COGNITIVE IMPAIRMENT AND FALLS IN THE OLDER ADULT POPULATION: INCIDENCE AND OUTCOMES IN A LEVEL ONE TRAUMA CENTER

by

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ABSTRACT

CHRISTINE CHURCHILL. Cognitive impairment and falls in the older adult population: Incidence and outcomes in a Level 1 Trauma Center (Under the direction of DR. DENA SHENK)

Cognitive impairment has been found to be associated with an increased risk of falls among older adults. The aim of this study was to compare in-hospital outcomes such as time-to-surgery, complications, length of stay, intensive care utilization, post-operative mobility and discharge disposition of older adults presenting with or without cognitive impairment who underwent surgical treatment for a low energy hip fracture. We identified 255 patients (women > 55 years, men > 60 years) with hip fracture treated during an 18-month period (5/2/11-11/29/12) while patient demographic and hospitalization data were examined. During the 18-month period, 30% presented with a diagnosis consistent with cognitive impairment (e.g. dementia, Alzheimer's disease, Lewy body, vascular dementia). Complication rates were higher among the cognitively-impaired patients versus those without cognitive impairment (p=0.0647). Moreover, 31% of cognitively-impaired patients experienced delirium compared to 14% of those without cognitive impairment (p=0.001), while 23% of cognitively-impaired patients had urinary tract infections (UTI) compared to 9% among those without cognitive impairment (p=0.002). There was no difference in the overall inpatient complication rates between both categories; however, cognitively-impaired patients were more likely to experience complications such as delirium and UTI. Based on these findings, we recommend systematic assessment of cognitive status on admission and identification of cognitive impairment. The recognition of the most common complications will allow clinicians to

create focused clinical pathways to help decrease complications in cognitively-impaired patients.

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CHAPTER 1: INTRODUCTION

One in three older adults falls each year, and every 15 seconds an older adult presents to the emergency room with a fall-related injury (Centers for Disease Control and Prevention, 2012). Falls can cause disability and mortality in the older adult population (Stevens, Mack, Paulozzi & Ballesteros, 2006; Van Doorn et al., 2013). Although younger adults are not immune to falls, research indicates that older adults are more prone to this type of accident (Talbot, Musiol, Whitham & Metter, 2005). Cognitively-impaired older adults are one of the vulnerable subgroups impacted by falls, and are at a greater risk of falls compared to those without cognitive impairment (Harlein, Dassen, Halfens & Heinze, 2009; Morris, Rubin, Morris & Mandel, 1987; Tinneti, Speechley & Ginter, 1988). One outcome of falls in the older adult population is fragility fracture. Fragility fracture is a break in the bone that occurs after a ground-level fall such as slip-and-trip, which is attributed to a low bone density (World Health Organization, 1994). The most common type is the break of the hip bone (World Health Organization, 1994).

Cognitively-impaired older adults are three times more likely to suffer a fall-related hip fracture in comparison with cognitively-intact older adults (Friedman, Menzies, Bukata, Mendelson & Kate, 2010; Van Doorn, et.al 2003). Fragility fractures impacts the healthcare system as well as the individual. For example, fragility fracture of

the hip costs the healthcare system $26,856 per patient (Ohsfeldt, Borisov & Sheer, 2006). On the individual level, a fall-related injury substantially decreases functional health and, in some cases, can lead to permanent disability (Friedman et.al, 2010; Hall, Goldswain, William, Senior & Criddle, 2008; Marottoli, Berkman & Cooney, 1992; Van Doorn et.al, 2003). This is a huge burden for the healthcare system due to the increase in the older adult population.

This study focused on adults 55 years and older admitted to a Level One trauma center with a hip fracture due to a fall between 5/2/2011 and 11/6/2012. Demographic characteristics and in-hospital outcome as measured by complications, length of stay, discharge disposition, ICU utilization and time to surgery among both categories of older adults were examined.

CHAPTER 2: LITERATURE REVIEW

Risk Factors for Fall-Related Hip Fracture in Older Adults

There are several studies examining risk for fall-related fracture in the older adult population. Fall-related hip fracture is not attributed to a single cause but rather to a multi-factorial interaction that can cause a hip fracture among older adults who fall (Bueno-Vaneillas, Padilla-Ruiz, Jimenez-Moleon, Peinado-Alonso & Galvez-Vargas, 2000). Risk factors for this type of fracture are classified as intrinsic or extrinsic in nature and include place of residence, impaired gait and balance, presence of dementia, medication use, tobacco use, and life satisfaction (Chen et. al, 2009; Colon-Emeric et al, 2013, Stolee, Poss, Cook, Byrne & Hirdes, 2009& Peel, McClure & Hendrikz, 2007). It appears that risk factors vary by primary residence. For example, Chen et al. (2009) examined the risk factors for hip fracture among institutionalized people 65 years and older living in nursing homes and intermediate-care communities. This study also showed an association with older age, lower weight and cognitive impairment. It appeared that older adults often disregard their high risk of falling when attempting to walk due to their desire to remain independent (Stolee et al, 2009). Similarly, Chen et al (2009) assessed adults aged 65 years and older in the community and discovered that those with impaired gait, use of ambulatory aides, or cognitive impairment were at high risk for a fall-related hip fracture. Further exploration of the relationship between cognitive impairment and hip fracture is necessary.

Cognitive Impairment

Dementia is defined as an acquired impairment of intellectual function in multiple areas, accompanied by impaired short-term or long-term memory, as well as in language, praxis, object recognition, or executive function (Swanson and Carnahan, 2007). Dementia has many causative factors with varying severity such as Alzheimer's, Vascular, Fronto-temporal and Lewy bodies (Alzheimer's Association, 2014). One of the most prevalent causes of dementia is Alzheimer's disease. Research indicates that Alzheimer's dementia accounts for 60 to 80 percent of all dementias (Alzheimer's Association, 2014). As the prevalence of dementia increases in the population, older adults continue to experience weakened occupational and social functions or interpersonal relationships. While specific symptoms vary across subtype of dementia, people affected with the condition are characterized by loss of language, memory and executive function, impairment in thinking, orientation, comprehension, judgment, perception, gait and balance. Individuals affected by dementia may be unable to perform their instrumental activities of daily living (IADL) and activities of daily living (ADL), which often leads to heavy reliance on caregivers. These deficits have been implicated in fall-related hip fractures in cognitively-impaired older adults.

The Influence of Cognitive Impairment on Fall-Related Hip Fractures

As stated previously, older adults with cognitive impairment are at higher risk for a fall-related hip fracture compared to those without cognitive impairment. Fall risk is multi-factorial and understanding the interaction of these risk factors is integral in the development of prevention programs. There are different analyses in the literature detailing the risk factors for fall-related hip fractures in the cognitively-impaired

population, including demographics, bone health, behavioral, gait and cause of dementia (Shaw, 2007; Zhao, Shen & Ji, 2012).

With regards to demographic characteristics, it has been noted that older adults with cognitive impairment are more likely to be aged 85 years and older and mostly female. Life expectancy in the United States has increased in the past decades in the older adult population, especially among women (Pinkhasov et al, 2010). Consequently, more older adults are living with chronic conditions such as dementia and hip fracture.

There are behavioral characteristics in the cognitively-impaired that contribute to fall and other related hip fractures. A study (Eriksson, Strandberg, Gustafson & Lundin-Olsson, 2009) of 191 adults aged 65 years and older with dementia at a skilled nursing community shows that behavioral disturbances were more common at night. Also anxiety, darkness and improper footwear use were all attributed to fall injuries such as hip fracture. In addition, there is a higher incidence of urinary tract infections among older adults who have had a fall-related injury.

Another risk factor for fall among these cognitively-impaired older adults is lower bone mineral density. Zhao et al (2012) discovered that bone mineral density was predictive of fracture in older adults with Alzheimer's compared to those without the disease. The risk for a fall-related hip fracture increases with low bone mineral density and gait and balance impairment in older adults with dementia.

These risk factors are all predictors for fall-related hip fracture in the cognitively-impaired older adult population. These fractures are often treated surgically, which may result in post-surgical consequences for the older adult patient.

Fall-Related Hip Fracture Outcomes Among Older Adults

The outcomes of hip fractures in older adults who have fallen vary in research. Several studies have examined outcomes such as length of hospital and intensive care stays, complications, mortality and functional status after surgical treatment of fall-related hip fractures among older adults. Length of stay in the hospital after a fall-related hip fracture have been found to be longer among older adults with dementia compared to those without dementia (Scandol, Toson, & Close, 2013). These older adults are also more likely to experience post-operative complications after a fall-related hip fracture. Previous studies have reported a post-operative complication in those patients with fall-related hip fractures of 20% (Lawrence et al., 2002), with complications including cardiac and pulmonary complications (Radcliff et al., 2008; Roche et al., 2005), urinary tract infection, pneumonia, infection, and respirator obstructions (Eschbach et al., 2013).

There was only one study examining post-surgical outcome among older adults with fall-related hip fracture with varying cognitive status. Menzies, Mendelson, Kates & Friedman (2012) conducted a study to determine whether patients with a higher burden of comorbidity or specific comorbidities are at risk for a worsened postoperative outcome among patients 60 years and older who underwent surgery for hip fracture. This population of older adults had a significantly high prevalence of dementia. The most prevalent postoperative complication included hypoxia and pneumonia. In a study of cognitively-impaired patients, there was increased impairment in functional ability after repair of the fracture compared to before the injury (Shua-Haim, Parikh & Gross, 1995).

Researchers agree that older adults with cognitive impairments are at an increased risk for fall-related hip fractures and post-operative complications. Therefore it is vital to

understand the impact of the care of these older adults on the medical system in order to reduce the financial burden. Consequently, it is essential to compare outcomes of older adults with varying cognitive status after surgical treatment for hip fractures and the implications of that status on their care.

CHAPTER 3: METHODS

The purpose of this study is to examine the differences in outcomes in the fall-related hip fracture patients with and without cognitive impairment. This chapter will (1) describe the research methodology of this study, (2) explain the sample selection, (3) describe the procedure for collecting the data, and (4) provide an explanation of the statistical procedures used to analyze the data.

Research Methodology

A prospective quantitative research approach was utilized for this study to determine whether there is a difference in outcome among fall-related hip fracture patients undergoing surgical repair with and without cognitive impairment. Patients were identified at the orthopaedic surgery department's daily checkout for an 18-month period. A data sheet containing the variables of interest was used to obtain data from individual patient's electronic medical records by a Nurse Practitioner and a Research Associate.

Sample

In early 2010, two faculty orthopaedic surgeons implemented the Fragility Fracture Program (FFP). With the help of a program coordinator, they addressed the management and cost of fragility fractures at the only Level One trauma center in the Charlotte metro area serving two states.

The FFP at this hospital is modeled after the Geriatric Fragility Fracture Program developed and tested by the University of Rochester Medical Center (Friedman,

Mendelson, Kates, & McCann, 2008). The Fragility Fracture Program (FFP) is a clinical innovation to address the cost and burden of falls from a standing height among older. The program is a "co-management" model in which the internal medicine and orthopaedic teams jointly manage the care of older adults with fragility fractures. The model was developed to acknowledge the medical complexity of geriatric patients, many of whom have multiple chronic conditions that need to be addressed in addition to their acute injury.

The program targets women 55 years and older and men 60 years and older who have fractured a hip due to a fall from a standing level. Most researchers have used 65 years as the start of older age, as a product of the government need for the identification of those eligible for pension benefits or retirement (Sugarman et al, 2002). However, other researchers have divided subjects into middle (50-64 years), late (65-79 years), and older age (80 years and above) when examining hip fractures in the aging population (roussard & Magnus, 2004; Langlois, Harris, Looker,& Madans, 1996).

It is important to note that chronological age of retirement does not always equate to biological age, as the aging process is unique for each individual. Morbidity and mortality have been more dependent on number and extent of comorbidities rather than chronological age. Therefore, this study examined women 55 years and older and men 60 years and older because of the comorbidities (such as the risk of osteoporosis) inherent in those groups. A study by Cummings & Melton (2002) exploring the epidemiology of osteoporotic hip fracture stated the lifetime risk of hip fracture starts at the age of 50 years for women. In addition, older men are often undertreated for osteoporosis but have a higher mortality for hip fractures than women. The combination of comorbidities and

age, rather than age alone, is more predictive of clinical outcome after a fall-related hip fracture. Patients included in the current data set required surgical repair of the hip fracture using screws, nails, rods, or plates. Hip fractures treated by partially or completely replacing the joint with artificial parts were excluded from this study. In late 2010, a research initiative was approved by the hospital's Institutional Review Board to evaluate the effectiveness of the program in the management and care of patients admitted to the Fragility Fracture Program. This current study explored the role of cognitive impairment on complications and in-hospital outcomes among patients admitted to this program between May 2012 and November 2012.

Table 1: Description of patient population

Patient Population	
Inclusion Criteria	**Exclusion Criteria**
Female 55 years and older	Female under 55 year of age
Male 60 years and older	Male under 60 years of age
Diagnosis of hip fracture requiring repair with surgical screws, nails, rods or plates	Fracture resulting from an underlying disease process other than osteoporosis/osteopenia (i.e. malignant tumor)
	Fracture resulting from traumatic injury such as motor vehicle and motorcycle accidents

Study data were collected and managed using REDCap electronic data capture tools. REDCap (Research Electronic Data Capture) is a secure, web-based application designed to support data capture for research studies.

Data Collection

Collected for all participants in the FFP, variables were divided into predictor and outcome variables. Predictive variables are confounding factors that an older adult may have prior to admission which may impact outcomes after a fragility fracture. Demographic characteristics such as age, gender, race/ethnicity, residence prior to hospitalization, past medical history, and mobility status were all abstracted from patient charts. Parker Mobility Score is a 3 item measure used to rank pre- and post-fracture mobility with a score from 0 (not able to walk at all) to 9 (fully independent). The Charlson Comorbiditity Index (CCI) was used to assess the impact of comorbidity on post-surgical outcome. Based on the CCI score, which provides a weighted score of a patient's comorbidities that can be used to predict post-surgical outcomes, the severity of comorbidity was categorized with three grades by CCI score: mild (1-2); moderate (3-4), and severe (>5). Data for the CCI is captured through medical record review.
Study outcomes include: complications, time to surgery, length of stay, hospital re-admission, and discharge disposition. Complications include: delirium (defined as any documented in-hospital mental status change), pneumonia, congestive heart failure and cerebrovascular events, urinary tract infection (requiring a positive urine culture plus clinical diagnosis not present on admission), surgical site infection, arrhythmia, myocardial infarction, pulmonary embolism, deep venous thrombosis, renal failure, bleeding events such as hemorrhagic stroke, intracranial or retroperitoneal bleed, and gastrointestinal bleed. Time to surgery was defined as time of admission to start of anesthesia induction. Deaths during hospitalization were recorded as in-hospital

mortality. Discharge from the hospital to home, acute rehabilitation, assisted living, or long-term care was also recorded.

Data Analysis

Data analyses focused on the effect of cognitive impairment on program process and outcome among older adults hospitalized for an operative hip fracture after a fall from a standing level. Analyses compared predictive and outcome variables between older adults with cognitive impairment versus those without cognitive impairment. Basic descriptive analysis, t-test and, cross-tabulation were conducted to compare older adults with and without cognitive impairment.

CHAPTER 4: RESULTS

Predictive Variables

There were 255 patients admitted with operative hip fractures who were part of the FFP between 05/02/11 to 11/29/2012. Those with a diagnosis indicative of cognitive impairment (e.g. dementia, Alzheimer's disease, frontal temporal dementia, vascular dementia) accounted for 30% (N=70) patients during this period. The average age of patients admitted during this period was 78.33 years. The average age of the cognitively impaired cohort was significantly higher; the average age of those with cognitive impairment was 82.79 years compare to 73.9 years in those without cognitive impairment ($p<0.0001$). The gender distribution is similar to the national gender distribution of the older adult population, with 67%of the patients being female.

Almost three quarters (74%) of the operative hip fracture population during this period were community-dwelling prior to the admission to the hospital. However, 55% of the cognitively impaired patients resided at home prior to admission, compared to 80% of the non-cognitively impaired ($p<0.0001$). Twenty-seven percent of the cognitively impaired versus 11% of the non-cognitively impaired lived in skilled nursing facility ($p<0.0001$) prior to injury. Among those who resided in skilled nursing homes (N=27) prior to admission, 77.7% (N=21) presented with cognitive impairment compared to the cognitively intact ($p<0.0001$). The Charlson risk index was used, an index for quantifying the prognosis of patients involved in clinical trials. The average Charlson risk index for the total population was 2.04. Patients with cognitive impairment scored an average of

2.77 versus 2.04 among those without cognitive impairment (p=0.007). The Parker Mobility Score (PMS) provides physiotherapists with a standard and validated score to assess the mobility of frail elderly patients. The average Parker Mobility Score (PMS) pre-admission for the overall population is 2.59. The average pre-fracture PMS for the cognitively impaired was 4.32 compared to 1.88 among patients without any cognitive impairment (p<0.001).

Outcomes Variables

The average length of stay (LOS) in the hospital for this fall-related hip fracture patients was 7.55 days. Among those with cognitive impairments' average LOS was 7.53 compared to 7.56 days for those without cognitive impairment (p=0.979). Sixty-seven percent of the fall-related hip fracture patients experienced at least one complication. The most commonly occurring complications were renal insufficiency/failure (N=23), delirium (N=49), hypoxia (N=8), pneumonia (N=6), and urinary tract infection (N=34). Cognitively impaired patients were more likely to experience delirium (p= 0.0014)), urinary tract infection (p= 0.0019) compared to those without cognitive impairment. Twenty-one percent of the population spent time in the Intensive Care Unit (ICU) during the hospital stay. The average ICU length of stay for the cognitively impaired patients was 0.69 days versus 0.72 among those without cognitive impairment (p=0.9345). Prior to discharge from the hospital the average PMS for those with cognitive impairment was 8.49 versus 7.52 with those without cognitive impairment (p<0.0001). Approximately 59% of the patient population overall experienced no delay in surgery. Delay to surgery, as defined as time to surgery greater than 48 hours post admission to hospital was not

statistically significant between the cognitively impaired and non-cognitively impaired cohorts of older adults (p=0.5065).

Table 2: Outcome variables

Outcome variables	Cognitively impaired (N=77)	Cognitively intact (N=178)	p-value
Average Length of Stay (days)	7.53	7.56	p=0.9793
Average length of Stay in the Intensive Care Unit (days)	0.69	0.72	p=0.9345
Post-Operative Parker Mobility Score (PMS)	8.49	7.52	p<0.0001
Delay to surgery (time to surgery> 48 hours post admission)	48	103	p=0.5065

Table 3: Outcome variable-complications

Complication	**Cognitively intact (N=178)**	**Cognitively impaired (N=77)**	**p-value**
Total Complications	113	58	0.0647
Renal Insufficiency/Failure	14	9	0.3279
Delirium	25	24	**0.0014**
Hypoxia	5	3	0.6475
Pneumonia	3	3	0.2850
Pulmonary embolism	1	1	0.5402
New CHF	0	0	
Hardware Fixation Failure	1	0	0.5099
-Surgical site infection	2	0	0.3504
Deep vein Thrombosis	1	1	0.5402
Myocardial infarction	2	0	0.3504
Cerebrovascular	1	1	0.5402
Urinary tract infection	16	18	**0.0019**
Death	8	2	0.4737
Reoperation	1	0	0.5099
Other	80	41	0.228

CHAPTER 3: DISCUSSION

Several studies have revealed a 30-50% prevalence of dementia in the older adult hip fracture populations (Gruber et.al, 2003, Given et.al 2008, Gruber et.al, 2003; Watne et.al, 2014 and (Sternvall et.al, 2012). This finding is reflected in the current study in which 30% of older adults treated for a hip fracture after a ground level fall had documented cognitive impairment. Moreover, while the age categories differ across studies, a report published in 2013 about older adults 65 years and older with fall-related hip fractures, demonstrated an increased prevalence of dementia (Scandol et.al, 2013). A randomized study in Sweden conducted with the objective of testing a multidisciplinary intervention to curtail postoperative complications and increase early mobilization reported finding that patients 70 years and older with dementia experienced fewer complications such as urinary tract infections, nutritional problems, falls and postoperative delirium (Stenvall et.al, 2012). However, Stenvall et al, (2012) did not compare patients according to cognitive status. This current study showed no significant difference in the total inpatient complication rate between the groups, although cognitively-impaired patients were more likely to experience moderate complications such as urinary tract infection and delirium.

The finding of urinary tract infection in this population of older adults is similar to a review article (Carpintero et al, 2014) of hip fracture complications. Urinary tract infection was found in 12 to 61 percent of these patients.

Our current study did not identify urinary tract infection in all patients prior to hip fracture study. In contrast, a study of older adults treated for hip fracture at an acute care center found that 12.5 percent of these patients were diagnosed with urinary tract infection identified with a positive urine culture prior to surgical treatment for the hip fracture (Johnstone, Morgan, Wilkinson & Chissell, 1995). Several studies (Eriksson, Gustafson, Fagerstrom & Olofsson, 2011; Balogun & Philbrick, 2014) have found a causative relation between urinary tract infection and delirium. However, in our current study, it was unclear whether urinary tract infection was attributed to the delirium.

This study of patients in the FFP established that cognitively-impaired elderly patients who sustained a hip fracture through a low-energy mechanism of injury had worse outcomes than patients without cognitive impairment treated during the same time period. This study supported the findings of Bjokelund et.al (2010) that older (65 years and older) and cognitively-impaired patients had a higher rate of delirium. In addition, cognitively-impaired patients in the FFP population were more likely to be non-ambulatory at discharge relative to those without cognitive impairment. The data analyzed among the FFP population illustrates the greater risk for complications and poor outcomes among cognitively-impaired patients following hip fracture

CHAPTER 4: CONCLUSION

Fall-related hip fracture is a tremendous burden for older adults with dementia. This study provided evidence that older adults with cognitive impairment tended to be older, more often institutionalized, and more likely to have problems with mobility after sustaining a fall-related hip fracture compared to their cognitively-intact counterparts. Also, cognitively-impaired patients in this study were more likely to experience complications such as delirium and urinary tract infections compared to the cognitively-intact patients. These findings present an opportunity for primary and secondary prevention among the cognitively-impaired older adults with hip fractures. Fall prevention strategies should incorporate targeted surveillance and clinical interventions to enhance cognitive function as well as modifications to the environment.

An effective primary prevention program for falls targeted to the cognitively-impaired is critical. This program should be geared toward the assessment of cognitively-impaired older adults in institutions such as skilled nursing facilities to decrease falls risk and increase mobility in order to counteract the effects of cognitive impairment.

Prevention of urinary tract infection among cognitive-impaired older adults in the skilled nursing facilities is necessary to reduce the risk for falls. One-third of UTIs are misdiagnosed in among nursing home residents, especially the cognitive impaired (Brown & Nay, 2006; D'Agata, Loeb & Mitchell, 2013). There are significant challenges

in diagnosis and treatment of urinary tract infections in the cognitively-impaired older adults. The traditional assessment strategies to diagnose UTI in nursing home residents such as presence of fever or dysuria was shown to be inadequate in diagnosing UTI in residents with advanced dementia. D'Agata et al (2013), showed that assessment of mental changes is proven indicative of UTI in the cognitive impaired resident. However, change in mental status is often difficult to diagnose due to severity of the cognitive deficit.

To improve mobility, exercise programs such as tai-chi have been found to be effective in reducing falls by increasing balance (Schleicher, Wedam & Wu, 2012). Other researchers examined the role of improved nursing staff in falls reduction. The study showed an improvement in fall rate when nursing home staff's perception of communication quality, shared decision making, safety climate, and caregiving quality was positive (Colon-Emeric et al, 2013).

Secondary prevention strategies include systematic assessment of cognitive status on presentation to the emergency room and identification of the cognitively-impaired. This is paramount to decrease complications such as delirium and UTI, which were found to be significantly higher in the cognitively-impaired older adult hip fracture patients. As reported previously, patients with urinary tract infections are more likely to experience delirium compared to those without. Therefore, early screening of urinary tract infection at presentation will help physicians monitor these vulnerable older adults. Proper prevention and management of these complications among those older adult hip fracture patients identified to be cognitively-impaired will help reduce the cost of treating fall-related injuries such as hip fractures.

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