; Bayliss, Edwards, Steiner, & Main, 2008; van den Akker, Buntinx, Metsemakers, Roos, & Knottnerus, 1998). Although there continues to be controversy over which term to use, *comorbidity* is used most frequently and is commonly accepted as the standard term in scholarly literature.

Comorbidity in the trauma population. Comorbidity in the trauma population is a significant issue because it has been found to influence the occurrence of a traumatic event (Dennison et al., 2012; Thompson, Dikmen, & Temkin, 2012; Tseng, Yu, Lum, & Coleman, 2012) and has been identified as a risk factor for post-trauma mortality

[1] Placko-Brotemarkle, R.A., Resnick, B., Morton, P. & Wells, C. Manuscript in preparation

(Brattström et al., 2012; Wardle, 1999) even independently of age (Hollis, Lecky, Yates, & Woodford, 2006; Wutzler et al., 2009). Comorbid conditions are most frequently considered after the initial stabilization of patients who have experienced a traumatic event and again during the recovery period (Kelley-Quon et al., 2010). A patient's having multiple comorbidities was found to be a strong predictor of mortality following surgery to repair hip fractures (F. Hu, Jiang, Shen, Tang, & Wang, 2012) Such additional outcomes as length of stay, 30-day readmissions, and cost of hospitalization are influenced by comorbid conditions (L.-T. Chen, Lee, Chua, & Howe, 2007; Khan, Hossain, Dashti, & Muthukumar, 2012; Nikkel et al., 2012; Niven, Kirkpatrick, Ball, & Laupland, 2012).

Comorbidity in the aging population. As age increases, the prevalence of patients with at least one comorbidity increases so that for those 20-24 years of age, the prevalence of comorbidities is generally 0.6%; for those 65-69 years of age, the prevalence is 47.2%; and for patients 85-89 years of age, the prevalence is 74.1% (Bergeron, Rossignol, Osler, Clas, & Lavoie, 2004). The Centers for Disease Control and Prevention estimates that in those over the age of 65, 80% have at least one comorbid condition, and 50% have two or more comorbid conditions (Bergeron et al., 2004). Since older age is associated with higher prevalence of comorbidities, older adults who have experienced a traumatic event are more likely to have poor outcomes (L.-T. Chen et al., 2007; F. Hu et al., 2012; Khan et al., 2012).

Trauma in the older population. Data from the National Trauma Data Bank (National Trauma Data Bank, 2012) reveal that a large percentage of all trauma incidents in 2010 occurred in people over age 55 (n=221,429, 33%) with most incidents resulting from falls or motor vehicle accidents. The percentage of traumatic events involving older adults increased from 19.92 percent in 2003 to 26.79 percent in 2008 and is expected to grow. The fastest growing segment of the geriatric trauma population is people over age 80, a situation which will impact the number of older adults requiring care after a traumatic event (U.S. Census Bureau, 2010). Trauma in the elderly involves many types of traumatic events and injuries, the most frequent in those over age 65 being hip fractures and/or other orthopedic injuries (NTDB, 2010). Other common injuries can be traumatic brain injuries, blunt trauma, piercing injuries, and burns (National Trauma Data Bank, 2012; Thompson & Bourbonniere, 2006).

Purpose

The purpose of this article is to explore ways to measure comorbidity in a geriatric trauma population. Because of the effects of comorbidities on morbidity and mortality in trauma patients, it is important to assess areas that can be addressed to control cost and to improve outcomes. Comorbidity is one area that can be addressed during hospitalization and may affect recovery, length of stay, and readmission rate. For example, a patient who comes to the hospital with a fractured hip may have uncontrolled heart failure, which may add a hospitalization day and thus add to the cost of care. Expenses for those patients with one comorbidity are estimated to cost twice as much (U.S. Department of Health and Human Services, 2006), and for those with five or more comorbidities costs are estimated to be 14 times as much as those with no chronic conditions (Partnership for Solutions, 2002).

Importance of measuring comorbidity. In clinical practice, age and comorbidity are taken into account when planning clinical management. In clinical research studies, it is important to identify anything that may interfere with measuring the outcome of interest. For example, in measuring length of hospital admission due to stroke, the number of days a patient is in the hospital may be influenced by diabetes and heart failure in addition to the original cause of hospitalization. In statistical research, the effects of comorbidity were rarely considered (Kaplan & Feinstein, 1974) but now are becoming more commonplace. In order to measure comorbidity in statistical studies in which coexisting disease is an important variable of interest, a valid comorbidity measure should be used. A comorbidity index can help with statistical efficiency because trying to determine the effect of multiple individual conditions or diseases can be very complex (de Groot et al., 2003; Hall, 2006).

Ways to measure comorbidity. Counting the number of disease conditions unrelated to the index disease (Grossman, Miller, Scaff, & Arcona, 2002; Marengoni et al., 2011) is the simplest way to measure comorbidities (see Table 1). Identification of comorbid conditions in order to make such counts is through medical chart review or through the use of administrative data, most frequently International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes or specific databases (Roche et al., 2005; Moore et al., 2008). Counting gives the total number of comorbidities, but all diagnoses are scored the same without taking severity or disease interactions into account.

Alternatively, comorbidity can be measured using an index which gives a single numeric score and allows for comparisons among patients (Hall,2006). Indices can be general or specific. Comorbidity can be measured using general indices that often include a list of conditions weighted for risk (Hall, 2006), such as the Charlson Comorbidity

Table 1. Comparison of Comorbidity Measures

Comorbidity Measure	Developer & Year	Description	Methodology	Advantages	Disadvantages
Counting	N/A	Using medical records or ICD-9 codes, the number of comorbid diseases is counted	• Simple counting of number of comorbid conditions • End-up with a total sum of comorbid conditions • May have a list of comorbid conditions from which to choose or can have an open list	• Conceptually simple • Ease of ascertaining data	• Diagnoses are all scored the same (different diseases and their severity may affect outcomes differently) • Ignores interactions between diseases
Charlson	Charlson, Pompei, Ales, MacKenzie. 1987	17 categories of comorbidity (another version has 22 conditions and predicts 10-year mortality)	• Primarily defines categories of comorbidity by ICD-9 or procedure codes • data are obtained from medical record review • Each category has an associated weight (from 1-6) from the original Charlson paper • Final score is the sum of the weighted values • Overall comorbidity score reflects the cumulative increased likelihood of one-year	• Coding has been updated for use with ICD-10 • Addresses non-equivalency and severity • Most widely used • Has been used with various forms of data	• ICD-9 codes can refer to complications or comorbidities which may overestimate burden of comorbid disease • Has been used with various types of data:

Table 1. (Continued)

			mortality • Higher score = more severe burden of comorbidity		
Elixhauser	Elixhauser, Steiner, Harris, Coffey 1998	defines 30 comorbid conditions	• uses ICD-9-CM codes • meant to be used with large administrative data sets assigning sets of 5-digit ICD-9-CM diagnoses	• Basis for software tool used by the (HCUP), a Federal-State-Industry partnership sponsored by the AHRQ • Addresses non-equivalency and severity • Data already collected for other purposes	• Data are of variable quality; missing data
Geriatric Index of Comorbidity	Rozzini, Frisoni, Ferrucci, Barbisoni, Sabatini, Ranieri, Guralnik, Trabucchi 2002	No specific number	• Comorbidity is measured as number of diseases and sum of disease severity which creates GIC • Mortality is measured after 12 months • Based on Greenfield's IDS as measure of severity of individual diseases as a correlation of disability and predictor of mortality • Uses a closed standard list of somatic chronic conditions that frequently affect geriatric patients	• Gives a composite score which takes into account the number of diseases and the occurrence of very severe diseases (or disease burden) • GIC has the greatest concurrent validity with disability and is the best predictor of mortality compared to count or disease severity	• The hierarchical nature of the GIC does not allow for discriminating degrees of comorbidity of conditions whose severity level is below most severe conditions • Not assessed in other clinical settings • Requires trained provider for the staging of disease severity using Greenfield's IDS

Table 1. (Continued)

High Risk Diagnoses for the Elderly Scale (HRDES)	Desai, Bogardus Jr, Williams, Vitagliano , Inouye. 2002	The HRDES was developed to predict 1-year mortality in elders admitted to the general medical service of an acute-care hospital; a weighted risk-adjustment index specific to older people; recommended for mortality prediction in patient groups or populations	• Uses 10 conditions selected from candidate list of 22 ICD-9-CM–coded conditions • Individual condition weights, based on the magnitude of 1-year mortality risk, ranged from 1 (pneumonia, diabetes mellitus with end-organ damage) to 6 (lymphoma/leukemia)	• uses readily available demographic, health system, and clinical comorbidity data • the prediction rule is nonproprietary • the High-Risk Diagnoses for the Elderly Scale was consistently a stronger, more accurate predictor of 1-year mortality • simplicity and ease of use compared with other risk-adjustment indices the 10 high-risk diagnoses that were included in the index have strong face validity for the older population • first risk-adjustment system designed specifically for older people based on administrative data	• the development and validation cohorts were selected and drawn from a single study site, raising a potential concern for the generalizability • a risk-adjustment index based on administrative records, such as the High-Risk Diagnoses for the Elderly Scale, potentially underestimates the effects of diagnoses that are underreported in administrative databases • lack of accuracy of administrative data • although comparable in size to the original Charlson study, the sample size of the development cohort was limited
Mortality Risk for Trauma Comorbidity Index (MoRT)	Thompson , Rivara, Nathens, Wang, Jurkovich, Mackenzie_2010	a comorbidity index to predict the risk of mortality associated with chronic health conditions following a traumatic injury	• Six comorbidity factors were independently associated with the risk of mortality and formed the basis for the MoRT	• The MoRT had a similar overall discrimination as the CCI for mortality at hospital discharge in injured adults • Similar results were seen at 1-	• although neither CCI or MoRT by itself performed well the development and validation cohorts were selected and drawn from a single study

Table 1. (Continued)

				year postinjury • The MoRTs primary advantage over current instruments is its parsimony, containing only 6 items	site, raising a potential concern for the generalizability

Index (CCI) and the Elixhauser method.

Examples of specific indices include those for epilepsy (St Germaine-Smith, Liu, Quan, Wiebe, & Jette, 2011), kidney disease with dialysis (Liu, Huang, Gilbertson, Foley, & Collins, 2010), and trauma (Thompson et al., 2010). Some examples of comorbidity measures developed for use in an older population include the High Risk Diagnoses for the Elderly Scale (HRDES) (Desai, Bogardus, Williams, Vitagliano, & Inouye, 2002), and the Geriatric Index of Comorbidity (GIC) (Rozzini et al., 2002) (see Table 1). The GIC was adapted from general indices (Miller et al., 1992; Rozzini et al., 2002); the HRDES was developed specifically using a geriatric population (Desai et al., 2002).

Methods

A search of the literature was performed using CINAHL and PubMed databases as well as Google Scholar. Search terms included comorbidity, multimorbidity, Charlson, and Elixhauser with each of these terms combined with the terms *geriatric* and *trauma*. Articles chosen were limited to those in English. The years were not limited since several of the tools were developed in the late 1900s and the definition of comorbidity was first proposed in 1970. The tools chosen for review included two widely used general indices, the CCI and the Elixhauser method, two indices specific to the geriatric population, the HRDES and the GIC, and one recently developed index for the trauma population, the MoRT.

Measures of Comorbidity Considered for Use in a Geriatric Trauma Study

General Indices

The Charlson Comorbidity Index. The CCI (see Table 1) was one of the first indices developed to measure the effects on mortality of comorbid conditions in hospitalized patients (Charlson et al., 1987). The CCI has been widely used to measure comorbidities and has been extensively studied (de Groot et al., 2003). Several adaptations exist for use with large administrative inpatient datasets, including independent adaptations by Deyo, Chirkin & Ciol (1992), Romano, Roos & Jollis (1993), and D'Hoore, Bouckaert & Tilquin (1996) using ICD-9 codes. The original measure included 19 diseases (see Table 2) that were weighted on a scale of one to six for their association with mortality and then summed to produce an index score in which a higher score means a more severe burden of comorbidity (Charlson et al., 1987). The index was initially developed using a sample of 559 patients admitted to the medical service at New York Hospital over a thirty-day period. The measure was then validated in a sample of 685 breast cancer patients (M E Charlson, Pompei, Ales, & MacKenzie, 1987). Comorbid diseases were identified using medical records review, and common diseases were also coded for severity (Charlson et al., 1987). The main strengths of the CCI include its wide use in various populations and settings and its ease of use and established reliability and validity. In addition, the CCI addresses non-equivalency of comorbid conditions in addition to the severity.

The CCI has been adapted for use with ICD-9 and ICD-10 codes from administrative data (Nuttall, van der Meulen, & Emberton, 2006; Quan, Parsons, & Ghali, 2002). Since the original version of the CCI, several adaptations have emerged, including the adaptations by Deyo, Romano, D'Hoore, Klabunde, and Librero. The Deyo adaptation was developed for use with administrative data (Deyo et al., 1992). The calculation of the comorbidity score involves using the same comorbid diseases as the

Charlson and matching them to ICD-9-CM codes (Deyo et al., 1992). Similarly, the Romano adaptation was developed for use with administrative data using the diseases in the original CCI, but with slightly different ICD-9-CM codes (Romano et al., 1993). The Deyo and Romano adaptations of the CCI have been used to consider comorbidity among patients across a wide variety of clinical conditions and situations including elderly patients with hip fracture (Radley, Gottlieb, Fisher, & Tosteson, 2008) and burn injury (Lundgren et al., 2009). Librero further revised the Deyo and Romano versions of the CCI using the extended ICD-9-CM codes (Deyo et al., 1992; Librero, Peiró, & Ordiñana, 1999; Romano et al., 1993). Klabunde and D'Hoore adapted the CCI for use with administrative data, each using slightly different ICD-9-CM codes matched to the original diagnoses in the CCI. A disadvantage of using ICD-9 codes is that they may include complications that can overestimate the burden of disease, and there may be miscoded or missing data.

Versions of the CCI using administrative data have been found to perform about equally well as the original CCI (Ghali, Hall, Rosen, Ash, & Moskowitz, 1996; Kieszak, Flanders, Kosinski, Shipp, & Karp, 1999). In a population of Medicare patients with atrial fibrillation, the chart review performed no better than administrative data indices in predicting mortality (Yan et al., 2005). However, in a population of Medicare beneficiaries undergoing a carotid endarterectomy, the Charlson index using chart data performed better than using ICD-9-CM coded administrative data in predicting mortality, length of stay, and complications (Kieszak et al., 1999). Moreover, the addition of the CCI to the Trauma and Injury Severity Score (TRISS), with or without the addition of age, did not improve the amount of variance explained by comorbidities with regard to mortality (Gabbe, Magtengaard, et al., 2005).

Elixhauser Method. An alternative method of measuring comorbidity using administrative data was developed by Elixhauser et al. (1998) (see Table 1). The Elixhauser method uses ICD-9-CM codes and includes 30 different categories of comorbid illness (Elixhauser et al., 1998) as shown in Table 2. This number is almost twice as many as in the CCI adaptations. In the Elixhauser method, there is no differentiation between diagnosis codes from prior admissions and those present at the beginning of the index hospitalization. In addition, codes for complications developed during the index hospitalization are not included (Stukenborg, Wagner, & Connors, 2001). Advantages of using the Elixhauser are that it addresses non-equivalency and severity, uses data that have already been collected for other purposes, and has a software program available for calculating a comorbidity score. However, a disadvantage of the Elixhauser and the adaptations of the CCI is that coding of administrative data carries the risk of inaccurate coding of diagnoses and the inability of certain databases to extend beyond a given number of diagnoses (Baldwin, Klabunde, Green, Barlow, & Wright, 2006; Iezzoni, 1997; Quan et al., 2002; Romano & Mark, 1994).

The initial sample used to develop the Elixhauser method included inpatients in community hospitals in California (n = 3,597,735) and was narrowed by making exclusions (i.e., excluding maternity patients) (n = 1,779,167). The comorbidities were chosen from a total of 41 because they were the ones most often associated with increased length of stay, increased hospital charges, and increased mortality (Elixhauser et al., 1998). The chosen conditions were evaluated in both a heterogeneous population and homogenous populations such as breast cancer, acute myocardial infarction, asthma,

Table 2. List of comorbidities for the CCI, Elixhauser Method, HRDES, MoRT	CCI	Elixhauser	HRDES	MoRT
Congestive heart failure	X	X	X	
Cardiac arrhythmias		X		X
Valvular disease		X		
Pulmonary circulation disorders		X		
Peripheral vascular disorders	X	X		
Hypertension		X		
Paralysis		X		
Other neurological disorders		X		
Chronic pulmonary disorders	X	X	X	
Diabetes, uncomplicated	X	X		
Diabetes, complicated/end organ damage	X	X	X	
Hypothyroidism		X		
Renal failure		X		
Liver disease		X		
Peptic ulcer disease excluding bleeding	X	X		
Acquired Immune Deficiency Syndrome	X	X		
Lymphoma	X	X	X	
Metastatic cancer	X	X	X	
Solid tumor without metastasis	X	X	X	
Rheumatoid arthritis/collagen vascular disease		X		
Coagulopathy		X		
Obesity		X		
Weight loss		X		
Fluid and electrolyte disorders		X		
Blood loss anemia		X		
Deficiency anemias		X		
Alcohol abuse		X		
Drug abuse		X		
Psychoses		X		
Depression		X		X
Myocardial Infarction	X			X
Cerebrovascular Disease	X			X
Dementia	X			X
Connective Tissue Disease	X			
Mild Liver Disease	X			
Hemiplegia	X		X	
Moderate-Severe Renal Disease	X			
Leukemia	X		X	
Moderate-Severe Liver Disease	X			X
Acute Renal Failure			X	
Chronic Renal Failure			X	
Pneumonia			X	

appendicitis, abdominal hernia, pneumonia, and diabetes mellitus with complications (Elixhauser et al., 1998). The Elixhauser method has also been used to determine the impact of comorbidities on 30-day readmissions (Silverstein, Qin, Mercer, Fong, & Haydar, 2008), osteoporosis (Lix, Quail, Teare, & Acan, 2011), and hip fracture (French, Bass, Bradham, Campbell, & Rubenstein, 2008).

The Elixhauser method uses binary coding: a score of one is given to a patient with one of the included conditions or a zero if the patient does not have a condition (Elixhauser et al., 1998). This method can be somewhat cumbersome when compared with fewer conditions that are counted and weighted, as in the CCI and its adaptations. One possible solution may be to condense the Elixhauser method into a single numeric score to summarize comorbidity from 21 of the 30 comorbidity conditions (van Walraven, Austin, Jennings, Quan, & Forster, 2009). Included in the Elixhauser method is an algorithm to remove any diagnosis code that is related to the primary diagnosis. For example, a secondary diagnosis of cardiac arrhythmia would not be included if the primary diagnosis is cardiac in nature (Stukenborg et al., 2001). Likewise, an algorithm is included that avoids double counting related diagnoses.

Specific Indices

A few years later, three specific indices, the Geriatric Index of Comorbidity (Rozzini et al., 2002), the High-Risk Diagnoses in the Elderly Scale (HRDES) (Desai et al., 2002), and the Mortality Risk for Trauma Comorbidity Index (MorT) (Thompson et al., 2010) were developed for use with the geriatric trauma population.

The Geriatric Index of Comorbidity. The Geriatric Index of Comorbidity (GIC) classifies patients into four groups of increasing comorbidity based on information from two areas—the number of diseases and the severity of diseases (Rozzini et al., 2002) (see Table 1). Severity of disease is based on Greenfield's Individual Disease Severity (IDS), which uses the following scale: IDS 0 = absence of disease, IDS 1 = asymptomatic disease, IDS 2 = symptomatic disease requiring medication but under satisfactory control, IDS 3 = symptomatic disease uncontrolled by therapy, and IDS 4 = life-threatening disease or greatest severity of disease (Rozzini et al., 2002). Severity of disease is then based on the definitions of each class: Class I – patients with one or more conditions with an IDS of 1 or lower; Class II – patients with one or more conditions with an IDS of 2; Class III – patients with one condition with an IDS of 3 and other conditions having an IDS of 2 or lower; and Class IV – patients with two or more conditions with an IDS of 3 or one or more conditions with an IDS of 4 (Rozzini et al., 2002). The GIC has been used with geriatric-hospitalized older patients (Zekry et al., 2010) with recurrent syncope (Vetta et al., 2009), with prolonged hospital stays after cholecystectomy (Cheng et al., 2008), and with a classification of having delayed discharges (Becchi, Pescetelli, Caiti, & Carulli, 2010).

One of the issues with the GIC is that the staging of severity using Greenfield's IDS requires a trained healthcare provider who has access to all necessary clinical data, such as history and physical, laboratory values, medication list, and progress notes (Rozzini et al., 2002). Also, the hierarchical nature of the measure does not take into consideration any conditions below the most severe. The GIC was found to have concurrent validity with disability and to be the best predictor of mortality compared to five other comorbidity scores (CCI, CIRS-G, Index of Coexistent Diseases, Kaplan, and Chronic Disease Score) (Zekry et al., 2011). The GIC was associated with an increase in delayed discharges; and, as would be expected, 74% of delayed discharges were in Class IV patients (Becchi et al., 2010). From a clinical perspective, this measure could be used to provide important clinical information: for example, those in Class IV might benefit from close monitoring for risk factors associated with longer lengths of stay.

High Risk Diagnoses in the Elderly Scale. The High Risk Diagnoses in the Elderly Scale (HRDES) was developed as a risk adjustment index for one-year mortality in hospitalized elders (Desai et al., 2002) (see Table 1). Two cohorts of general medical hospitalized patients over age 70 were used to test this measure initially. Development of the HRDES was done with a sample of 524 patients, and validity was tested using a sample of 852 patients (Desai et al., 2002). Ten diagnoses (Table 2) found to be high risk diagnoses for mortality in this population were used and weighted on a scale of one to six based on the magnitude of risk for one-year mortality (Desai et al., 2002). The High Risk Diagnoses in the Elderly Scale was used to examine 30-day readmission rates and was found to be valid in a population of older adults (65+) who were admitted to the hospital between July 2002 and June 2004 (Silverstein et al., 2008).

Advantages of the HRDES are that it uses readily available data, it is nonproprietary, it is relatively simple to use, and it has strong face validity. The main disadvantage is that the development and validation samples were taken from the same site, making generalizability an issue. Also, coding of the data may not be accurate.

Mortality Risk for Trauma Comorbidity Index. The Mortality Risk for Trauma Comorbidity Index (MoRT) was developed to predict mortality in trauma patients who had chronic health conditions in addition to those comorbid conditions included in general comorbidity indices, such as the CCI (Thompson et al., 2010) (see Table 2). The study used data from the National Study on the Costs and Outcome of Trauma with the sample (n=4644) divided in half, one-half to develop the scale using those conditions with a prevalence of ≥ 1% in the total population and the other half to validate the scale, comparing its performance to the CCI (Thompson et al., 2010). The sample had a mean age of 43 years, was predominantly male, and had injury scores indicative of moderate injury. Six comorbid conditions were found to be independently associated with mortality risk (see Table 2), two of which were not identified in the CCI—cardiac arrhythmias and depression (Thompson et al., 2010). The MoRT uses the six comorbid conditions and assigns weights to them based on the coefficients from the final multivariate logistic regression model. The MoRT was found to be similar to the CCI for predicting in-hospital mortality but was not as good at predicting one-year post-discharge mortality unless age and gender were added to the model (Thompson et al., 2010). One of the major benefits of the MoRT is the parsimony of the model since it includes only six comorbid conditions.

Applicability to the Geriatric Trauma Population. Each of the comorbidity measures reviewed as appropriate options for older trauma patients has its unique characteristics, advantages, and disadvantages, most often with great variation (Table 3).

Purpose, population, setting and outcome. The purpose, population, and outcomes vary from measure to measure. In selecting a comorbidity measure, it is best to match the population, settings, and outcomes as closely as possible based on the available data.

Table 3. Characteristics of Comorbidity Measures

Comorbidity Measure	Sample	Type of data	Number of Conditions	Outcome	Validity
Charlson	n = 604 hospitalized adults	Chart abstraction	17	In-hospital mortality and 1-year mortality	- Gold standard with which others are compared - originally validated in breast cancer patients - Used in many populations
Elixhauser	n = 1,779,167 hospitalized adults	Administrative data	30	Length of stay, cost, mortality	- Several studies have compared to CCI and its different versions - Usually outperforms CCI
HRDES	n = 524 hospitalized general medical patients 70 +	Chart abstraction	10	1-year mortality	- 524 used to develop measure and 852 used to validate
GIC	n = 493 elderly patients admitted to hospital (mean age = 79 years)	Chart abstraction	15	In-hospital mortality and 1-year mortality	- Used in geriatric hospital, recurrent syncope patients, delayed discharges, prolonged hospitalization for cholecystectomy - Score increases as disability increases - Most delayed discharges in Class IV patients
MoRT	n = 4644 hospitalized trauma patients; primarily male, average age 43, moderate injury severity	Chart abstraction	6	In-hospital mortality and 1-year mortality	- ½ of sample used to develop measure and ½ sample used to validate - Compared to CCI: similar in-hospital mortality only

been used in several studies as the index against which others are measured (Beloosesky et al., 2011; Chu et al., 2010; Fortin et al., 2005; Kieszak et al., 1999; Lix et al., 2011; Southern et al., 2004; Yan et al., 2005; Zekry et al., 2011). Content, construct, and criterion validity have been established for the CCI, and reliability has been established using inter-rater reliability. The Elixhauser method has shown criterion validity using the CCI and its adaptations as the gold standard. The GIC has been found to be valid for predicting mortality and to have concurrent validity since as the GIC score increased, disability also increased in an elderly population (Rozzini et al., 2002). Both the HRDES and the MoRT used one sample to develop the measure and a similar sample to validate the measure. Reliability has not been addressed for the Elixhauser method, the HRDES, and the MoRT.

Feasibility and generalizability. The CCI is somewhat generalizable to many populations since it has been used in so many different types of samples and has been found to be reliable and valid. The CCI is somewhat difficult to use since it requires a trained healthcare provider to complete. Similarly, the GIC, the HRDES, and the MoRT also require a trained healthcare professional for completion. The Elixhauser method, the GIC, the HRDES, and the MoRT are generalizable only to populations similar to those used in the original studies. The MoRT is one of the easiest to use since it has only six items. The Elixhauser method, on the other hand, has 30 items and uses administrative data. Since a software program is available for the Elixhauser, it is relatively easy to use.

Discussion

Among the comorbidity measures for use with adults, several have been used with older adults or with trauma patients. One way to determine the best comorbidity measure for the older trauma population is to look at the feasibility and generalizability of the measures, the population of interest, the performance of the measures, and the outcomes of interest.

Choosing a comorbidity measure. When considering which comorbidity measure to use, it is important to consider the purpose of measurement for the given study or clinical situation. The instrument used to measure comorbidity must be matched to the outcome or purpose of use. Each comorbidity measure has been developed for a specific reason (Hall, 2006) and with a focus on a specific population, setting, and/or clinical outcome.

The psychometrics of the measure are also of importance. In addition to demonstrating evidence of the reliability and validity of the measuring being used, it is also important to consider feasibility and generalizability. Outside the actual measure, the type of data available must be matched to the index to be used. Therefore, for the CCI, patients' charts must be available for abstraction; for the Elixhauser method, a database with administrative data must be used. Finally, use of a general or a specific index should be determined (Hall, 2006). For a study examining the predictors of length of stay and discharge disposition, the Elixhauser method is the best fit.

Use of reviewed measures in geriatric trauma. The CCI has been used in the elderly with hip fracture, burn injury, and general hospitalization. The Deyo and Romano variations of the CCI have also been used in many different populations but not specifically in the older trauma population. The Elixhauser method has been used in an older adult population with 30-day readmissions and with hip fracture. Neither the CCI nor the Elixhauser method has been found to be particularly useful in a general trauma population (Gabbe, Magtengaard et al., 2005). The lesser known comorbidity indices—the GIC, the HRDES and the MoRT—that were reviewed are more specific to the population of interest. The GIC has been used in older patients admitted to a geriatric hospital, with recurrent syncope, with prolonged hospital stays after cholecystectomy, and with a classification of having delayed discharge. The HRDES was developed in an older general medical population and has not been widely used. The MoRT was recently developed using a general trauma population and has not yet been validated in other populations. However, the MoRT appears to take older adults into consideration due to the selection of predictors commonly found in an older population: the index was developed using adults between the ages of 18 and 85, excluding those over age 85.

Comparison of the Charlson and Elixhauser Methods. In a study comparing the Elixhauser method to the revised CCI by Deyo (1992) or Romano (1993), the Elixhauser outperformed both of the CCI adaptations. The Romano adaptation outperformed the Deyo adaptation in that it predicted short-term and long-term mortality in two patient populations, those with acute MI and with COPD (Chu, Ng, & Wu, 2010). Moreover, the Elixhauser method identifies more patients with comorbid illness than does the Deyo when used in five different disease categories: acute myocardial infarction, heart failure, chronic obstructive pulmonary disease, hypertension, and acute cerebrovascular disease (Stukenborg, Wagner & Connors, 2001). Conversely, when testing the Elixhauser, Charlson/Deyo, and Charlson/Romano against use of a chart index in a Medicare beneficiary atrial fibrillation population, the three methods and the chart index were found to be comparable in predicting mortality (Yan, Birman-Deych, Radford, Nilasena, & Gage, 2005). In studies comparing the Elixhauser method to adaptations of the CCI, the Elixhauser either outperformed or performed as well as the CCI and its adaptations.

Clinical practice implications. Comorbidities in older adults are measured and considered in research and in clinical management for a variety of reasons. The existence of comorbidities is particularly relevant following a traumatic event or when considering recovery following acute illness or surgery. For example, the recovery of an older adult who has sustained a fall and fracture will be different if he/she has an underlying neurological problem such as a right hemiparesis secondary to a stroke from the recovery of an older adult with no comorbidities or one who has hypertension as a comorbidity. In clinical practice, the ultimate goal is to use as a tool for patient management the information about patients' comorbid conditions.

Use of comorbidity measures in geriatric trauma. Comorbidity measures can be used in the clinical management of geriatric trauma patients to identify the risk of mortality, readmission, and cost. Identification of the patient who is at higher risk will allow the clinician to focus resources on that patient with attention focused on the comorbidities once initial stabilization has occurred. Controlling comorbidities such as heart failure, chronic obstructive pulmonary disease, diabetes, and acute renal failure may prevent complications for the older trauma patient.

Comorbidities have been found to affect outcomes in trauma patients regardless of age (Bergeron et al., 2004; Elixhauser et al., 1998). When combined with the effects of aging, comorbid conditions have an even greater effect on outcomes (Bergeron, Lavoie, Moore, Clas, & Rossignol, 2005; Elixhauser et al., 1998; U.S. Department of Health and Human Services, 2006). Through identifying the comorbidities in an older trauma patient, those conditions can be controlled to minimize their effects on trauma recovery.

Research implications. Given the implications of comorbidities in recovery following trauma, comorbid conditions should be evaluated in trauma research, whether clinical, epidemiological, or health services research (Valderas et al., 2009). Comorbidities provide descriptive information about the sample, can be a possible predictor of clinical outcomes, or may serve as a modifier of outcomes. In clinical research, comorbidity measures can be used to stratify patients according to risk of mortality, poor outcomes, readmission, or increased cost (Hall, 2006). Information on comorbid conditions in health services research can be used to allocate resources and describe population outcomes such as healthcare utilization and costs (Valderas et al., 2009). In this type of research, comorbidity is critically important for analysis purposes as it is commonly noted to be a confounding variable in a study (de Groot et al., 2003; Lash et al., 2007).

Another way in which comorbidities are employed is as predictors in outcome or natural history studies (de Groot et al., 2003). Comorbidity has been identified in studies focused on mortality in older adults' post-hospital admission (Beloosesky, Weiss, & Mansur, 2011; van Doorn et al., 2001), for those who have had various types of traumatic injury (Grossman et al., 2002; McGwin, Melton, May, & Rue, 2000; Milzman et al., 1992), and among elderly veterans post-hip fractures (French et al., 2008). Additional outcomes of interest that commonly consider the influence of comorbidities include readmission rates and length of stay (Librero et al., 1999), functional status (Groll, To, Bombardier, & Wright, 2005; Kelley-Quon et al., 2010), and health-related quality of life (Fortin et al., 2005).

Research findings can then be used to guide clinical practice. Treatment of comorbid conditions in trauma patients can lead to improved outcomes, shortened length of stay, and decreased healthcare costs. In addition, patients could be stratified according to risk and then treated accordingly. Information from healthcare utilization and allocation of resources can be employed in healthcare settings.

Recommendations. Recommendations for using the available methods for measuring comorbidities depend on the outcome of interest. If a study's outcome is primarily mortality, the CCI and its variations is the best choice. However, if the outcomes include readmission rates, length of stay, discharge destination, or cost, the preferred method is the Elixhauser method. The population specific indices are best used in the population for which the measurement was developed, HRDES and GIC in an older adult population and the MoRT in a general trauma population.

Limitations. The use of generic indices may not provide enough information since they are not specific to the geriatric trauma patient population. The more specific indices omit either the geriatric population or the trauma population. Each measure was developed for a specific purpose and may not be appropriate for older trauma patients. In addition, the quality of available data might have influenced the development of the measure and, therefore, subsequent uses of the measure.

Future directions. Since the number of older trauma patients is on the rise, development of a specific index to measure comorbidity in older trauma patients might be ideal. Older adults who have experienced a traumatic event are more likely to have more comorbid conditions than their younger counterparts. By addressing comorbid conditions, healthcare providers can improve such outcomes as length of stay, cost of care, readmission rate, and mortality.

Conclusion

No ideal comorbidity index was identified for use with the older trauma population. The original Charlson Comorbidity Index has been widely used, in some instances with an older trauma population; however, it is more difficult to use since it requires medical record review by a trained person. The Elixhauser method has been used in various populations and has generally outperformed the CCI and its variations. The GIC and the HRDES are specific to the geriatric population but have never been tested in a trauma population. The MoRT holds promise since several of the included conditions are prevalent in the older population and should be validated in a population aged 65+. In summary, the Elixhauser method may be the best overall since it performs as well as the CCI and its adaptations are better for predicting mortality risk; also, it has been used more often for such other outcomes as length of stay, readmission rates, and cost. The most important issue to consider is that the measure used must be appropriate for the outcome of interest and the type of available data.

CHAPTER THREE:

Pain in Older Trauma Patients during Therapy[2]

Introduction

Trauma in older adults. Data from the National Trauma Data Bank (National Trauma Data Bank, 2012) showed that a large percentage of all trauma incidents in 2012 occurred in those over age 65 (n=194,635; 25% of all trauma incidents), with most incidents the result of falls (49%) and motor vehicle collisions (11.7%). The percentage of traumatic events involving older adults increased from 20% in 2003 to 25% in 2012. By the year 2050, 40% of all trauma patients will be over age 65 (Campbell, Degolia, Fallon, & Rader, 2009).

Pain in trauma. The majority of individuals who experience traumatic injury have significant pain, with moderate to severe pain reported to occur 61% to 74% of the time (Berben et al., 2008; Gianni et al., 2010; Platts-Mills, Hunold, Esserman, Sloane, & McLean, 2012; Whipple et al., 1995). Pain from trauma can occur from multiple types of injuries and is generally classified as acute pain. Acute pain can arise from the initial injury, an exacerbation of a pre-existing condition, or from surgery used to correct the injury. Acute pain is defined as any pain that is relatively short-term (less than one to six months), improves with healing, and results from disease, inflammation, or injury to tissues (Bonica, 1977; National Institute of Neurological Disorders, 2009; Pasero et al., 1999; E. A. Watkins, Wollan, Melton, & Yawn, 2008).

There are three main treatment phases in trauma care—the resuscitation phase, the acute phase, and the rehabilitation phase (Alpen & Morse, 2001). During the resuscitation

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phase, pain can result from life-saving procedures (e.g., chest tube insertion, endotracheal intubation, and cut-downs) (Public Health Service, Agency for Healthcare Policy and Research, 1992). During the acute phase of trauma care, the experience of pain will depend on the injured site; for example, a hip fracture may cause different pain from blunt abdominal trauma or burns. In addition, acute pain can be superimposed on chronic pain, each type requiring different treatment modalities (Clay, Watson, Newstead, & McClure, 2012). Finally, the rehabilitation period is focused on optimizing function and recovery. During the acute phase and/or rehabilitation phase, patients are referred to physical, occupational, and speech/language therapy as appropriate. Therapy can take place in the hospital, a rehabilitation facility, an outpatient clinic, at home, or in all of these settings (Kosar, Seelen, Hemmen, Evers, & Brink, 2009). Pain management must be taken into consideration during the acute and rehabilitation phases since pain can interfere with a patient’s ability and desire to participate in therapy (Chmielewski et al., 2008; Feldt & Oh, 2000; Morrison et al., 2003; Nicholson Perry, Nicholas, & Middleton, 2009; Nilsdotter, Petersson, Roos, & Lohmander, 2003).

Pain in older adults. Pain in postoperative and hospitalized older patients is often undermanaged (Apfelbaum, Chen, Mehta, & Gan, 2003; Herr, 2010; Sauaia et al., 2005; Sinatra, 2010) due to the misconceptions that pain is different in older adults, certain analgesics may be too strong and cause too many side-effects, and assessment of pain is often ineffective (Bruckenthal & D’Arcy, 2007). Untreated acute pain can result in additional complications including immunosuppression, sleep disturbances, catabolism, hypertension, tachycardia, hypercoagulability, pulmonary compromise, gastrointestinal dysfunction, increased fatigue, psychological distress, and cognitive dysfunction

(Charlton, 2005; Jakobsson, Hallberg, & Westergren, 2004; Malchow & Black, 2008). In addition, pain in older adults may be associated with anxiety and anticipatory fear of pain or falling. Unmanaged pain can cause a progressive cycle of decreased mobility, increased weakness, deconditioning, exacerbation of pain, and immobility with its associated pneumonia, pressure ulcers, and functional decline (Barkin, Barkin, & Barkin, 2005; Chmielewski et al., 2008; MacDermid, Roth, & Richards, 2003). Delay in treatment or less than full participation in therapy may result in slower recovery times and increased length of hospital stays (A. F. Chen, Stewart, Heyl, & Klatt, 2012; Juliano et al., 2011; Lenze et al., 2004).

Factors associated with pain in older adults. Acute pain tends to decrease as age increases due to both physiologic changes with age and less reporting of pain (Gagliese & Katz, 2003; Li, Greenwald, Gennis, Bijur, & Gallagher, 2001). For postoperative pain, females have been shown to report more pain (Cepeda & Carr, 2003; De Cosmo et al., 2008; Gagliese, Gauthier, Macpherson, Jovellanos, & Chan, 2008; Lau & Patil, 2004). Race has been shown to be a factor in the reporting of pain, with African-Americans and Hispanics reporting more pain than Caucasians (Allen et al., 2009; Golightly & Dominick, 2005; Reyes-Gibby, Aday, Todd, Cleeland, & Anderson, 2007). In other studies, no difference in pain reporting was found between Caucasians and these other ethnic groups (Cho, Kim, Lim, & Kim, 2012; McGorry, Shaw, & Lin, 2011; Racine et al., 2012). One possible explanation for this difference in reporting increased pain is that African-Americans and Hispanics often have more of the characteristics associated with increased pain, such as depression and lower educational levels (Gansky & Plesh, 2007; Portenoy, Ugarte, Fuller, & Haas, 2004).

There are several comorbid conditions associated with aging that commonly cause pain, including diabetes (McGreevy & Williams, 2012; Rodrigues & Motta, 2012; Vincent, Callaghan, Smith, & Feldman, 2011), stroke (de Oliveira, de Andrade, Machado, & Teixeira, 2012; Lindgren, Lexell, Jönsson, & Brogårdh, 2012; Roosink et al., 2011), degenerative joint disease (McDougall & Linton, 2012; Schaible, 2012; Schaible et al., 2009), and heart failure (Goodlin et al., 2012; Udeoji, Shah, Bharadwaj, Katsiyiannis, & Schwarz, 2012). For post-trauma older adults, comorbidities may exacerbate or reduce acute pain experienced depending on the traumatic event. For example, an older adult with chronic shoulder pain due to degenerative joint disease who sustains a fractured hip may exacerbate the shoulder pain by using an assistive device and bearing weight on that joint.

Challenges to pain assessment in older adults. Numerous challenges to pain assessment in older adults have been identified. One of the major challenges is cognitive changes, which may interfere with a patient's ability to understand, interpret, recall, or verbally describe the pain (Banicek, 2010; Bjoro & Herr, 2008; Herr, 2011). Older adults may assume that pain is a normal aspect of aging and thus may not report pain when asked (D'Arcy, 2008; Herr & Garand, 2001). Culturally, expression of pain can be seen as a weakness or as being a bother, leading to fewer reports of pain (Herr & Garand, 2001). Since older adults may also be worried about the side-effects of analgesics and the potential for addiction, they may not want to express need for pain medication (Banicek, 2010; Herr & Garand, 2001). Some older adults may be reluctant to report pain because they perceive pain as an indicator of serious illness (Fine, 2012). In addition, providers may be reluctant to prescribe analgesics due to side-effects (Morrison et al., 2003) and may face difficulty in identifying pain since documentation of pain is often not complete (Abdalrahim, Majali, Stomberg, & Bergbom, 2011; J. C. Brown, Klein, Lewis, Johnston, & Cummings, 2003; Iyer, 2011).

Several studies (Gagliese, Weizblit, Ellis, & Chan, 2005; Herr, Spratt, Mobily, & Richardson, 2004; Jones et al., 2005; Jones, Vojir, Hutt, & Fink, 2007) have established the most appropriate measures to use when evaluating pain intensity in older adults with or without cognitive impairment (See Table 4). Most frequently, the verbal numeric rating scale is used and is preferred for older adults who are cognitively intact to rate their pain on a scale of 0 (no pain) to 10 (worst pain) (Gagliese et al., 2005; Herr, 2011; Herr et al., 2004). Additional possibilities include a visual analog scale (Banicek, 2010; Gagliese et al., 2005; Herr et al., 2004), the verbal descriptor scale (Falzone, Hoffmann, & Keita, 2013; Gagliese et al., 2005; Hadjistavropoulos et al., 2007; Herr et al., 2004), and the Faces Pain Scale-Revised (Hadjistavropoulos et al., 2007; Herr, 2010). For those who have dementia, there is a special tool—the Pain Assessment in Advanced Dementia Scale (PAINAD) (Bjoro & Herr, 2008; Ersek, Herr, Neradilek, Buck, & Black, 2010)—and for nonverbal patients, there is the Checklist of Nonverbal Pain Indicators (Bjoro & Herr, 2008; Ersek et al., 2010; Feldt, 2000; Jones et al., 2005).

Pain management. Various interventions are available for the treatment of pain, analgesic administration by nurses being the most common method in the acute-care setting. Physical and occupational therapists have various modalities they can use to alleviate pain: timing therapy with medication administration, rest, repositioning, mobilization, elevation, heat therapy, cold therapy, stretching, or transcutaneous electronic nerve stimulation.

Table 4. Commonly Used Pain Assessment Tools

Scale	Selected Studies	Description	Setting/Population Tested	Reliability/Validity
Verbal Rating Scale (VRS)	Bergh, Sjöström, Odén, & Steen, 2000; Bergh, Sjöström, Odén, & Steen, 2001; Gagliese et al., 2005; Herr, Titler, et al., 2004; Pesonen, Suojaranta-Ylinen, Tarkkila, & Rosenberg, 2008	A patient verbally rates pain on a scale of 0 (no pain) to 10 (worst imaginable pain).	Geriatric, Acute Care	Internal consistency (Cronbach's alpha): .88-.97; Construct validity (correlation to isolated factor): .95
Visual Analog Scale (VAS)	Bergh, et al., 2000; Bergh, et al., 2001; Gagliese, et al., 2005; Herr, Titler, et al., 2004; Pesonen, et al., 2008	A patient marks the level of pain on a 100 millimeter line from no pain to worst pain	Geriatric, Acute Care	Internal consistency (Cronbach's alpha): .88-.96 Construct validity (correlation to isolated factor): .94
Verbal Descriptor Scale (VDS)	Gagliese, et al., 2005; Herr, Titler, et al., 2004; Peters, Patijn, & Lamé, 2007; Williamson & Hoggart, 2005; Zhou, Petpichetchian, & Kitrungrote, 2011	A patient is asked to rate pain intensity with the following descriptors: "no pain," "slight pain," "mild pain," "moderate pain," "severe pain," and "worst pain imaginable"	Geriatric, Acute Care	Internal consistency (Cronbach's alpha): .86-.96 Construct validity (correlation to isolated factor): .95
Faces Pain Scale - Revised	Herr, Spratt, Garand, & Li, 2007; Ware,	A patient is asked to point to one	Outpatient Clinic, Acute Care	Internal consistency (Cronbach's

	Epps, Herr, & Packard, 2006; Zhou, et al., 2011	drawing out of six faces that is most like her/his experience of pain The facial expressions denote varying levels of pain		alpha): .88-.97 Construct validity (correlation to isolated factor): .86
Pain Assessment in Advanced Dementia Scale (PAIN-AD)	DeWaters et al., 2008; Leong, Chong, & Gibson, 2006; Warden, Hurley, & Volicer, 2003; Zwakhalen, Hamers, Abu-Saad, & Berger, 2006	The provider assesses breathing, negative vocalization, facial expression, body language, consolability on a 0-2 scale	Long-term care, Acute care	Internal consistency: .50-.67; Interrater reliability: r = .82-.97; Concurrent validity: r = .76-.95
Checklist of Nonverbal Pain Indicators (CNPI)	Feldt, 2000; Jones et al., 2005; Nygaard & Jarland, 2006; Ersek et al., 2010	A provider checks-off a patient's behaviors from a list of six behaviors—vocalization, facial grimacing, bracing, rubbing, restlessness, and vocal complaints—indicated on a 6-point scale. Indicates only the existence of pain not intensity	Acute care, Long-term care	Inter-rater reliability: Kappa: .45-.69; Concurrent validity – Spearman's rank correlations: .69-.88

Purpose

The purpose of this study was to describe pain among older adult trauma patients undergoing physical and occupational therapy and the pain assessment practices used by physical and occupational therapists caring for these older trauma patients.

The research questions are

1. What tools did therapists use to measure pain in older trauma patients?
2. What was the experience of pain intensity in older trauma patients?
3. What actions did therapists use to help manage older trauma patients' pain?
4. What are the factors associated with pain in older trauma patients?

Specifically, the measurement, experience of pain, and therapists' response to pain at the start, during, and immediately after occupational and physical therapy were explored. In addition, the relationships among number of comorbidities, gender, race, patient age, and admitting diagnosis of fracture or traumatic brain injury with pain at and around the time of therapy were explored. This study described pain in older trauma patients to determine if pain in this population is underreported and undertreated. The information gained may help guide assessment of pain and interventions for post-trauma older adults before, during, and after therapy sessions. Given the often short length of stay in acute care, understanding pain during therapy may assist with pain management in order to optimize the success of therapy.

Methods

Design. This study was a retrospective descriptive correlational secondary data analysis using chart data obtained from physical and occupational therapy notes during treatment interactions throughout the participants' acute-care trauma stay. Data were obtained from a level- one trauma center and were de-identified. The study was approved by a University Institutional Review Board and consent was waived.

Sample. The sample, taken over a two-year period from 2010-2011, of 137 older trauma patients was randomly selected from a list of 1,387 trauma patients age 65 and older who were hospitalized after a traumatic event. The sample size was determined by sampling approximately 10% of the frame. A power analysis determined that given the number of variables, the sample size provided adequate power for a linear regression to answer the question of what factors are associated with pain in older trauma patients. When a patient had more than one admission, the admission for the initial traumatic event was used.

Data collection and measures. All data were collected from patients' electronic charts and transcribed onto a data-collection form. Data were then entered into a database using SPSS version 19.0. Descriptive data included age, gender, and race/ethnicity as obtained from the participants' medical records. Comorbidities were measured by using a simple count of the number of diagnoses listed in the medical record, excluding admission trauma diagnoses (Grossman et al., 2002; Marengoni et al., 2011; Moore et al., 2008; Roche et al., 2005).

Pain data were obtained from electronic medical notes completed by physical and occupational therapists during each therapy session. Therapists were required to evaluate pain and had the option to use any of the following three measures: the Verbal Rating Scale (VRS), Verbal Descriptor Scale (VDS), or the Checklist of Nonverbal Pain Indicators (CNPI) (Table 4). Therapists selected the pain scale to use based on their personal preferences and clinical judgment. In addition, therapists had the option to describe the duration and the location of pain, if there were relieving factors, and to indicate if any intervention was done during the course of the session.

The VRS is a verbal numeric scale in which patients are asked to rate their pain on a scale of zero (no pain) to ten (worst imaginable pain), where one to three indicates mild pain, four to six indicates moderate pain, and seven to ten indicates severe pain. The VDS uses a categorical list of pain intensity with the following descriptors: "no pain," "slight pain," "mild pain," "moderate pain," "severe pain," and "worst pain imaginable". The CNPI is a list of six behaviors—vocalization, facial grimacing, bracing, rubbing, restlessness, and vocal complaints—that are indicated as a way to assess pain in nonverbal and/or cognitively impaired adults (Feldt, 2000) and is scored on a 12-point scale. All three scales have been validated in the acute-care setting and have been suggested for use with older adults (Herr 2011, Bjoro & Herr 2008). For this study, only the VRS scale was used for analysis since the VDS uses words to describe the level of pain and the CNPI does not measure intensity, only the presence of pain. Pain was measured using the VRS at three different times—before, during, and after a physical or occupational therapy session. For the regression analysis, the average of the three pain scores was used.

Physical and occupational therapists also had the option of indicating what interventions they used to alleviate pain: timing therapy with medication administration, notifying a nurse or physician, rest, repositioning, mobilization, elevation, heat therapy, cold therapy, stretching, and transcutaneous electronic nerve stimulation. The interventions were in a checklist format and were completed whenever the pain assessment was completed.

Data Analysis. Data analysis was completed using SPSS 21.0. Data were examined for normality and to make sure assumptions for each statistical test were met. Descriptive statistics were used to answer research questions one, two, and three and involved calculation of number and percentage for categorical data and mean and standard deviation for continuous data. Bivariate correlations were examined and a multivariate linear regression performed. The linear regression using stepwise entry of variables was performed to answer research question four with average physical therapy pain as the dependent variable. The independent variables entered were comorbidities, gender, race, patient age, and admitting trauma diagnosis. A $p < .05$ level of significance was used in all analyses.

Results

There were 137 participants with a mean age of 78.3 years (S.D. = 9.7). The participants were close to being evenly divided on gender with 63 (46.3%) males and 73 (53.7%) females. A total of 114 (83.8%) participants were Caucasian, 16 (11.8%) African American, 2 (1.5%) American Indian or Alaskan native, 1 (0.7%) Asian, 2 (1.5%) Hispanic, and 1 (0.7%) in the “other” race/ethnicity category. (Table 5). A list of the top ten comorbid conditions for the sample can be found in Table 6, which includes disease processes such as hypertension, cardiac disease, diabetes, cancer, dementia, and arthritis.

Pain Assessment. Of the total patients seen for physical (PT) or occupational therapy (OT), a pain assessment was completed 67.2% of the time by the physical therapists and 36.5% by occupational therapists, leaving 32.8% and 63.5% without a pain assessment because the patient had no pain. For physical therapy (PT), 79.3% of the pain assessments completed had all three time-points evaluated (pre-, during, and post-

Table 5. Sample Characteristics

Demographic Variables	Total (n = 137)
Age: Mean (S.D.)	78.30 (9.67)
Range	65 - 92
Gender: Number (%)	
Male	63 (46.3)
Female	73 (53.7)
Race/Ethnicity	
Caucasian	114 (83.8)
African-American	16 (11.8)
American Indian/Alaska Native	2 (1.5)
Asian	1 (0.7)
Hispanic	2 (1.5)
Other	1 (0.7)
Number of Comorbidities: Mean (S.D.)	3.11 (1.64)
Fracture as admitting diagnosis: Number (%)	76 (55.5)
Traumatic brain injury as admitting diagnosis: Number (%)	47 (34.3)

Table 6. Ten most frequent comorbid conditions (n = 137)

Comorbidity	Number (%)
Hypertension	59 (43%)
Cardiac Disease	37 (27%)
Diabetes	18 (13%)
Cancer	16 (12%)
Dementia	15 (11%)
Arthritis	8 (6%)
History of fall	8 (6%)
Psychiatric	6 (4%)
Seizure	6 (4%)
Other	85 (62%)

session). For occupational therapy (OT), 70.0% of the pain assessments completed had all three times recorded. The physical therapists most commonly used the VRS (76.1%) to assess pain, then the CNPI (18.2%), and finally the VDS (5.7%). Similarly, the occupational therapists were most likely to evaluate pain using the VRS (77.6%). In contrast to the physical therapists, however, the occupational therapists used the VDS (12.9%) more often than the CNPI (9.5%) for pain assessment. The CNPI was most frequently used for the patients who had a diagnosis of dementia or were on a ventilator.

Pain rating. There were no statistically significant differences in mean pain during therapy based on gender, race/ethnicity, or admitting diagnosis of traumatic brain injury (results not shown). For an admitting diagnosis of fracture, there was a significantly lower amount of pain during an occupational therapy session ($t = -2.17$, $p = .036$).

The average pain rating before an occupational therapy session was 4.71 (S.D. = 2.69, range 0-10) (Figure 4); during the occupational therapy session, pain was rated at 5.69 (S.D. = 2.64, range 0-10); and after the occupational therapy session, pain was rated at 5.02 (S.D. = 2.60, range 0-10). The average pain rating before a physical therapy session was 4.86 (S.D. = 2.16, range 0-10); during the physical therapy session 6.13 (S.D. = 1.93, range 0-10); and after the physical therapy session, 5.27 (S.D. = 1.89, range 0-10). There was no significant difference in pain between OT and PT for the before, during, and after time-points.

The peak pain experience occurred during physical therapy or occupational therapy sessions; at the during time-point, 32% of PT patients and 32% of OT patients had severe pain (Table 7). Moderate pain occurred in 39% of both PT and OT

Figure 4. Mean Pain Ratings for Physical Therapy and Occupational Therapy

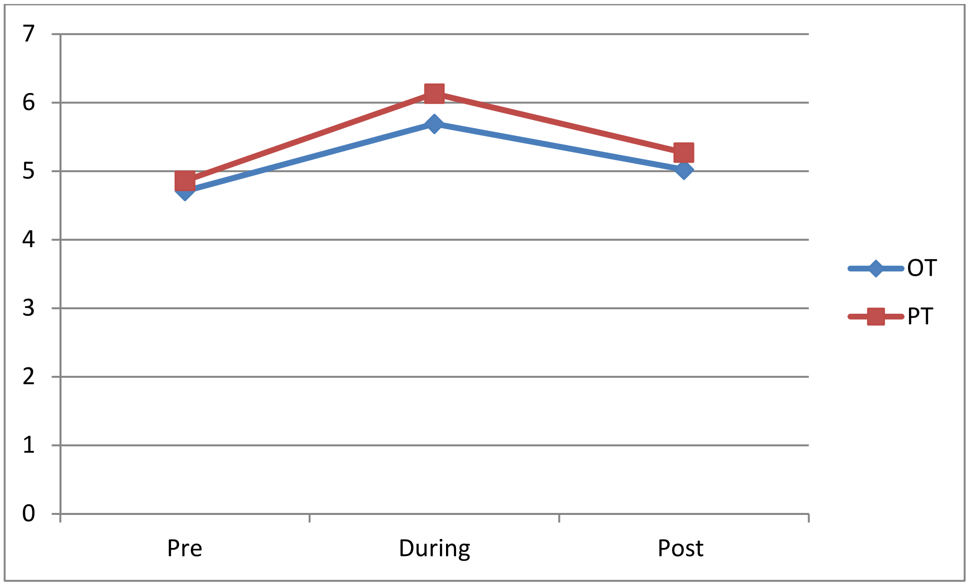


Table 7. Pain Ratings during Therapy (n = 77)

	Pre-Session	During Session	Post-Session	Average
Physical Therapy				
Severe Pain (Rating 7-10)	21%	32%	26%	26.3%
Moderate Pain (Rating 4-6)	31%	39%	31%	33.7%
Mild Pain (Rating 1-3)	32%	21%	30%	27.7%
No Pain (Rating 0)	16%	8%	13%	12.3%
Occupational Therapy				
Severe Pain (Rating 7-10)	22%	32%	24%	26.0%
Moderate Pain (Rating 4-6)	26%	39%	32%	32.3%
Mild Pain (Rating 1-3)	19%	7%	13%	13.0%
No Pain (Rating 0)	33%	22%	31%	28.7%

participants during the therapy session. During PT, mild pain occurred 21% of the time, leaving only 8% who had no pain. During OT, mild pain occurred 7% of the time; 22% of patients had no pain. Pain severity varied somewhat depending on demographic variables (Table 8). In patients over 75 years and in those with an admitting diagnosis of traumatic brain injury, no pain was reported more frequently. In female and non-white patients, severe pain was reported more frequently.

Pain management. The most frequent initial response to manage the pain experienced by the patient was to not intervene and to continue with therapy—64% of PT sessions and 58% of OT sessions. Alternatively, in slightly less than half the cases, OT and PT (47% of the cases for PT and 46% of the cases for OT) timed therapy with administration of pain medications; in approximately a third of the cases, the therapists notified the patient's nurse or physician about the pain (PT 36.9% and OT 36%); and in approximately one-fourth of the cases, the patient was positioned to help manage the pain (PT 31.5% and OT 26%). Relieving factors initiated by the therapists included rest (PT 38%, OT 48%), repositioning (PT 38%, OT 24%), medications (PT 21.7%, OT 8%), mobilization (PT 11.9%, OT 0%), and elevation (PT 8.7%, OT12%). There was no evidence that heat or cold therapy, stretching, or transcutaneous electronic nerve stimulation units or other non-pharmacological interventions were used to relieve pain during the sessions.

Factors related to pain. The factors related to pain included in the regression model were age, gender, race/ethnicity, number of comorbidities, and admitting diagnosis of fracture or traumatic brain injury. The regression model was significant ($F = 9.08$, $p < .001$), and the variance explained by the model was 21% ($R^2 = .213$). The number of

Table 8. Severity of pain by demographic variables (n = 77)

Demographic Variable	None N (%)	Mild N (%)	Moderate N (%)	Severe N (%)	χ^2 p value
Age					
<=75	0 (0)	8 (23)	14 (40)	13 (37)	.021
>75	6 (14)	8 (19)	16 (38)	12 (29)	
Gender					
Male	2 (5)	9 (22)	19 (46)	11 (27)	.442
Female	4 (11)	7 (19)	11 (31)	14 (39)	
Race					
White	6 (9)	14 (21)	28 (42)	19 (28)	<.001
Non-white	0 (0)	2 (20)	2 (20)	6 (60)	
Fracture					
Fracture	1 (2)	10 (22)	19 (42)	15 (34)	.932
No Fracture	5 (16)	6 (19)	11 (34)	10 (31)	
Traumatic Brain Injury					
TBI	5 (22)	3 (13)	9 (39)	6 (26)	<.001
No TBI	1 (2)	13 (24)	21 (39)	19 (35)	

comorbidities the participant experienced ($p < .001$) and whether or not fracture was the admitting diagnosis ($p = .035$) were the only variables associated with pain (Table 9). Those patients who had fractures and those who had more comorbidities had greater pain.

Discussion

The results of the study support prior findings (Berben et al., 2008; Gianni et al., 2010; Platts-Mills, Hunold, et al., 2012) noting that pain is prevalent and largely undertreated in older adults who experienced a traumatic event. When pain was reported in those prior studies, however, it was not tied specifically to the time of therapy. As would be expected in the majority of the cases, pain increased during therapy. It was not documented in the medical record exactly what activities the patient was engaged in that caused the increase in pain, nor is it known if fear associated with activity exacerbated the pain or interpretation of the pain at that time. Further research is needed to further examine the relationship between activity during therapy and what types of activities might be expected to exacerbate pain and cause an interruption in therapy.

Although pain assessments were completed in two-thirds of the cases, leaving one-third of the cases with undocumented pain ratings. It is possible that pain was not a problem during those sessions, or therapists did not consider the degree of pain experienced by patients to be important enough for documentation, or they did not take the time to document pain during the time devoted to recording activities. This finding is consistent with prior research, indicating that pain assessment and documentation of pain have been found to be less than adequate in studies of emergency room and post-operative patients (Abdalrahim et al., 2011; J. C. Brown et al., 2003; Iyer, 2011).

Table 9. Linear Regression with Dependent Variable: PT Mean Pain (n = 77)

Variables	B	Std. Error	t	p
Constant	2.365	.661	3.578	.001
Comorbidities	.620	.165	3.756	.000
FXvsNoFX	1.366	.636	2.147	.035
Excluded Variables	Beta In		t	p
Age	-.114		-.993	.324
Gender	.053		.476	.635
Race	-.162		-1.464	.148
TBIvsNoTBI	.105		.869	.388

Consistent with recommendations for appropriate tools to use when assessing pain in older patients, the VRS was most commonly used in this study (Gagliese et al., 2005; Herr, 2011). The CNPI was used primarily with those patients who were unconscious and/or on a ventilator, and therefore, were excluded from analyses with pain variables. However, given the 11% of older adults in this study with a diagnosis of dementia, a measurement option relevant for these patients should be considered. Moreover, therapists may need some ongoing education about pain assessment for older adults with altered levels of cognition.

The degree of severe pain reported by the participants was high. What is unknown is what efforts were being made to address the pain among these patients. It cannot be known based on study design, if insufficient pain management was the result of overall inadequate management in terms of ordering medications, if there was a fear among healthcare providers of using narcotics in older adults (Murnion, Gnjidic, & Hilmer, 2010), if there was a lack of knowledge or belief in the benefits of alternative approaches (e.g., use of ice), or if there was a lack of coordination/communication between therapists and nurses regarding pain medication administration prior to therapy. Moreover, as shown in prior research (Catananti & Gambassi, 2010; Coker et al., 2010; Fitzharles, Lussier, & Shir, 2010; Herr, Titler, et al., 2004; Martin, Williams, Hadjistavropoulos, Hadjistavropoulos, & MacLean, 2005), it is possible that the older patients in this study were choosing to have the pain rather than the side-effects of pain medication. Fear of addiction (Catananti & Gambassi, 2010; Fitzharles et al., 2010), or cultural beliefs that they should be stoic and endure the pain (Catananti & Gambassi, 2010; Martin et al., 2005) may also have been factors. In general, older adults vary in their desire to participate in their pain management (Catananti & Gambassi, 2010; Martin et al., 2005; Teh et al., 2009).

Number of comorbid conditions and fracture were the only significant factors related to pain. All comorbidities were summed, and due to sample size and number of comorbid conditions, it was inappropriate to test each comorbid condition independently to determine the impact that arthritis, for example, might have on post-trauma pain. However, this finding serves to remind practitioners to be certain to address pain among those patients with multiple comorbid conditions who sustain a traumatic injury as they may experience a combination of both chronic and acute pain or may exacerbate chronic pain. Moreover, symptoms, including pain, among patients with comorbidities may be more difficult to manage, as is noted in the recently published document *Guiding Principles for the Care of Older Adults with Multimorbidity: An Approach for Clinicians* (Boyd et al., 2012).

Age, gender, race/ethnicity, and traumatic brain injury were not associated with increased pain, which mirrors some of the findings in the literature for age and race (Cho et al., 2012; McGorry et al., 2011; Racine et al., 2012; E. Thomas, Peat, Harris, Wilkie, & Croft, 2004). One reason for the finding about traumatic brain injury is that those with traumatic brain injury may have more difficulty characterizing and reporting pain. However, this study's findings were inconsistent with prior research that noted that females were generally found to report more pain (Cepeda & Carr, 2003; De Cosmo et al., 2008; Gagliese et al., 2008; Lau & Patil, 2004). It is possible that the relationship between demographic factors and pain is limited and sample- specific.

Limitations. This study is limited by the sample size and use of secondary data collected routinely during clinical care. The sample was not very homogenous and many other factors could explain the results. Among these factors are the use of pain medication and taking into account the natural trajectory of pain post trauma. Although most variables did not have missing data, data for pain intensity were missing when an assessment was not completed. Measurement of pain was done using three different scales; however, only the VRS scale data were analyzed since the VDS word answers were not recorded and the CNPI cannot be used for intensity of pain. It is possible that other measures that use a numeric scale could have increased the sample size. In addition, this study focused on a single institution. Despite these limitations, the findings provide useful information to guide future clinical work in terms of encouraging pain assessment during therapy sessions. Providing a greater focus on options for interventions, using analgesics prior to therapy, and improving communication with other members of the healthcare team may lead to improved therapy outcomes.

Conclusions

Additional studies with pain in older trauma patients are necessary. Studies including larger sample sizes, more complete pain assessments, and information about analgesics would offer additional information not available in the current study. Another area to examine is the communication between nurses and therapists regarding timing of analgesic administration. In addition, use of non-pharmacologic interventions for pain relief could be explored. Further research also should be considered for what type of activities are most likely to cause pain and what interventions are best tolerated and most effective for older adults, especially following traumatic experiences by patients with comorbidities,.

Findings from this study can be translated to clinical work. Specifically, documentation and management of pain should be a primary focus during therapy sessions for older patients who have experienced trauma. In addition, evaluation and management of comorbid conditions should be considered as they may inform strategies to reduce some of the pain experienced during therapy and ultimately impact patient participation in the therapy session and improve clinical outcomes.

CHAPTER FOUR:

Factors Associated with Length of Stay and Discharge Disposition in Older Trauma Patients[3]

Trauma in Older Adults

As the 65+ population increases and remains active longer, the incidence of traumatic events in this population also increases. From 1900 to 1994, the number of Americans aged 65 and older increased from three million to 33 million and is expected to reach 80 million by 2050 (U.S. Census Bureau, 2010). Falls and motor vehicle accidents are the most likely mechanisms of injury in those 65+ with and 25% of all trauma incidents occurring in those over the age of 65 (National Trauma Data Bank, 2012). One of the fastest growing cohorts is those over 80 years old (U.S. Census Bureau, 2010) and with less disability reported in this cohort (Seeman, Merkin, Crimmins, & Karlamangla, 2010) an increase in traumatic injuries in this age group can be expected.

It has been shown that older trauma patients' admission to trauma centers improves outcomes (Stone, Barbaro, Bhamidipati, Cucuzzo, & Simon, 2007) especially if a geriatric trauma consultation service is available (Fallon et al., 2006). However, studies have shown that older patients compared with younger patients experience worse outcomes, such as longer hospital stays (Peschman et al., 2011; Susman et al., 2002), and older patients are more likely to be discharged to rehabilitation or long term care facilities (Cuthbert et al., 2011; Dinh et al., 2013; Frontera, Egorova, et al., 2011). The following factors have been shown to be associated with worse outcomes for older trauma patients: increased age, increased pain, being uninsured, having more comorbidities, having higher injury severity, and the type of injury (Claridge et al., 2006; Inaba et al., 2003; Lim et al.,

[3] Placko-Brotemarkle, R.A., Resnick, B., Morton, P. & Wells, C. Manuscript in preparation

2007). The effects of gender (Berry et al., 2009; Brazinova et al., 2010; Croce, Fabian, Malhotra, Bee, & Miller, 2002; Ringburg et al., 2011) and race/ethnicity (Haider et al., 2008b; Heffernan et al., 2011; Tepas, Pracht, Orban, & Flint, 2011) have been mixed, in some cases making a difference and in others making no difference.

Length of Stay and Discharge Disposition

Length of stay (LOS) is associated with many factors: greater injury severity, increased age, female gender, and more hospital complications (Ong et al., 2009; Peschman et al., 2011; Scheetz, 2005a; Susman et al., 2002). Longer LOS in an acute care setting is also associated with discharge to a facility (Aitken et al., 2010; Scheetz, 2005a). The impact of LOS on cost of care is significant in that each day in the acute care setting adds to overall cost of care (Frontera, Egorova, et al., 2011; Newell et al., 2009). Before 1983, hospitals were reimbursed on a fee-for-service basis for the care they gave in the acute care setting (Phillips & Wineberg, 1984). However, with changes in insurance, hospitals may not be reimbursed for days that extend beyond the recommended number of days depending on a particular diagnosis (Mitus, 2008). Therefore, an overall goal in trauma care is to decrease LOS in order to decrease cost without impacting quality of care (Frederickson, Renner, Swegle, & Sahr, 2013; Jarrett & Emmett, 2009). In fact, LOS in the acute care setting for trauma care has decreased over time, as the focus transitions to moving patients into lower levels of care (e.g., skilled nursing facilities and rehabilitation centers) as soon as possible (Frontera, de los Reyes, et al., 2011).

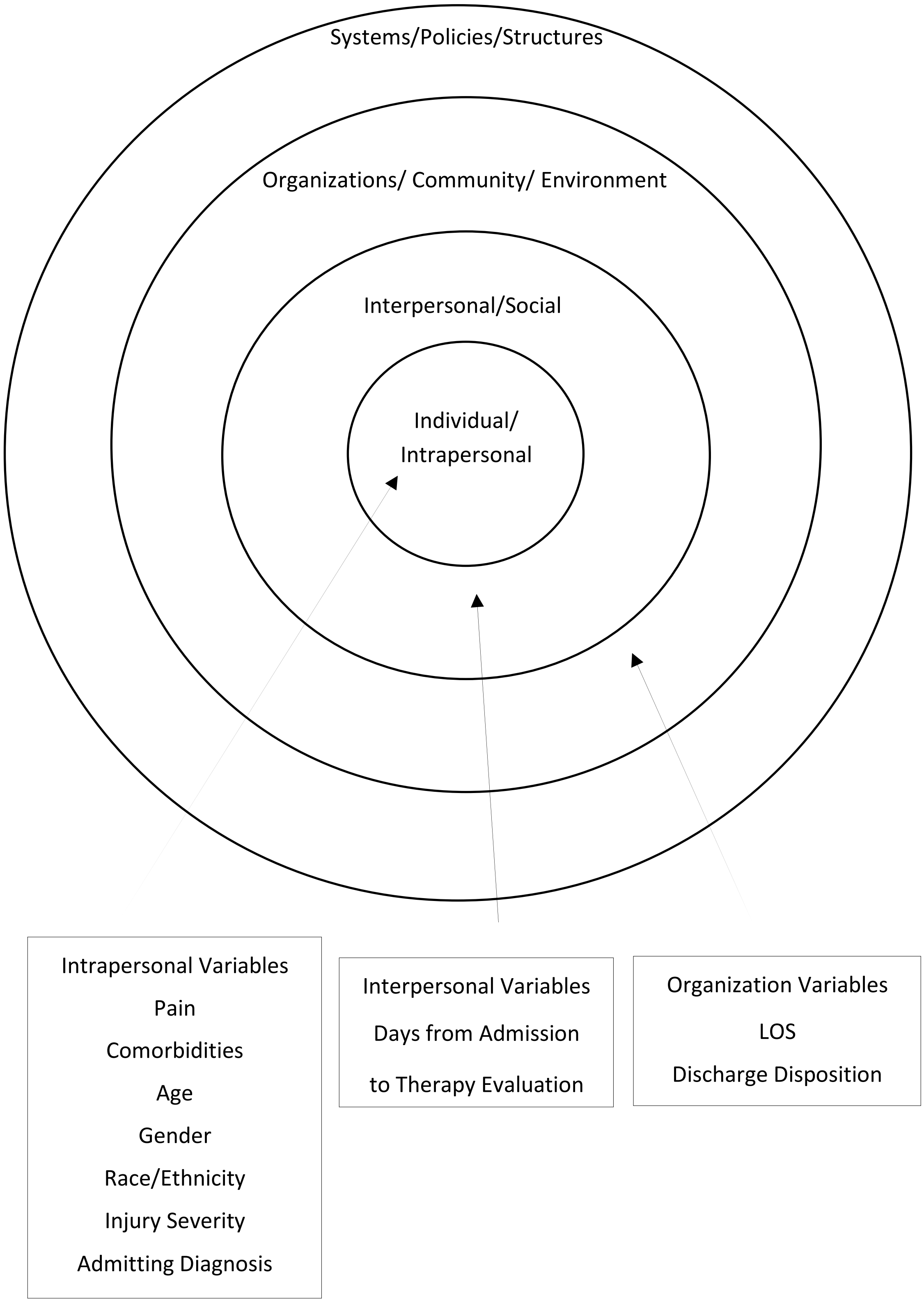
Following a trauma admission, older adults are discharged to a variety of settings for additional rehabilitation (Cuthbert et al., 2011; Sacks et al., 2011; Scheetz, 2005a).

The appropriate discharge setting is decided upon by a multidisciplinary team, including physicians, nurse practitioners, physical and occupational therapists, and social workers/case-managers, taking into account patient/family preferences (Enderlin et al., 2012; Shepperd et al., 2010). The discharge settings may be home with no services, home with outpatient services or home services, assisted living, boarding homes, senior housing, acute rehabilitation, skilled nursing care, long term care with no rehabilitation services, and hospice care (Society for Hospital Medicine, 2004). Matching the discharge disposition correctly to the older trauma patient's needs and preferences ideally decreases acute care LOS, assures appropriate resource allocation, and decreases readmissions following discharge (Shepperd et al., 2010).

Theoretical Framework

The Social-Ecological Model (SEM) (Bronfenbrenner, 1977; Green et al., 1996; Gregson et al., 2001; McLeroy et al., 1988; National Center for Injury Prevention and Control, 2009b) serves as a guide to better understanding the many factors that influence acute care trauma experiences with regard to LOS and discharge disposition. This model is used by the National Center for Injury Prevention and Control (2009b) as a framework for prevention of violence and injury. Within the SEM are several levels: the interpersonal level, the intrapersonal level, the environment/community level, and the policy/systems level (Figure 5). The intrapersonal level includes the demographic variables and the health-related variables of the older trauma patient (age, gender, race/ethnicity, pain, comorbidities, injury severity, and admitting diagnosis). The interpersonal level can be conceptualized as the many

Figure 5. The Social-Ecological Model



interactions that occur with such health care providers as therapists and with the number of days until the patient is seen. The environmental level includes the many hospital environment factors which are important to the patient: height of the bed, chairs, sink, other furniture, availability of open space for walking, staffing levels, and patient census. Policy factors, the outer-most circle, include hospital policies and the influence of health care reform. The availability of therapists is dependent upon the hospital environment in terms of hospital census and staffing, as well as other environmental factors on the unit; e.g., nurses having patients ready for therapy, communication among providers about timing, etc. The various levels in the SEM are interrelated; therefore, intrapersonal factors (e.g. age, pain, etc.) are interactive with interpersonal factors (e.g. therapists, staffing issues, etc.).

Effects of Demographics, Pain, and Comorbidities on LOS and Discharge Disposition

Several demographic variables have been identified in the literature as affecting LOS and discharge disposition for geriatric trauma patients (Ong et al., 2009; Peschman et al., 2011; Scheetz, 2005a; Susman et al., 2002). Some of these factors are increased age, race/ethnicity, and gender. Increased age is associated with increased LOS (Ong et al., 2009; Shah, Aharonoff, Wolinsky, Zuckerman, & Koval, 2001; Taylor et al., 2002; Trottier, McKenney, Beninati, Manning, & Schulman, 2007) and with discharge to a facility instead of to home (A. Y. Chen et al., 2012; Cuthbert et al., 2011) . In terms of race, nonwhites have a shorter length of stay following a traumatic event (Millham & Jain, 2009). Findings are mixed regarding the effect of race on discharge disposition: nonwhite patients are more likely to be discharged to home (B. R. Englum et al., 2011;

Shafi et al., 2007), to a facility (Millham & Jain, 2009), or race is not a factor (Marquez de la Plata et al., 2007). Female patients are more likely to be discharged to a facility (Cuthbert et al., 2011; Evans et al., 2012); however, gender apparently is not a factor in LOS (Ottochian et al., 2009; Starnes et al., 2011).

Approximately one-third of older adults who experience acute pain when hospitalized are discharged from therapy or have some interruption in therapy opportunities (Mehta et al., 2010). Uncontrolled pain, therefore, may interfere with the patient's motivation and ability to move, influencing the correct assessment of an older patient's functional abilities (Linton, Buer, Samuelsson, & Harms-Ringdahl, 2010; Pergolizzi Jr., Raffa, & Taylor Jr., 2012). The assessment and treatment of pain are important because pain can impact functional outcomes (decrease of Functional Independence Measurement score by 8.77 for every 1 point increase in pain score), prolong rehabilitation (LOS increased by 4.76 days for every 1 point increase in pain score), and increase cost of care (Arinzon et al., 2007). If pain interferes with a patient's ability or desire to participate in therapy, slower recovery times and increased length of hospital stays (from 0.21 to 3 days longer) are likely to occur (A. F. Chen et al., 2012; Juliano et al., 2011; Lenze et al., 2004).

It has been noted repeatedly that comorbidity is a factor that can impact outcomes in older trauma patients (Chan, Moran, Clarke, Martin, & Solomon, 2009; Evans et al., 2012; Frontera, Egorova, et al., 2011; McMahon, Schwab, & Kauder, 1996; Niven, Kirkpatrick, Ball, & Laupland, 2012; Sacco et al., 1993; Scheetz, 2005b; Soles & Tornetta, 2011). Comorbidity is the presence of disease conditions in addition to the condition for which the patient was admitted to the hospital (Hall, 2006). Comorbidities affect LOS with more comorbid conditions being related to longer LOS (Lefaivre et al., 2009; Nikkel et al., 2012); however, in at least one case, comorbidities were not related to LOS (Garcia et al., 2012). Differences in the studies may be due to different samples (different ages, numbers and types of comorbidities counted, and sample size) and different analyses (ANOVA and generalized linear model vs. proportional hazards ratio model). The effect of comorbidities on discharge disposition appears to not have been studied.

In addition, there are multiple other factors that can influence discharge disposition and length of stay. Specifically, these are patient and family preferences, insurance coverage, availability of a caregiver in the home, and recommendations made by physicians, social workers/case managers, and most often by rehabilitation therapists. In one physical therapy study (D. U. Jette, Grover, & Keck, 2003b), four constructs influenced the recommendation for discharge placement from the acute care setting: the patient's function and disability, the patient's wants and needs, the patient's ability to participate in care and the patient's life context. A therapist's recommendations may be influenced by the health care team's opinion and by health care regulations (D. U. Jette et al., 2003b).

Impact of Exposure to Therapy

Older adults have been shown to have accelerated functional decline after a traumatic event and exposure to therapy is particularly important for these patients (Buurman et al., 2011; Huang et al., 2013; Mudge et al., 2010; Shapiro et al., 2001). Studies of mechanically ventilated patients with respiratory failure or hip fracture show that early exposure to therapies improved functional outcomes and is associated with decreased LOS and increased discharge to home (Banerjee, Girard, & Pandharipande, 2011; Barone et al., 2009; Diane E Clark, Lowman, Griffin, Matthews, & Reiff, 2013; Harada, Chun, Chiu, & Pakalniskis, 2000; Kamel et al., 2003; Morris et al., 2008; Needham et al., 2010; Oldmeadow et al., 2006; Schweickert et al., 2009). One study (Diane E Clark et al., 2013) examined the effects of early mobilization in a trauma intensive care unit and found that LOS decreased by 1.5 days after adjustment for injury severity. This study, however, found no effect on discharge disposition.

Given the increasing number of older trauma patients and cost implications of these scenarios, overall little work has been done to consider the factors that influence LOS and discharge disposition in older trauma patients. In particular little focus has been given to the impact of pain, comorbidities, and the number of days from admission to initial therapy evaluation. Understanding the factors that influence LOS and discharge disposition in older trauma patients provides useful information to guide future interventions in order to optimize outcomes in this growing group of older adults. The purpose of this study, therefore, was to test models developed to explain LOS and discharge disposition in older trauma patients. Specifically, it was hypothesized that controlling for the demographic variables of gender, age, and race/ethnicity and trauma-related variables of injury severity and admitting diagnosis, comorbidities, pain, and days from admission to initial therapy evaluation will be directly related to length of stay. It is further hypothesized that gender, age, race/ethnicity, injury severity, admitting diagnosis and comorbidities will be indirectly related to length of stay through pain and days from admission to initial therapy evaluation.

With regard to factors that influence discharge disposition, it is hypothesized that the demographic variables of gender, age, race/ethnicity, the trauma-related variables of injury severity and admitting diagnosis, comorbidities, pain, and days from admission to initial therapy evaluation are related to discharge disposition. Specifically, it is hypothesized that those patients who are older, female, more severely injured, and have more comorbidities, greater pain, and a longer time from admission to initial evaluation will be discharged to rehabilitation or long term care facilities.

Methods

Design

The study was a secondary data analysis using data from the Shock Trauma Therapy Study in which therapy for older trauma patients was described. Data collection was done using a retrospective chart review from Powerchart, an electronic medical record used in the participating trauma center. Specifically, the data sources included computerized therapy (physical, occupational and speech) notes for each exposure to therapy during the patients hospital stay or up to 30 days post admission.

Sample

Eligibility is based on the participants being 65+ and having been admitted to an urban Level I Trauma Center following a traumatic event. A sample size of 137 adults was randomly chosen from 1,387 admissions over a two-year period from 2010 to 2011. This sample size is sufficient to assure a reproducible logistic regression model with a ratio of at least ten cases per predictor variable (Peduzzi, Concato, Kemper, Holford, & Feinstein, 1996). For structural equation modeling, a ratio of at least five cases per free parameter is necessary which means that for 43 parameters (the number in the full model) a sample size of 215 is necessary and for the significant path model with 28 free parameters, 140 is necessary (Bentler & Chou, 1987). Alternatively there are references that suggest a sample size of 200 is sufficient for generating a replicable model (Bollen, 1989). Thus the sample size utilized is slightly smaller than generally recommended and it is recognized that future work needs to replicate the model tested in other samples. University Institutional Review Board approval for the study was obtained.

Data Collection and Measures

Data were collected by registered nurses with acute care experience and expertise in the use of Powerchart. These individuals had not provided direct care to the study participants. The data collectors were instructed how to access the necessary data and how to complete the data collection forms for each patient.

Therapy notes include preadmission function, admission day and length of stay, rehabilitation order day, day of first/initial therapy evaluation and subsequent visits. Baseline assessments by all of the therapists include cognitive function and pain. In addition, physical and occupational therapy evaluated activities of daily living, instrumental activities of daily living, range of motion, manual muscle testing, and activity tolerance. Speech language pathologists included assessment of language skills and swallowing capabilities. Entries are not forced and therapists completed assessment components based on their expertise and clinical decision-making. Descriptive information about each rehabilitation encounter was also obtained, including the reason for the visit, what occurred during that visit, and documented reasons why a visit did not occur (e.g., patient refused). Demographic information about patients was obtained, including age, gender, race/ethnicity, comorbidities, living location prior to the traumatic event, and location after discharge. Length of stay was measured as the day of admission until the day of discharge, however, the day of discharge was not included in the count of days. For those patients admitted and discharged on the same day, the LOS was counted as one day.

Discharge disposition was based on recommendations of the physical and/or occupational therapists. The discharge disposition options were: home, home with home health services, inpatient rehabilitation, acute rehabilitation, chronic rehabilitation, traumatic brain injury rehabilitation, stroke rehabilitation, spinal cord injury rehabilitation, subacute rehabilitation, or skilled nursing facility. For the purposes of data analysis, these options were collapsed into two categories, either to home (with or without home health services) or to a facility (rehabilitation, skilled nursing, or long term care).

Pain was conceptualized as pain experienced prior to, during and immediately following therapy (Figure 6). The computerized system allows therapists to choose one of three pain assessment tools: the Verbal Rating Scale (VRS) (Herr, Spratt, et al., 2004), Verbal Descriptor Scale (VDS) (Gagliese et al., 2005; Herr, Spratt, et al., 2004) or the Checklist of Nonverbal Pain Indicators (CNPI) (Feldt, 2000). The VRS is most commonly used and involves a rating of zero to ten, where zero is no pain and ten is the worst imaginable pain. For the purpose of this study, only the VRS data are used (n = 88) since the other measures are not on a numeric scale or do not measure pain intensity. Among the 44 participants in which the VRS was not completed, 29 (65%) have no assessment of pain identified and 15 (35%) use one of the other measurement options. All three paths explained by the latent variable pain (Figure 6) are significant with path coefficients shown in Table 10.

Figure 6. Full Hypothesized Model

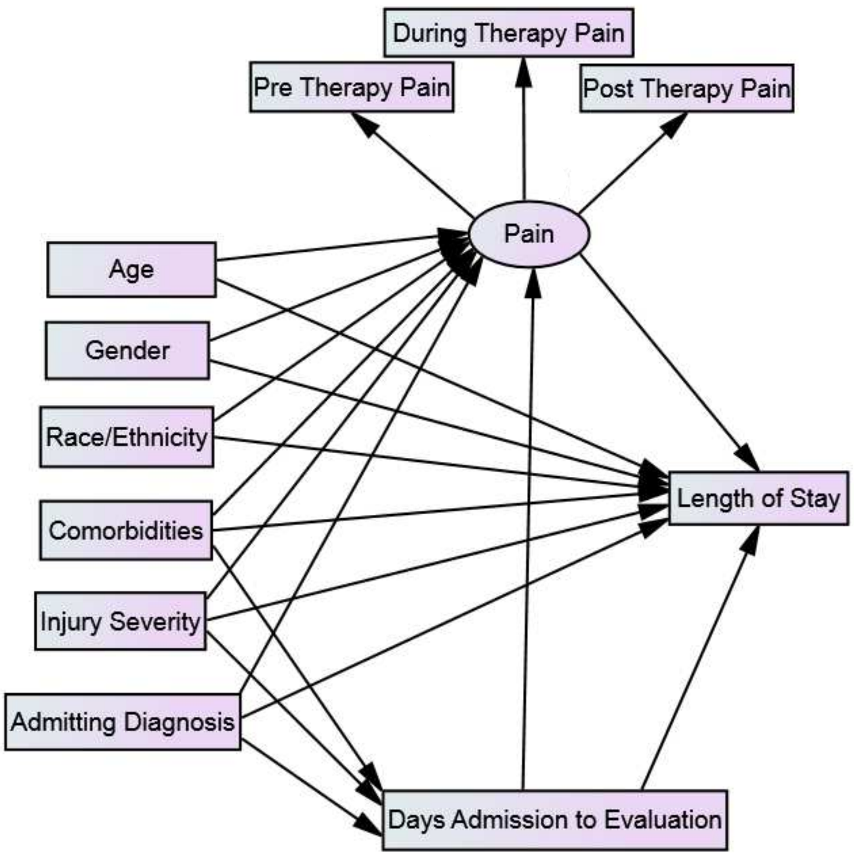


Table 10. Standardized regression weights for full model

Variables	Estimate	p
LOS ← Age	**-.163**	**.019**
LOS ← Comorbidities	**.197**	**.007**
LOS ← Severity	**.252**	**<.001**
LOS ← Admitting Diagnosis	-.129	.074
LOS ← Race	.102	.127
LOS ← Days to Eval	**.386**	**<.001**
LOS ← Pain	**-.250**	**.002**
LOS ← Gender	-.024	.715
Days to Eval ← Comorbidities	**.270**	**<.001**
Days to Eval ← Severity	**.201**	**.013**
Days to Eval ← Admitting Diagnosis	.032	.692
Pain ← Age	**-.246**	**.007**
Pain ← Comorbidities	**.258**	**.006**
Pain ← Severity	-.016	.863
Pain ← Admitting Diagnosis	. 108	.232
Pain ← Race	-.045	. 612
Pain ← Days to Eval	-.052	.586
Pain ← Gender	.024	.791
Pre Pain ← Pain	**.894**	**<.001**
During Pain ← Pain	**.719**	**<.001**
Post Pain ← Pain	**.978**	**<.001**

Bold font = significant

Injury severity was determined based on anatomic factors (the number of injured body areas) and the physiologic method of measuring severity of injury (shock or coma) (Oyetunji et al., 2010). Severe injury was based on having more than one trauma diagnosis and having a diagnosis of shock or a head injury with coma. Otherwise, if there was only one trauma diagnosis and there was no diagnosis of shock or coma, then the injury severity was considered to be mild/moderate.

Comorbidities were counted as the number of conditions not related to the admitting diagnosis that are checked off a list of diagnoses recorded in the electronic medical record. Some of the most frequent conditions in the sample were diabetes, dementia, cancer, cardiac disease, hypertension, stroke, arthritis, seizure, and a psychiatric diagnosis. Age was based on the patient's at the time of injury and hospitalization. Gender and race/ethnicity were based on what was recorded in the medical record. Primary admitting trauma diagnosis was separated into two possibilities: the patient was hospitalized for either a fracture (e.g., fracture of arm, leg, or ribs) or a head injury (e.g., skull fracture, subdural hematoma, or brain laceration). Additional admitting diagnoses among three participants did not fit into these two categories. These additional diagnoses include infection, syncope, and seizure and the three individuals with these diagnoses were excluded from the analysis.

Data Analysis

Descriptive statistics were used to describe the sample characteristics. Frequency and percentages were used for categorical level data; mean and standard deviation were used for continuous level data. Normality and outliers were examined to determine if variables met assumptions for the parametric statistical tests (e.g., correlations, t-tests, ANOVA) that were used. All variables except for length of stay met the assumption of normality. Length of stay was transformed using the natural log and then the assumption of normality was met. Logistic regression was used to determine the most parsimonious model for identifying the predictors of discharge disposition (nominal level of data as the outcome). Data were analyzed using SPSS 21.0.

Structural equation modeling was used to test the hypothesized model shown in Figure 6. Model testing was done using AMOS 21.0 and maximum likelihood estimation. Missing data are accounted for by using the 'estimate means and intercepts' function in AMOS. AMOS handles missing data through the full information maximum likelihood (FIML) method in which model parameters and standard errors are estimated directly from the available data. As previously noted, pain data was available in 88 cases. With 44 cases missing, a missing values analysis was performed, which showed that the data were missing completely at random using Little's MCAR test (Chi-Square = 47.737, DF = 38, p = .134). Model fit was estimated using the chi square statistic, the normed fit index (NFI) and Steigers Root Mean Square Error of Approximation (RMSEA). The larger the p value associated with the chi square, the better the model fits the data (Pedhazur & Schmelkin, 1991). The NFI, an incremental fit index, tests a hypothesized model against a baseline or one that does not fit the data. Ideally, the NFI should be as close to 1 with $\geq$ .95 as the recommended cut-off value to indicate a good fit (L. Hu & Bentler, 1999). The RMSEA is an absolute fit index which explains how well the model would fit the population covariance matrix (Byrne, 2001). The RMSEA is sensitive to the number of parameters in the model and a cut-off value less than .06 indicates a good model fit (Hu & Bentler, 1999). The Critical Ratio (CR), the parameter estimate divided by an estimate of the standard error, is used to determine path significance. A CR that is greater than the absolute value of two is considered significant (Pedhazur & Schmelkin, 1991). A $p < .05$ level of significance was used for all analyses.

Results

A total of 132 patients were included in the analysis. The group was almost half male (46.9%, n = 62) and half were female (53.1%, n = 70). The average age of the sample was 78.3 (S.D. = 9.7) years. The sample was 84.1% (n = 111) Caucasian and 15.9% (n = 21) other races/ethnicities (Table 11). The average number of comorbidities (including hypertension, cardiac disease, diabetes, cancer, dementia, arthritis, history of fall, psychiatric diagnosis, and seizure) per patient was 2.29 (S.D. = 1.96). Injury severity showed that about a third (34.1%, n = 45) of the patients had mild or moderate injuries and the remaining two thirds (65.9%, n = 87) had severe injuries. Approximately one third (40.2%, n = 53) of the patients had an admitting diagnosis of head injury and almost two thirds of the patients (59.8%, n = 79) had an admitting diagnosis of fracture. The average length of stay was 4.3 (S.D. = 4.0) days. Discharge disposition showed that 42.4% (n = 56) were discharged to home and 57.6% (n = 76) were discharged to a facility (inpatient rehabilitation, acute rehabilitation, chronic rehabilitation, traumatic brain injury rehabilitation, stroke rehabilitation, spinal cord injury rehabilitation, subacute rehabilitation, or skilled nursing facility). Two patients died during the hospital stay.

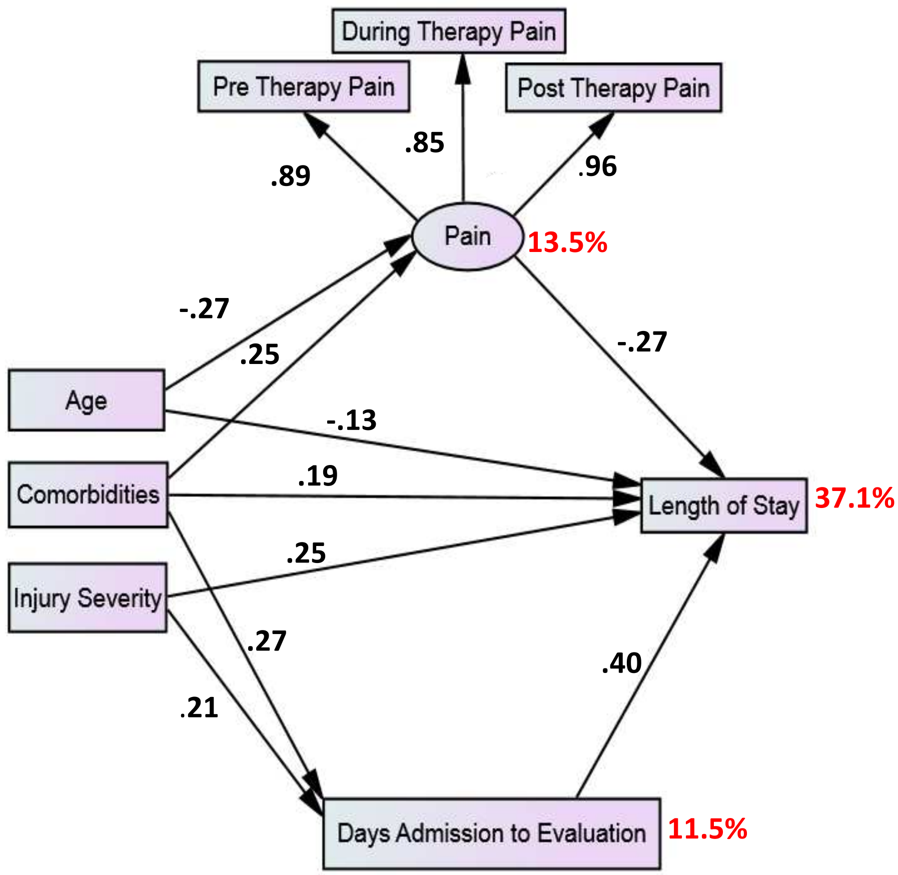
Model Testing for Length of Stay

Of the 21 hypothesized paths (Figure 6), 12 were significant (Figure 7). Specifically, younger age, more comorbidities, greater injury severity, and admitting diagnosis have significant direct relationships to pain accounting for 13.7% of the

Table 11. Sample Characteristics (N = 132)

Demographic Variables	
Age: Mean (S.D.)	78.3 (9. 7)
Range	65 - 92
Gender: Number (%)	
Male	62 (46.9)
Female	70 (53.1)
Race/Ethnicity: Number (%)	
Caucasian	111 (84.1)
Non-Caucasian	21 (15.9)
Health Related Variables	
Number of Comorbidities: Mean (S.D.)	2.29 (1.96)
Severity: Number (%)	
Mild-Moderate	45 (34.1)
Severe	87 (65.9)
Head Injury: Number (%)	
No	79 (59.8)
Yes	53 (40.2)
Fracture: Number (%)	
No	53 (40.2)
Yes	79 (59.8)
Length of Stay and Discharge Disposition Variables	
Days from Admission to Evaluation: Mean (S.D.)	1.85 (1.32)
Range	0 - 6
Length of Stay in Days: Mean (S.D.)	4.3 (4.0)
Range	1 - 26
Length of Stay: Number (%)	
< 2 days	47 (35.6)
> 2 days	85 (64.4)
Discharge Disposition: Number (%)	
Facility	76 (57.6)
Home	56 (42.4)

Figure 7. Model with Significant Paths



variance in pain and had indirect relationships to LOS through pain. Number of comorbidities and injury severity were directly associated with days between admission until therapy evaluation, accounting for 11.5% of the variance of the days from admission to evaluation. Controlling for comorbidities, admitting diagnosis, and injury severity, days from admission to evaluation, age, and pain had significant direct relationships to LOS and accounted for 37% of the variance in LOS (Table 10). Those with less pain, who were older, and those with a greater number of days from admission to therapy evaluation were noted to have a longer hospital LOS.

The full hypothesized model did not fit the data with a Chi-square of 89.782 (degrees of freedom = 34, $[\chi^2]$/df = 2.641, $p < .001$). The NFI was .776 and the RMSEA was .110. In order to test a more parsimonious model, the model was respecified by removing non-significant paths (Figure 4.2). There was a slight improvement in model fit with the non-significant paths removed (χ^2 difference = 54.5, df difference = 18, $p <.001$, and the difference in NFI = .12 and RMSEA = .016) (Table 12).

Analysis for Discharge Location

The results of logistic regression modeling the likelihood of discharge to home are summarized in Table 13. Controlling for age, gender, race/ethnicity, admitting diagnosis, comorbidities injury severity, and time from admission to evaluation, overall length of stay (O.R. .049, 95% CI .008 - .301) and pain intensity during therapy (O.R. .531, 95% CI .310 - .908) were associated with discharge to home (Chi-square = 45.05, $p < .001$, Cox & Snell R Square = .440, Nagelkerke R Square = .592, Hosmer & Lemeshow Test: ChiSquare = 3.85 p = .871, 86.1% of cases correctly predicted). For length of stay greater than or equal to 2 days, older trauma patients were 95% less likely to be discharged

Table 12. Differences in Fit Indices between the Full Hypothesized Model and the Revised Model with Significant Paths Only

	χ^2	df	Ratio	RMSEA	NFI	p
Hypothesized Model	89.782	34	2.641	.110	.776	<.001
Revised Model	35.306	16	2.207	.094	.896	.004
Difference	54.476	18	.434	.016	-.120	<.001

Table 13. Odds Ratios with Discharge Disposition as Dependent Variable

Variable	Odds Ratio	95% Confidence Interval Lower	Upper
Age	.945	.863	1.034
Gender	2.263	.551	9.292
Race	.817	.117	5.700
Comorbidities	.830	.540	1.276
Injury Severity	2.232	.319	15.594
Admitting Dx: Head Injury	.481	.049	4.757
Admitting Dx: Fracture	.353	.049	2.525
Pain	**.531**	**.310**	**.908**
Length of Stay	**.049**	**.008**	**.301**
Days Admit to Eval	.660	.305	1.429

Bold font = significant

to home. For every one point increase in pain score, older trauma patients were 47% less likely to be discharged to home (Table 13).

Discussion

Length of Stay and Discharge Disposition

The results of this study were similar to those previously reported with regard to some factors that influence discharge disposition and LOS. There is a relationship between LOS and discharge disposition, with longer LOS increasing the likelihood of the patient being discharged to a facility (A. Y. Chen et al., 2012; Cuthbert et al., 2011; Scheetz, 2005a). There were several possible reasons for these findings with one possibility being payment systems. Medicare is the payer for most of the hospital and post-acute care for older trauma patients, so Medicare guidelines can have a significant effect on LOS and discharge disposition. Medicare is a prospective payment system, meaning that payment is decided up front based on a patient's admitting diagnosis and characteristics (Grabowski, Afendulis, & McGuire, 2011; Phillips & Wineberg, 1984). Medicare has a "three midnight rule" which states that patients must be admitted to the hospital as inpatients for the period of three days before Medicare will pay for care in a rehabilitation center or skilled nursing facility (Birmingham, 2008). In addition, the hospital stay must occur within 30 days of admission to post-acute care (Centers for Medicare and Medicaid Services, 2007). Thus, it is possible that this guideline influenced both provider recommendations as well as patient/family preferences.

Days from Admission to Initial Therapy Evaluation

Current practice by rehabilitation therapists in acute care settings seems to focus their visits on establishing a discharge plan (Masley, Havrilko, Mahnensmith, Aubert, &

Jette, 2011; Smith, Fields, & Fernandez, 2010a). In many situations, the only visit that the patients have with the therapists may be on the day of discharge (D. U. Jette et al., 2003b; Maramba, Richards, Myers, & Larrabee, 2004; Masley et al., 2011). This type of interaction is likely to limit the therapists' ability to provide treatment (i.e. to work on functional skills) with patients during the trauma stay. Given the limited amount of time therapists have to provide services to older trauma patients, it is particularly important to have therapy services provided as soon as possible after hospital admission. Early physical rehabilitation programs have shown a length of stay reduction of 22% for intensive care units and 19% for floor units (Lord et al., 2013). Moreover, if the patients are not seen and evaluated by a therapist, it is possible that they will remain in bed and be at risk for associated risks of immobility (e.g., pressure ulcers, blood clots, and pneumonia).

Less commonly considered in prior research, the relationship between days from admission to therapy evaluation was tested and it was found that this factor, controlling for pain, comorbidities, and demographic and health related variables, was directly associated with LOS. This finding has important clinical implications because by shortening the time until a therapy evaluation, the overall length of stay might also be shortened. There is evidence that earlier evaluations and mobilization after hip repair or with patients with respiratory failure lead to better outcomes (A. F. Chen et al., 2012; Lord et al., 2013; Needham et al., 2010; Wellman et al., 2011). The sooner a patient can be evaluated and mobilized, the shorter the length of stay and the more likely that patient is to be discharged to home (Kamel et al., 2003; Oldmeadow et al., 2006). If therapists were able to see patients as soon as possible post trauma, early mobilization could occur and length of stay might be decreased (Diane E Clark et al., 2013; Garzon-Serrano et al., 2011; Kress, 2009; O'Brien, Bynon, Morarty, & Presnell, 2012). Challenges to making earlier visits include failure to receive requests/orders for therapy, staffing, patients' instability or unavailability, nurses not having patients ready for therapy, and lack of communication among providers (Resnick, Wells, Brotemarkle, & Payne, 2013, manuscript under review). Alternatively, it is possible that length of stay was influenced by patient/caregiver choice and refusal to go to rehabilitation, to be discharged home, or to be discharged to a specific setting. (Gregg et al., 2010; Mason et al., 2009).

Pain

As expected, pain was affected by severity of injury and comorbidities. Patient age was another factor that influenced pain, with older patients reporting less pain, a finding supported by other researchers (Catananti & Gambassi, 2010; Gagliese & Katz, 2003; Li et al., 2001). Overall, pain has received little consideration in earlier research exploring recovery post trauma among older adults. Further, this study considers pain during the entire therapy experience rather than evaluating pain only at a single, random point in time. Controlling for time from admission to therapy evaluation, demographic and injury-related variables, pain was associated with discharge disposition as well as LOS. As pain increases, older trauma patients are less likely to be discharged to home. The relationship between pain and LOS, however, indicated that experiencing more pain during therapy was associated with a shorter LOS. One explanation for this is that acute pain from injury and surgery decreases with time and thus the natural trajectory of the trauma injury was observed (Keene, Rea, & Aldington, 2011; Koneti & Jones, 2013). Conversely, it is possible that those who experienced pain and perhaps were less engaged in therapy are discharged sooner to subacute settings for a lower and slower level of rehabilitation. It is further possible that these individuals had a prolonged, costly rehabilitation stay and/or ended up in a long term care facility.

Comorbidities

Comorbidities were another area observed to influence pain, LOS, and the time from admission to evaluation. Among older adults, numerous comorbid conditions are common, such as degenerative joint disease or chronic obstructive pulmonary disease, both of which might influence the individual's ability to engage in rehabilitation activities. For example, the older patient who sustained a hip fracture but also has significant osteoarthritis of the knees and/or shoulders may be limited in the ability to tolerate walking with an assistive device or alternating weight due to the hip fracture (i.e., putting more weight on the right knee following a left hip fracture). Consideration of comorbid conditions to prevent exacerbation of these problems is critical so that recovery can be optimized. Moreover, management of comorbidities early in the trauma admission may provide an opportunity to improve outcomes and decrease length of stay (McMahon et al., 1996).

Limitations and Future Research

This study was limited by being a secondary data analysis and descriptive in nature. The sample size was small and included only one site which limited the generalizability of these findings. In addition, the sample was not very homogenous and the various trauma diagnoses could also have influenced the findings. Other variables that may be related to the outcome variables of LOS and discharge disposition were not collected. For example, it is possible that the nursing care patients on the units received, with regard to pain management, encouragement to go to therapy, and help to facilitate getting ready for therapy, influenced the length of time between admission and first therapy evaluation (Resnick et al., manuscript under review), which in turn affected LOS and discharge disposition. Other factors that may influence LOS and DD that should be considered in future research include communication among providers, personal choice, availability of caregivers, availability of alternative discharge locations, and insurance (D. U. Jette, Brown, Collette, Friant, & Graves, 2009; Masley et al., 2011; Needham et al., 2010). It would have been helpful to have measures that were standardized and that therapists were taught to use the measures in the same way. Despite these limitations, this study reinforced the association of age, pain, comorbidities, injury severity, and the number of days from admission to therapy evaluation with LOS and discharge disposition. It also provides guidance for future research to focus on such factors as pain management during the therapy session in older trauma patients and early evaluation and mobilization by therapy.

CHAPTER 5: Discussion, Implications, Recommendations

Introduction

The purpose of this secondary data analysis was to:

1. Review the concept of comorbidity and the ways in which comorbidity can be measured as one of the factors that affects pain, length of stay, and discharge disposition in older trauma patients (Chapter Two/Manuscript One).

2. Describe pain in older trauma patients before, during, and after physical, occupational, and speech therapy and determine the factors that are associated with pain. Also, to describe the ways in which pain was measured and what was done to help alleviate pain (Chapter Three/Manuscript Two).

3. Determine the factors that are related to length of hospital stay and to discharge disposition after hospitalization in older trauma patients (Chapter Four/Manuscript Three).

The Social-Ecological Model (see Figure 5 in Chapter Four/Manuscript Three) was used to organize the factors that were at the intrapersonal, interpersonal, and community levels. Specifically, models were tested that involved comorbidities, pain, time from admission to initial therapy evaluation, admitting diagnosis (fracture), injury severity, age, gender, and race/ethnicity and their effects on length of stay (LOS) and discharge disposition. This chapter discusses the findings from the review of measurement of comorbidity manuscript (Chapter Two), from the manuscript on pain in older trauma patients (Chapter Three) and the secondary data analysis (Chapter Four), as well as the implications and recommendations for practice, teaching, and future research.

Comorbidity

Comorbidity is one of the factors that has been associated with worse outcomes in hospitalized trauma patients, such as mortality (Patel, Malinoski, Nguyen, & Hoyt, 2011; Thompson et al., 2010), LOS (Bergeron et al., 2005; Hong et al., 2013; Lefaivre et al., 2009), readmissions (Boutin et al., 2013; Moore et al., 2013), and cost of care (Chan et al., 2009). Comorbidity increases with age (Ahluwalia et al., 2011; Bergeron et al., 2005; Vu, Finch, & Day, 2011) which puts older patients at risk of having poor outcomes if they are hospitalized following a traumatic injury.

In order to understand comorbidity and the ways in which it can be measured, a review of comorbidity as a concept and tools to measure comorbidity was completed for this study (Manuscript #1/Chapter 2). Comorbidities can be measured in several different ways; some of the methods appropriate for the population of interest include a sum of the number of comorbidities (Guralnik, 1996), the Charlson Comorbidity Index (Mary E. Charlson, Pompei, Ales, & MacKenzie, 1987), the Elixhauser method (Elixhauser et al., 1998), the Geriatric Index of Comorbidity (Rozzini et al., 2002), the High Risk Diagnoses in the Elderly Scale (Desai et al., 2002), and the Mortality Risk for Trauma Comorbidity Index (Thompson et al., 2010). For this study, additional diagnoses from the medical chart were used to determine comorbidities.

Comorbidities were measured by using the sum of diagnoses not related to the trauma admitting diagnosis. In this study, participants had a mean number of comorbidities between two and three (2.29, S.D. = 1.96), with a range of zero to ten comorbidities (See Table 11 from Chapter Four/Manuscript Three). This was a little lower than expected since higher comorbidity in the older trauma population has been reported, with an average of 4.1 comorbid conditions in those between 65 and 74 years and 5.5 comorbid conditions in those ≥75 years (Evans et al., 2012). The most common comorbid conditions were hypertension, diabetes, dementia, cancer, cardiac disease, stroke arthritis, seizure, and a psychiatric diagnosis (See Table 3.3 from Chapter Three/Manuscript Two). The number of comorbid conditions was found to be weakly but significantly correlated with increased age (r = .223, p = .009).

Pain in Older Adults Who Have Experienced a Traumatic Injury

Acute pain was considered as one of the factors that could influence length of hospital stay and discharge disposition in older trauma patients. Pain in older adults is different than pain in younger adults due to physiologic changes with age (Edwards, Fillingim, & Ness, 2003; Herr, Spratt, Mobily, & Richardson, 2004; Peters, Patijn, & Lamé, 2007). Differences in pain based on gender (Soetanto, Chung, & Wong, 2006; Toomey, 2008) and race/ethnicity (Shavers, Bakos, & Sheppard, 2010) have also been found. Comorbid illnesses such as arthritis, diabetes, and cancer can often contribute to chronic pain which can in turn influence a patient's overall experience of pain (Gerbershagen et al., 2009; Pogatzki-Zahn, Englbrecht, & Schug, 2009). In addition, the type and severity of injury may also affect the intensity of acute pain. The acute pain experience may be different in those with cognitive impairment, either because of the actual experience of pain or the ability of a cognitively impaired adult to report pain (Herr, Bjoro, & Decker, 2006).

Multiple measures have been used to evaluate pain in older adults including: the verbal rating scale (Hjermstad et al., 2011; Ware et al., 2006), the verbal descriptor scale (Herr, 2011; Ware et al., 2006), a visual analog scale (Herr, 2011; Hjermstad et al., 2011), the Checklist of Nonverbal Pain Indicators for those who are unable to communicate (Feldt, 2000), and the Pain Assessment in Advanced Dementia Scale for those with cognitive impairment (Warden et al., 2003). In this study, pain intensity levels were recorded by physical and occupational therapists before, during, and after a therapy session. However, therapists did not document pain intensity in 17% of the cases. In these situations, it was not clear, if pain was evaluated by the therapists but not documented or if it was not evaluated at all. Approximately 75% of the evaluations were done using the verbal rating scale and the remaining 25% of the evaluations were divided between the verbal descriptor scale and the Checklist of Nonverbal Pain Indicators. Thus, for the purposes of this analysis and interpretability of the findings the verbal rating scale was used .

Based on the scores from the verbal rating scale, the average pain intensity levels before, during, and after occupational therapy were 4.71, 5.69, and 5.02, respectively. The average pain intensity levels before, during, and after physical therapy were 4.86, 6.13, and 5.27, respectively (See Figure 3.1 in Chapter Three/Manuscript Two). Prior research has also noted that hospitalized older adults have similar levels of pain postoperatively (Berben, Meijs, van Grunsven, Schoonhoven, & van Achterberg, 2012; Cavalieri, 2005; Gianni et al., 2010; Morrison, Flanagan, Fischberg, Cintron, & Siu, 2009; Platts-Mills, Burke, et al., 2012). Patients experienced moderate to severe pain about half of the time before and after therapy sessions and almost three quarters of the time during therapy sessions (See Table 3.3 in Chapter Three/Manuscript Two). The higher pain level reported during the therapy session was expected since pain frequently increases with movement and weight-bearing in patients during therapy (Alami et al., 2011; Cote & Bement, 2010; Söderlund & Asenlöf, 2010).

Pain was not adequately treated given the amount of moderate to severe pain reported by patients. When patients reported pain, the therapists responded by continuing with the therapy session, timing therapy with medication administration, repositioning the patient, or reporting the pain to the physician or the nurse. Although other non-pharmacologic interventions, such as transcutaneous electrical nerve stimulation, heat, cold, and massage, are available for therapists to use (Beissner, 2012), therapists did not use them or if they did, it was not documented.

Factors Associated with Length of Stay

Length of stay is important in today's health care climate with cost of care being a primary focus of health care reform (Centers for Medicare and Medicaid Services, 2012). Given the high cost of acute care, there has been a focus on decreasing costs since a period of health care cost inflation noted during the early 1970s (Kaiser Family Foundation, 2009) and then with the rise of managed care and the Medicare prospective payment system in the mid-1980s (Jiang, Friedman, & Jiang, 2013). This has become even more important with the passage of the Affordable Care Act (Centers for Medicare and Medicaid Services, 2012). Thus any interventions that are likely to help decrease LOS are greatly needed (Kolstad & Kowalski, 2012; Shafi et al., 2010).

Length of stay as a primary outcome was defined as the length of time from hospital admission to discharge. If a patient was admitted and discharged on the same day, it was counted as one day. The average LOS in this study was 4.3 days (S.D. = 4.0) with a range from one to 26 days. In addition, about two thirds of the patients had a length of stay greater than two days (see Table 4.2 from Chapter 4/Manuscript 3). The LOS in this sample was actually shorter than expected since other studies have reported longer LOS in older trauma patients from 6.18 to 27.5 days (Dinh et al., 2013; Evans et al., 2012; Harrington et al., 2010; Scheetz, 2005a). Moreover, in the state of Maryland the average LOS for older trauma patients (at least among those who sustained a fall) was noted to be 5 days (Johns Hopkins Center for Injury Research and Policy, 2012).

Various factors can influence LOS, some of which were considered in this study: days from admission to initial therapy evaluation (as a way to determine early initiation of therapy) (Brahmbhatt, Murugan, & Milbrandt, 2010; Diane E. Clark, Lowman, Griffin, Matthews, & Reiff, 2012; Needham et al., 2010), pain (Kerr et al., 2010), comorbidities (Bergeron et al., 2005; Hong et al., 2013), age (Bergeron et al., 2005), gender (Mahmood, Eldeirawi, & Wahidi, 2012), race/ethnicity (Kimani et al., 2012), and injury severity (Newgard et al., 2010). Additional factors that can impact LOS have been reported in the literature, although these were not considered in this secondary data analysis. Some examples of other factors that were found to increase LOS include: trauma-related complications (Ingraham et al., 2010), infections (Ong et al., 2009), and delirium (Lat et al., 2009). The use of trauma nurse practitioners (Jarrett & Emmett, 2009) and teamwork training (Capella et al., 2010) were found to decrease LOS.

Days from admission to therapy evaluation. The number of days from admission to the initial therapy evaluation was found to be directly related to LOS. The average number of days from admission until initial therapy evaluation was 1.85 days (S.D. = 1.32) with a range from 0 – 6 days (See Table 4.2 from Chapter Four/Manuscript Three). This measure was of particular interest for two reasons: as a means to decrease overall length of stay and also as an indicator of the initiation of early therapy. Early initiation of rehabilitation therapy has been shown to decrease length of stay and improve outcomes in critically ill patients (Diane E. Clark et al., 2012; Lord et al., 2013; Needham et al., 2010).

Pain. A measurement model for pain was developed using a measure of pain intensity before, during, and after therapy (see Figure 6 in Chapter Four/ Manuscript Three). All paths in the measurement model were significant (see Table 10 in Chapter Four/ Manuscript Three). This measurement model was then used in a full hypothesized model (see Figure 6 in Chapter Four/ Manuscript Three) developed to test the relationships of various factors with LOS. Using structural equation modeling, pain was found to be directly related to LOS such that less pain was associated with a longer length of stay (see Table 10 in Chapter Four/ Manuscript Three).

Comorbidities. A higher number of comorbidities was found to be directly associated with more pain and a longer LOS and indirectly associated with LOS through pain and days from admission to initial therapy evaluation (see Table 10 from Chapter Four/ Manuscript Three).

Age. Age was directly related to pain and LOS and indirectly related to LOS through pain. There was a negative relationship between age and LOS and between age and pain, meaning the higher the age the lower the LOS and the lower the pain. Shorter LOS in older patients has similarly been noted in at least one study (Bennett, Scarborough, & Vaslef, 2010b) but not by others who found as age increases so does LOS (Dinh et al., 2013; Ong et al., 2009; Spaniolas et al., 2010; Verma, Rigby, Shaw, & Mohsen, 2010). The negative relationship between age and pain is related to physiologic changes with aging as has been reported by others (Cole, Farrell, Gibson, & Egan, 2010; Gibson & Farrell, 2004; Lautenbacher, Kunz, Strate, Nielsen, & Arendt-Nielsen, 2005).

Injury severity. Injury severity was directly related to LOS and indirectly related to LOS through days from admission to evaluation. Injury severity has been found to be related to LOS (Newgard et al., 2010) and in one study was found to be the greatest predictor of LOS (Scheetz, 2005b). This could be explained by the fact that patients with greater injury severity would need longer times to recover to the point where they could be transferred to a lower level of care (Ong et al., 2009; Sviri, Aaslid, Douville, Moore, & Newell, 2009)

Non-significant factors. Gender, race/ethnicity, and admitting diagnosis were not directly or indirectly related to LOS.

Factors Associated with Discharge Disposition

Discharge disposition after an admission to the hospital is an important consideration for patients, caregivers, and payers. There are several different discharge locations to consider including: discharge to home, home with home care services, inpatient rehabilitation, skilled nursing facilities, and long term care. Generally, when asked about preferences older adults will choose to go home upon discharge (Cook et al., 2013). However, based on recommendations of therapists, physicians, or nurse practitioners, patient and family needs and preferences, and the availability of payment for the services rendered, patients may be sent to other locations. Physical therapists are noted to make their recommendations based on the patient’s function, the patient’s wants and needs, the patient’s ability to participate in care, the patient’s life context, opinions of the health care team, and health care regulations (D. U. Jette et al., 2003a). Physicians and nurse practitioners tend to make their final discharge recommendations based on information from therapists and patient preferences (D. U. Jette et al., 2003a; Masley et al., 2011). Patients' preferences for going home must be balanced with their needs for rehabilitation and skilled nursing care (Kane, 2011). Finally, decisions are often based upon the availability of payment for additional services (Buntin, Colla, & Escarce, 2009). Thus, a discharge to home may not be the best decision for the patient but given restricted coverage for rehabilitation, may be the only option the patient/family can afford.

The patients in this study were over the age of 65 years and thus Medicare was the primary payer. Medicare is the payer for most of the acute and post-acute care for older trauma patients, and Medicare coverage guidelines have a significant effect on discharge disposition. Medicare has a "three midnight rule" which states that patients must be admitted to the hospital as inpatients for the period of three days before Medicare will pay for care in a rehabilitation center or skilled nursing facility (Birmingham, 2008; Centers for Medicare and Medicaid Services, 2007). In addition, the hospital stay must occur within 30 days of admission to post-acute care (Centers for Medicare and Medicaid Services, 2007). Although not articulated, there may be a tendency for providers to keep a patient an additional day or two to meet the three day rule.

A recent trend reported in the health care literature is the use of observation units, which are extensions of an emergency department visit and therefore considered to be an outpatient visit (Birmingham, 2008) . Observation units generally keep patients for less than 48 hours to continue diagnostic testing and monitoring of patients while awaiting results (Moseley, Hawley, & Caterino, 2013). Having this observation status does not allow patients to count any of that time towards the three day stay to qualify for payment of post-acute care (Birmingham, 2008). In addition, it means that patients frequently have higher co-pays and, if they end up in a rehabilitation center or skilled nursing facility, they will be responsible for payment for services they receive (Moseley et al., 2013). Although insurance coverage was not considered in this study, all trauma patients in this acute care setting are admitted and thus there were no individuals in which observation stays influenced discharge disposition.

Future trends in health care suggested by the Affordable Care Act may influence discharge disposition. One trend involves the use of a bundled payment initiative in which providers and services are paid together for one episode of care, both in the acute care and post-acute care settings (Virani et al., 2013). Related to this is the high cost of therapy care and the need to demonstrate quality outcomes, since the failure to provide value in service could lead to the irrelevance of the profession (Jewell, Moore, & Goldstein, 2013). Failure to demonstrate outcomes from therapy can result in the discontinuation of these services in acute care, which is certainly a concern, given the benefits of early mobilization in these settings (Brahmbhatt et al., 2010; Diane E Clark et al., 2013; Lord et al., 2013; Needham et al., 2010; Schweickert et al., 2009).

Unfortunately, given limitations in staffing, another current trend in health care service provision is for physical therapists to focus their visits with patients on establishing a discharge plan rather than providing treatment (Masley et al., 2011; Smith, Fields, & Fernandez, 2010b). In many situations this may be the only visit that the patient has with the therapists and it may be on the day of discharge (D. U. Jette et al., 2003a; Maramba et al., 2004; Masley et al., 2011). This then leaves little time for treatment to occur and for functional status to be optimized to facilitate a discharge to the home setting. To improve opportunities for greater exposure to therapeutic rehabilitation sessions, it may be helpful to initiate therapy earlier in the hospital stay for older patients post-trauma. Moreover, this early evaluation may help decrease the immobility and excessive time spent in bed (C. J. Brown et al., 2004; C. J. Brown, Redden, Flood, & Allman, 2009; Zisberg et al., 2011) among older adults in acute care settings. This is particularly true as nursing staff tend to keep patients in bed until cleared by physical and occupational therapy (Boltz, Capezuti, & Shabbat, 2010). Early exposure to physical therapy during inpatient stays has been noted to decrease length of stay by 22% for those in intensive care units and 19% for those on medical units (Lord et al., 2013). .

Pain. Pain was found to be inversely related to a discharge disposition of home with an odds ratio of .531 (95% CI: .310 - .908) (See Table 13 in Chapter Four/Manuscript Three). This means that those with more pain were 47% less likely to be discharged home. One possible explanation for this finding may be that those who have more pain are not ready for discharge to home, since pain may be interfering with their functional abilities. It may also mean that patients with more pain were more seriously injured which would require additional rehabilitation services.

As noted in Chapter Three/Manuscript Two, patients continued to report moderate to severe pain about two thirds of the time during therapy. Better coordination between therapists and nursing staff might help with improved pain management. For example, if patients are medicated so that adequate time passes for analgesics to take effect, it may help to control pain during the therapy session. Education of the patients might also be necessary to encourage them to report pain and to be involved in identifying alternative methods of pain relief that may have worked for them previously or that they may be willing to try. Overall, patients who have improved pain may be more motivated and able to participate in therapy, thus improving their functional status and making a discharge to home more likely.

Length of stay. Length of stay was found to be inversely related to a home discharge disposition with an odds ratio of .049 (95% CI: 008 - .301) (See Table 13 in Chapter Four/Manuscript Three). This means that those with a longer length of stay were 95% less likely to be discharged to home. One reason for this longer LOS could be that a bed in a rehabilitation or skilled nursing facility might not be immediately available, especially if there is no insurance coverage (Popejoy, Galambos, Moylan, & Madsen, 2012). Alternatively, it is possible that patients who have a longer LOS are more critically injured and in greater need of rehabilitation services (i.e., a patient who has a severe traumatic brain injury, may not be stable enough in a short period of time to be transferred to a rehabilitation center).

Non-significant Factors. Comorbidities, demographic variables (age, gender, race/ethnicity), health-related variables (injury severity and admitting diagnosis) and time from admission to initial therapy evaluation were not related to discharge disposition.

Additional Factors that May Influence LOS and Discharge Disposition

In model testing, only 37% of the variance in LOS was explained and for discharge disposition the Cox & Snell R Square was .440 and the Nagelkerke R Square was .592. Therefore, there are additional factors that were not captured in this study that influence LOS and discharge disposition. As noted, the Social-Ecological Model was used to guide this research and provided a framework for the identification of additional factors that may influence LOS and discharge disposition. This framework thus provides guidance for other factors that may influence LOS and discharge disposition. Within the Intrapersonal sphere, additional factors might include such things as the patient's preinjury functional level, cognition, psychological factors (e.g., depression, motivation, and the tendency to catastrophize pain), medications, severity of comorbidities and associated symptoms.

At the Interpersonal level, there are also additional factors that may influence outcomes. For example, whether or not the patient has appropriate social supports, whether or not there are caregivers in the home setting, and the type and quality of interactions between acute care staff and patients during the inpatient stay (whether or not they provided verbal encouragement and motivation to engage in functional activities, to go home, or to go to another inpatient setting) may all influence LOS and discharge disposition.

The Environmental factors that might also influence LOS and discharge disposition include such things as the patients' physical environment and how well that facilitates function (e.g, chairs that the individual can sit in and transfer from), safety factors in the home environment (e.g., stairs and handrails, grab bars in the bathroom), and community resources (e.g., a helpful neighbor, available stores to obtain food). Environmental factors may also include the culture of care; for example, the care recovery process may be impacted by a culture that believes a sick patient should stay in bed (Boltz et al., 2010).

Finally, at the Policy/System level additional factors to consider are insurance status, regulations around rehabilitation services, and coordination between institutions at various levels of care. Likewise, consideration of the services within a hospital system are necessary, such as individuals to help facilitate the discharge process and to work with facilities to assure bed availability. In addition, having therapists available to see patients in a timely fashion, nursing staff to address such things as pain prior to therapy, and the use of alternative treatments for pain management (e.g, the ability to use a heating pad at the bedside) could further impact LOS and discharge disposition. Finally, once a patient is discharged, additional factors that can influence outcomes are the availability of home care services and transportation for follow-up appointments.

Missing Data

Missing data in this study were noted in the evaluation of pain pre, during, and post therapy. Eighty eight cases were available for the pain intensity variable using the verbal rating scale, leaving 44 cases missing after removing the two patients that expired and the three that did not have a trauma diagnosis. A missing data analysis was performed which showed that the data were missing completely at random using Little's MCAR test (Chi-Square = 47.737, DF = 38, p = .134). For structural equation modeling, AMOS 21.0 uses a full information maximum likelihood (FIML) technique, which allows for estimation of parameters and standard errors from the available data. That being said, it is impossible to know if these estimates were consistent with would have been the true assessments of pain by these participants.

Limitations

The major limitation of this study was that it was a secondary data analysis and thus was not developed to answer the research questions. For example, many factors that may have influenced pain, LOS, and discharge disposition such as anxiety, depression, availability of a caregiver, and patient preferences in terms of discharge location were not collected in the parent study. One major problem is that information on medication, what was ordered and what was taken was not available. Another major limitation of this study was the small sample size. Although randomly selected from a pool of 1387 participants, this small percentage of patients included (n = 137, 9.9% with analyses done on n=132, 9.5%) may not be reflective of the full sample of older adults admitted for trauma. Due to the small sample size, the study results most likely will not be able to be replicated and a larger sample size should be used to test the model. The trauma patients in this study included those that experienced a fracture or head injury. In other groups of trauma patients, there may be a much larger number of individuals with blunt trauma, for example, and their outcomes and the factors that influence those outcomes may be very different than noted in this sample.

Implications for Nursing Practice

The findings from this study suggest that pain remains under-evaluated and undertreated, since the mean pain score was 6.13 during therapy. Participants also reported moderate to severe pain at rest about 50% of the time, which increased to a little over 70% during therapy. Pain at the moderate to severe level may have caused some patients to stop or modify therapy. All of this implies that patients were not being adequately treated, possibly due to insufficient ordering of medications, lack of use of non-pharmacologic interventions, and nurses not having the opportunity to check with patients prior to a therapy session and not pre-medicating these individuals. Improved communication between therapists and nurses may lead to improved pain management during therapy as well as when patients are at rest. Although the study used data from the notes of physical and occupational therapists, nurses have the opportunity to help facilitate the therapy process by helping with pain management and patient preparation for therapy.

Pain was also a factor in discharge disposition, with higher pain being associated with a discharge to an institutional setting and a shorter acute care length of stay. Unmanaged pain may mean that a patient's participation in therapy might be decreased which may prolong the need for therapy and inadequately prepare a patient for discharge to home.

Implications for Nursing Education

This study has implications for teaching that are important. As the population ages and there are proportionately more older adults with traumatic injury, nurses and other health care professionals will need knowledge of how to provide their care. The American Academy of Colleges of Nursing (American Association of Colleges of Nursing, 2010a, 2010b; Watman, Escobedo, & Langston, 2011) has put forth the idea that content on the care of older adults should be integrated into the baccalaureate and graduate nursing curriculum. Pain in this population needs to be studied since pain remains undertreated and underreported (Berben et al., 2012; Cavalieri, 2005; Gianni et al., 2010; Platts-Mills, Burke, et al., 2012). Evidence-based findings, such as current guidelines for the assessment and management of pain, should be integrated into the curricular content. Education of nurses at all levels, should include information on collaboration and communication with other health care professionals to optimize pain management for the patient.

In addition, discharge planning and the continuum of care need to be included in the nursing curriculum at both the undergraduate and graduate levels. An acute hospitalization is only a very small portion of a patient's life and the patient's life before and after hospitalization must be taken into account. An appropriate discharge plan will ensure that a patient is discharged to the setting which best meets their needs, preferably to the setting from which they came, as long as it is safe and appropriate for their post-injury status. However, if a patient needs additional services to maximize their function, the discharge plan should include those services. Current nursing education focuses on the acute care setting, so information about the alternative settings for care, such as home or a facility, should be included in the curriculum. In addition, length of stay and its implications for cost of care must be considered.

Implications for Nursing Research

Despite a current emphasis on pain management in health care (Bial & Cope, 2011; International Association for the Study of Pain, 2010; Joint Commission on Accreditation of Health Care Organizations, 2001), this study shows that therapists may not be recording pain on a consistent basis and they may not be documenting the use of some of the available modalities for managing pain. It is also not clear what medications, if any, were given, and if they were not given, it may be because they were not ordered. Future research should include studies of the communication between nurses and physical therapists to examine when analgesics should be given to reduce pain during therapy. Additional research could look at the reasons why therapists and nurses rarely use other non-pharmacological modalities for pain relief. The study of older adults and what affects their reporting of pain also has a place in future research since the findings of this study may have been impacted by older trauma patients' perception of pain and their motivation to report pain. Another area for future research is the effect of managing comorbidities in older trauma patients on pain and LOS. The management of comorbidities in older adults has been a recent focus of the American Geriatrics Society as they have developed guiding principles for the care of older adults with multimorbidities (Boyd et al., 2012).

This study has identified factors that may influence discharge disposition and length of stay. Future research could examine additional factors that were not obtained in this study. In addition, future research could explore the impact of social supports, functional status and underlying physical capability of patients, and the amount and type of therapy received. Discharge planning methods and case management could be studied to see which methods are most efficient and lead to the best outcomes.

Recommendations

Older trauma patients need to be considered as a special population with unique needs. First, consideration of comorbidities in older trauma patients, especially the number of comorbidities, is necessary to understand the effect on LOS. Appropriate management of comorbidities may help with overall outcomes. Next, management of pain is necessary for optimal participation in therapy sessions. In addition to managing pain through timing therapy sessions with pain medication and using positioning for patient comfort, therapists may want to consider the use of other modalities, such as TENS, ice, heat, and massage. Education about pain management and treatment modalities may assist therapists to improve their patient care and documentation of pain. Patient education about reporting pain and available pain management strategies may help patients feel more confident in voicing their needs and obtaining appropriate interventions. Improving communication between providers may facilitate a patient's participation in therapy and may improve outcomes, including decreased LOS and discharge to home. In addition, decreasing the length of time from admission to initial evaluation may decrease overall length of stay. Early initiation of therapy also may improve outcomes. Use of home care services and additional resources to allow patients to be discharged to home may provide the opportunity to decrease overall cost of care. A prospective study with a larger sample size could be conducted to further the understanding of factors that influence LOS and discharge disposition in older trauma patients.

Summary

This chapter summarized the study findings and discussed the implications for nursing practice, education, and research. Design and measurement issues were discussed in the limitations section of this chapter. Findings from the study can be used to guide pain assessment and management as well as improve communication between nurses and other health care providers. In addition, the management of pain and comorbidity are important factors that impact discharge disposition and length of hospital stay.

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