A comparative effectiveness secondary data analysis: Selected short term economic and clinical outcomes of rapid surgical intervention in the geriatric fracture population

Susan Elizabeth Dries
Molloy College

The Division of Nursing

PhD in Nursing Program

A COMPARATIVE EFFECTIVENESS SECONDARY DATA ANALYSIS: SELECTED SHORT TERM ECONOMIC AND CLINICAL OUTCOMES OF RAPID SURGICAL INTERVENTION IN THE GERIATRIC FRACTURE POPULATION

a dissertation

by

SUSAN ELIZABETH DRIES

Submitted in partial fulfillment of the requirements

for the degree of

Doctor of Philosophy

November, 19, 2014
MOLLOY COLLEGE
DIVISION OF NURSING

The Dissertation of SUSAN ELIZABETH DRIES

Entitled: A COMPARATIVE EFFECTIVENESS SECONDARY DATA ANALYSIS: SELECTED SHORT TERM ECONOMIC AND CLINICAL OUTCOMES OF RAPID SURGICAL INTERVENTION IN THE GERIATRIC FRACTURE POPULATION in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

In the Division of Nursing has been read and approved by the Committee:

[Signatures]

Veronica D. Feeg, PhD, RN, FAAN
Associate Dean and Director
PhD Program in Nursing

Date: 11/19/14
DEDICATION

Many people struggle to access higher education.

This work is dedicated to those who have found their way

and to those who still seek a way
ACKNOWLEDGEMENTS

I am grateful for all the family, friends, colleagues, and mentors who have shared this scholarly journey. Their presence has made the path joyful and I hope I have made them proud. There are many who merit thanks, I welcome the opportunity to name even a few.

I appreciate working within an organization that supported my educational goals and granted me access to study the geriatric fracture population. Many thanks are offered to Patricia Hogan who globally encouraged the ongoing education of our nurses and who shared the first venture when we attended the Molloy PhD introductory session together. I appreciate my colleagues Patricia Gilroy, Samantha Chester, and Sarah Brady who offered proficiencies that were invaluable. Thanks also to Karol Olsen and Vincent Angeloro who persistently supported my efforts through their encouragement and excellent work.

I am grateful that the Molloy faculty admitted me to the first PhD cohort and guided my passage to nascent researcher. I am thankful to my committee members Dr. Ellen Rich and Dr. Aliya Kuerban for their knowledge, their interest in my research, and the kind way in which they generously offered expertise and time. I am indebted to my committee chair and mentor Dr. Veronica Feeg for her vision, her investments in my progress, and her personal guidance through the processes of research and the mechanisms of policy. This accomplishment would also not have been possible without the research expertise of Theresa Rienzo, data mentoring from Dr. Patricia Eckardt, and the steadfast assistance of Drue Kerls-Spoto.

I am grateful for the support of all my family and friends. To my sons, thank you for your fortitude during the tumultuous life changes of the last few years, your excellent
ideas for the project, and your patient support during technology vs. mother meltdowns.

Finally, much appreciation is offered to my friends who constantly encouraged me.

Special thanks to Donna Trombino who has been a partner in the process from the GREs to the dissertation, and who along with Rita Regan and Marie Mandell offered extraordinary friendship during the most challenging times.
ABSTRACT

The percentage of the U.S. population that is over 65 years of age is expected to increase to over 20% by 2040. Within that geriatric population, 50% of women and 20% of men will experience osteoporotic fractures. The cost of their care is estimated in billions of dollars annually. The outcomes from osteoporotic fractures account for more morbidity than all cancers, except lung cancer, combined.

Rapid surgical intervention protocols, which reduce the time between fracture and surgical repair, are intended to improve outcomes and reduce costs. The protocols require intense care coordination and their effectiveness has not been unequivocally established. This study explored the relationships of rapid surgical intervention to the clinical outcomes of in-hospital delirium and pressure ulcer and the economic outcomes of post-procedure length of stay and total hospital charges. These outcomes were investigated through a secondary data analysis of the New York State administrative billing database (SPARCS) from a five-hospital system. The sample included 1,979 subjects from the years of 2010 through 2013; a modified Charlson Co-morbidity and Age Index score was applied to all subjects in order to approximate their admission health status.

Rapid Surgical Intervention was a predictor (p < .001) of lower post-procedure lengths of stay lower total hospital charges, and lower rates of pressure ulcer development. High Modified Charlson Index scores were predictive of higher mortality rates, longer lengths of stay, and higher total charges. Male gender was significant for higher lengths of stay, mortality rates, and pressure ulcer development. Femur/hip fractures were related to longer lengths of stay and higher total charges than other fracture sites, but were not a predictor of mortality or pressure ulcer development.
# TABLE OF CONTENTS

TABLE OF CONTENTS .................................................................................................................. 1

TABLE OF FIGURES .................................................................................................................. 5

LIST OF TABLES ....................................................................................................................... 6

CHAPTER 1 .................................................................................................................................. 7

INTRODUCTION ............................................................................................................................... 7

BACKGROUND AND SIGNIFICANCE OF THE STUDY .................................................................. 9

Background ........................................................................................................................................ 9

Significance ........................................................................................................................................ 10

PURPOSE OF THE STUDY .............................................................................................................. 13

THE RESEARCH QUESTIONS ......................................................................................................... 16

CONCEPTUAL AND OPERATIONAL DEFINITIONS OF TERMS .................................................. 17

Terms and definitions ....................................................................................................................... 17

DEMOGRAPHIC INDICATOR DESCRIPTORS ............................................................................ 23

CONCEPTUAL MODEL .................................................................................................................. 23

Health Services Research .............................................................................................................. 25

Comparative Effectiveness Research ............................................................................................ 26

Patient Centered Outcomes Research .......................................................................................... 26

Secondary Data Analysis Research ............................................................................................... 27

SUMMARY .................................................................................................................................. 30

CHAPTER 2 .................................................................................................................................. 31

LITERATURE REVIEW ................................................................................................................... 31

Introduction .................................................................................................................................. 31
Health Services Research

Comparative Effectiveness Research

Patient Centered Outcomes Research

Care Coordination

SECONDARY DATA ANALYSIS

Data sources

Recommendations for conducting SDA

Secondary data analysis (SDA) in nursing

ASSESSMENT OF CO-MORBID CONDITIONS IN CER

CONCEPTS IN GERIATRIC HEALTH CARE

Frailty

Fragility

Osteoporosis

Prevention of Recurrent Fractures

GERIATRIC OSTEOPOROTIC FRAGILITY FRACTURE

Incidence of Geriatric Osteoporotic Fragility Fractures

Economic Cost and Quality of Life Impact of Geriatric Fragility (Osteoporotic) Fractures

Patient Outcomes Based on RSI or Non-RSI in Geriatric Fragility (Osteoporotic) Fractures

COMPLICATIONS OF CARE

Delirium

Pressure Ulcers

SUMMARY OF LITERATURE REVIEW

CHAPTER 3

RESEARCH METHODS
# TABLE OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>Concept Model</td>
<td>24</td>
</tr>
<tr>
<td>Figure 2</td>
<td>Concept Diagram</td>
<td>25</td>
</tr>
<tr>
<td>Figure 3</td>
<td>Bivariate Analysis PPLOS</td>
<td>116</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Bivariate Analysis TC</td>
<td>116</td>
</tr>
<tr>
<td>Figure 5</td>
<td>Bivariate Analysis Mortality</td>
<td>117</td>
</tr>
<tr>
<td>Figure 6</td>
<td>Bivariate Analysis Pressure Ulcer</td>
<td>117</td>
</tr>
</tbody>
</table>
LIST OF TABLES

Table 1 Descriptive Analysis of the Categorical Variables .............................................. 97
Table 2 Descriptive Analysis of the Continuous Variables .............................................. 97
Table 3 Bivariate Analyses of PPLOS by RSI, Gender, and Fx Site ......................... 100
Table 4 Bivariate Analysis of PPLOS and MCS ............................................................ 100
Table 5 Bivariate Analyses of Total Charges by RSI, Gender, and Fx Site ............... 102
Table 6 Bivariate Analysis of Modified Charlson Score and Total Charges .......... 102
Table 7 Bivariate Analysis of Modified Charlson Score to In-Hospital Mortality ...... 104
Table 8 Bivariate Analysis of Gender to In-Hospital Mortality ..................................... 105
Table 9 Bivariate Analysis of Modified Charlson Score to Pressure Ulcer ............... 108
Table 10 Bivariate Analysis of RSI, Gender and Fx Site to Pressure Ulcer .......... 108
Table 11 Multiple Linear Regression Analysis of Rapid Surgical Intervention, Modified
Charlson Score, Gender, and Fracture Site to Post-Procedure Length of Stay .......... 111
Table 12 Multiple Linear Regression Analysis of Rapid Surgical Intervention, Modified
Charlson Score, Gender, and Fracture Site to Total In-Hospital Charges .......... 112
Table 13 Binary Logistic Regression Analysis for Mortality ......................................... 113
Table 14 Binary Logistic Regression for Pressure Ulcer with RSI, MCS, and Gender . 114
CHAPTER 1

INTRODUCTION

Geriatric fragility fractures are a known and growing problem in worldwide healthcare (Ström et al., 2008). These geriatric fragility fractures occur in osteoporotic bones, usually from standing position or low impact falls. Osteoporosis is a syndrome commonly due to aging, occurring most frequently in post-menopausal Caucasian women, but prevalent to varying degrees in all of the geriatric populations (Kanis et al., 2004). In their lifetime, approximately 50% of women and 20% of men will experience a fragility fracture (Ström et al., 2008). It is estimated that nine million of these fractures occurred in 2000 (Kanis et al., 2004); hip and wrist fractures were most common, with vertebral fractures a close third. In the United States (U.S.) in 2002, the care required for the treatment of fragility fractures cost approximately 13.8 billion dollars (Cummings & Melton III, 2002). Within the U.S. health care system, Kates et al. (2010) reported approximately 350,000 patients per year were affected by hip fractures alone, and estimated the annual cost of their care at $7.2 billion dollars.

In spite of this investment, the in-hospital morbidity risks from fragility fractures are high and the one-year mortality rate associated with the occurrence of a hip fracture in the geriatric population is reported by Schnell and colleagues (2010) to be between 14% and 58%. These poor outcome statistics have led to the development and implementation of specific acute care geriatric hip fracture management protocols that focus on rapid surgical intervention, gerontological medical management, and early discharge planning (Friedman, Mendelson, Kates, & McCann, 2008). Some researchers (Ellis, Whitehead, Robinson, O'Neill, & Langhorne, 2011; French, Bass, Bradham, Campbell, & Rubenstein, 2008; Pedersen et al., 2008; Vidan, Serra,
Moreno, Riquelme, & Ortiz, 2005), but not all (Adunsky, 2005), report statistically significantly improved clinical outcomes in the geriatric population from an early surgical intervention. Other studies recommend a coordinated and comprehensive approach to treatment through geriatrician-led pre and post-surgical protocols (Friedman et al., 2008; Leigheb et al., 2013) to improve outcomes. No consensus has been reached however on what regimens positively influence outcomes or mortality (Akesson et al., 2013; Holvik, Ranhoff, Martinsen, & Solheim, 2010; Rosenzweig & Mishra, 2009).

The studies in the literature have focused extensively on the hip fracture population with almost no inclusion of the many other body sites affected by fragility fractures. This may be in part due to the severe consequences of a hip fracture; however hip fractures account for only approximately 18% of all osteoporotic fractures, and in the younger population other fracture sites account for major portions of the morbidity from fragility fractures (Johnell & Kanis, 2006). Kanis and colleagues (2004) estimate that in Swedish women in their 50s fracture sites other than hip account for six times more morbidity than hip fractures. Johnell and Kanis (2006) report this focus on hip fractures is because there is readily available epidemiological information on hip fracture patients, and that this information is not available for the other fracture sites. In fact, no studies were found from the literature search that explored the topic of rapid surgical intervention in the totality of the fragility fracture population (Bass, French, Bradham, & Rubenstein, 2007; Brauer, Coca-Perraillon, Cutler, & Rosen, 2009; Haentjens, Autier, Barette, & Boonen, 2001; Kates et al., 2010; Pedersen et al., 2008).

Hip fractures are the most common fragility fracture reported (Kanis et al., 2004), and can be the most debilitating, but they are far from the only site, as wrist and vertebral fractures
are almost as common. Patients who suffer a fragility fracture are twice as likely to experience a repeat event in another site, which is another reason that the totality of the population warrants study (Kanis et al., 2004; Klotzbuecher, Ross, Landsman, Abbott, & Berger, 2000). It seems possible that the tacit supposition has been, what was effective in the fragility hip fracture patients would be applicable to the complete geriatric fracture population; however no evidence to support that assumption was found in the literature. Therefore, the purpose of this research study is to evaluate the effects of rapid surgical intervention on the reduction of morbidity, mortality, length of stay, and costs, associated with hospitalization in the geriatric fragility fracture population.

**BACKGROUND AND SIGNIFICANCE OF THE STUDY**

**Background**

Worldwide half a billion people will reach the age of sixty-five years old or older within the next twenty years (Akesson et al., 2013). In the United States, the Federal Administration on Aging predicts 56 million people will be over the age of 65 by 2020 with that number increasing to almost 80 million by 2040 (Administration on Aging, 2012). This will represent a growing percentage of the total population; in 2011 people over 65 years old represented 13.3 percent of the U.S. population, by 2040 that is expected to increase to 21% (Administration on Aging, 2012). The impact of fragility fractures on this growing segment of the population has been assessed by Johnell and Kanis (2006). They report 9 million fragility fractures occurred in 2000, and that these injuries accounted for more morbidity than all cancers combined except for lung cancer. If between 20% of men and 50% of women over 65 years of age experience a fragility fracture (Ström et al., 2011), and the cost of that care is estimated in billions (Borgström et al.,
2013; Haentjens, Lamraski, & Boonen, 2005; Haentjens, Autier, Barette, & Boonen, 2001; Titler et al., 2006), it will be important to manage the care of that population as efficiently and successfully as possible. Investigating the efficacy of different treatment regimens will contribute to the knowledge base and inform care management decisions that may positively influence this population’s health and reduce healthcare costs.

**Significance**

As the body ages, intrinsic and extrinsic factors contribute to increasing frailty; among these factors is osteoporosis (Mohandas, Reifsnyder, Jacobs, & Fox, 2011; NIH Consensus Development Panel on Osteoporosis Prevention, Diagnosis, and Therapy, 2001). A known and increasingly problematic issue, osteoporosis can lead to geriatric fragility fractures from low impact traumatic events, and these events are often repeated (Akesson et al., 2013), resulting in reductions in function from which the geriatric population does not adequately recover (Beloosesky et al., 2002).

Among fragility fractures, hip fractures are well studied in the literature. Maher and colleagues (2013) report that approximately one point six million hip fractures occur each year with the incidence expected to rise, as the world’s population continues to age to over ten million annually by the year 2050. These fragility fractures contribute greatly to the morbidity and mortality of the geriatric population and add billions to the cost of healthcare worldwide (Brauer, Coca-Perraillon, Cutler, & Rosen, 2009; Haentjens et al., 2005; Haentjens et al., 2001).

All fractures in the elderly impose multiple complication risks and the potential for a downward trajectory of functional health (Mohandas et al., 2011; Rich, Hustey, Sun, & Carpenter, 2009). Hospitalization and surgery can accelerate functional decline for any elder
who experiences a fall or accident that leads to a fracture (Rosenzweig & Mishra, 2009). When the geriatric population suffers joint and long bone fractures from low energy falls it is primarily due to the underlying presence of osteoporosis, and the unexpected injury brings the geriatric patient into the emergency department in varying conditions (Hung, Egol, Zuckerman, & Siu, 2012).

Many fractures require surgical intervention, and frequently assessment and some medical treatment is necessary prior to surgery. Unless the patient arrives with a medical dossier that unequivocally documents their clearance for surgery, the medico-legal environment traditionally will require multiple specialty testing and assessment prior to surgery. Depending on the coordination of care, and political realities within individual institutions, the pre-surgical preparation can take days to complete (Beaupre et al., 2005; Deschodt et al., 2011; Vidan, Serra, Moreno, Riquelme, & Ortiz, 2005). These delays lead to extended periods of bed rest, immobility, and complicating incidents that can greatly contribute to the morbidity and mortality associated with joint and long bone fractures in the elderly (Sander, Elliot-Gibson, Beaton, & Bogoch, 2008; Thompson, 2011). Timely surgical intervention (referred to as Rapid Surgical Intervention [RSI]) and rapid return to functionality would seem essential to reduce these substantial risks (Butler, Forte, Joglekar, Swiontkowdki, & Kane, 2011). The extensive research to date on the hip fracture population has failed to reach consensus on what interventions are most effective and how the timing of surgical repair factors into the desired outcome of preserved functionality (Elliott et al., 2003).

Multiple features must be considered when studying the geriatric fracture population and the functional outcomes desired are difficult to measure. There is much literature that reports on
various studies in the geriatric hip fracture population; however, there have been no replicable conclusions that have led to consensus. Various studies from the literature have had sample sizes that were too small to assess with statistical adequacy the influence of treatment regimens on the many outcomes of interest (Verbeek, Ponsen, Goslings, & Heetveld, 2008). Others have studied large samples but were unable to establish treatment effects, and hypothesized that the pre-existing co-morbidities of the population dictated time to surgery and outcomes (Grimes, Gregory, & Noveck, 2002). This has left the important question of what is the most effective treatment course for this patient population immersed in controversy.

The implications of rapid surgical intervention (RSI) carry hazardous consequences for the geriatric population and the implementation of treatments that safely ready them for surgery in under twenty-four hours are expensive to employ and difficult to coordinate (Adunsky et al., 2005; Miura, DiPiero, & Homer, 2009). Operationally, the planned synchronization of pre-surgical procedures for rapid surgical intervention would need an expeditious execution of bundled orders; this coordination of care is a traditional nursing function (Maher et al., 2012; Maher et al., 2013). In addition to the pre-surgical coordination and investment, the care logistics required in the post-surgical follow-up period raise questions to be answered concerning patient care planning and resource consumption (Titler et al., 2006). If rapid surgical fracture repair reduces the complications in the patient population, there will be staffing and cost effects in addition to the benefits to the patient (Dochterman, Titler, Wang, Reed, & et al., 2005; Maher et al., 2012; Maher et al., 2013). These are significant medical, nursing, and health related reasons to establish whether the efforts to repair geriatric fractures rapidly are safe, cost effective, and contribute positively to improved patient outcomes.
PURPOSE OF THE STUDY

The purpose of this study is to describe and explore the relationship between rapid surgical intervention (RSI) in the geriatric fragility fracture population and their in-hospital patient outcomes. The study investigated a large sample from a group of hospitals using the hospitals’ own datasets (HOD) of the New York State Statewide Planning and Research Cooperative System (SPARCS) database. The secondary analysis of the SPARCS administrative database used the demographic, diagnosis, and procedure information for patients who received RSI versus those who did not to compare patient results for post-procedure length of stay, total charges, mortality, and the post admission development of pressure ulcers and delirium.

The dependent variables and outcomes of interest for the study population were:

In-hospital post-procedure length of stay (PPLOS): Extended hospital lengths of stay are correlated with increased hospital-acquired complications that adversely affect all patients (Rothschild, Bates, & Leape, 2000). The elderly population has an increased frailty and therefore a reduced resiliency to recover from these complicating incidences (Rosenzweig & Mishra, 2009). It is pertinent to measure in-hospital PPLOS to explore if hospital RSI programs reduce the geriatric patients’ PPLOS and, by inference from the literature, examine any relationship to the reduction of observed complications. The literature has reported varying effects of a RSI program on patient outcomes and length of stay (LOS) (Adunsky et al., 2005; Ellis, Whitehead, Robinson, O’Neill, & Langhorne, 2011; Pedersen et al., 2008; Vidan et al., 2005). The variations reported by some authors have addressed the confounding factor that those patients who had increased delays to surgery were perhaps more debilitated or had more co-morbidities. It has been difficult to separate out any consistent relationships between early
intervention (RSI) and outcomes due in part to this question. In addition, the lack of separate
measurements of what was the PPLOS for the patient groups when the pre-surgical days in
hospital were subtracted from the total LOS has been an issue. Therefore, this study will
discretely measure the PPLOS to explore any information that this measurement may add to the
knowledge about the possible effects of RSI.

The development of in-hospital acquired complications: By their very description,
complications are untoward and unwanted events. Current thinking and much effort in
healthcare is focused on the prevention of complications from hospital care (Institute of
Medicine U.S., Committee on the Learning Health Care System in America, 2012). This study
will explore and describe the effect of RSI on two in-hospital complications.

The development of delirium: Delirium is a factor that confounds the treatment and
recovery of many hospitalized patients. Rice et al. (2011) report delirium to be the most
common complication affecting the older patient in the United States. Rothschild et al. (2000)
report delirium as one of the six most frequent and preventable complications for older patients.
The condition is associated with increased lengths of stay in the hospital, increased morbidities,
reduced functional recovery, and higher in-hospital mortality (Marcantonio, 2012; Scandol,
Toson, & Close, 2013). The preoperative diagnosis of dementia, surgery times greater than two
hours, and long waiting times between presentation at the hospital and surgical intervention, are
reported as exogenous factors in the development of delirium (Edlund, Lundström, Brännström,
Bucht, & Gustafson, 2001; H. Lee et al., 2011; Rice et al., 2011). Phillips (2013) concludes that
nursing is in the best position to recognize and mitigate delirium symptoms due to nurses’
continuous presence at the bedside. A relationship between RSI and the development of post-operative delirium would inform nursing to increase surveillance of patients with surgical delays. The development of a pressure (decubitus) ulcer: Grimes et al. (2002) studied the effect of RSI on patient outcomes from a database that included 10 years of data. They did not discover a correlation between RSI and mortality, but did find a significant relationship between RSI and the reduced incidence of pressure ulcers in the geriatric population, even after adjusting for active medical problems. The development of pressure ulcers is considered a nurse-sensitive indicator and is included in the National Database for Nurse Sensitive Indicators (NDNQI) (Quality improvement solutions from ANA | nursing quality | NDNQI.2014). If surgical delay is related to increased development of pressure ulcers, nursing can increase preventative measures and perhaps include a risk adjustment for appropriate patients.

In-hospital mortality: The literature has reported variable results on a relationship between RSI and in-hospital mortality (Doruk, Mas, Yıldız, Sonmez, & Kýrdemir, 2004; Elliott et al., 2003; Grimes et al., 2002; Hommel et al., 2008). Given that few outcomes are more vital to the patient and healthcare professionals, the inclusion of mortality as a dependent variable was considered appropriate.

In-hospital charges: Most geriatric patients in the U.S. are insured through Medicare. Currently Medicare pays for hospital care in an episodic paradigm based on the principal diagnosis and procedure codes called Diagnostic Related Groupings (DRGs). This fixed payment is regardless of the costs incurred by the hospital in caring for the patient. If the hospital can treat patients and safely discharge them to an after-hospital level of care in an efficient and timely manner, then the hospital can cover its costs and make a profit. If the patient
experiences a long LOS and/or complications that increase the cost of care, the hospital will lose money on the episode of care. This makes the cost of the patient’s treatment a separate measure of interest for a hospital.

THE RESEARCH QUESTIONS

The literature investigating the effect of RSI on patient and process outcomes in the geriatric fragility fracture population focuses exclusively on the hospitalized hip fracture patient. This descriptive and explorative study seeks to contribute, through a secondary analysis of an existing dataset, to the knowledge concerning RSI in the inclusive population of long bone and joint geriatric fragility fracture patients.

The research questions will be:

1. What is the relationship between rapid surgical intervention for the geriatric fragility fracture population and their in-hospital outcomes?
2. Which patient characteristics (combined age and comorbidity score, race, gender, fracture site) predict outcomes (length of stay, charges, complications, and mortality) for patients with rapid surgical intervention (RSI)?
3. Does the proxy severity of illness on admission influence the outcomes (length of stay, charges, complications, mortality) for patients with rapid surgical intervention?
4. Is there a difference in outcomes (length of stay, charges, complications, mortality) for patients between RSI (surgery in < 24 hours) and non-RSI (surgery in > 24 hours) by fracture site (hip versus all other sites)?
5. Does RSI reduce negative outcomes and charges for geriatric patients with fragility fractures (covaried by combined age and comorbidity assessment score, race, gender, fracture site)?
CONCEPTUAL AND OPERATIONAL DEFINITIONS OF TERMS

The model for this study is a retrospective secondary data analysis of indicators coded in the SPARCS database from patients discharged from the hospitals with a health care system between January 1, 2010 and June 30, 2013.

Terms and Definitions

Acquired In-hospital Complications: The complications will include the conditions of delirium and pressure ulcer that are coded in the SPARCS database. The acquired complication conditions chosen for this study are those conditions that are applicable to surgery patients, are coded in the SPARCS database as Present on Admission (POA) or Hospital Acquired, and are considered nurse-sensitive indicators.

Delirium: Is a disturbance of consciousness characterized by an acute onset, disorganized thinking, and a fluctuating course of inattention. Delirium is acute confusion or acute cognitive dysfunction, it can be hyperactive, hypoactive, or have fluctuations of activity (American Psychiatric Association, 2000; Schuurmans, Shortridge-Baggett, & Duursma, 2003). Delirium was measured as a complication only if it did not have the prefix in SPARCS that would indicate that it was present on admission (POA). The delirium codes that were included are: Dementias 290.x, Drug induced delirium 292.x, Delirium due to conditions classified elsewhere 293.x, Sub acute delirium 293.x, and Altered mental status 780.x.

Emergency department arrival to surgical intervention start time; termed in this research as rapid surgical intervention (RSI): Was measured in days from the date of patient’s presentation to the emergency department to the date of the surgical intervention for the fracture repair. The SPARCS database only reports dates for admission, procedures, and discharge, no times of day
are included. Therefore, it was necessary to count the time to surgery in days (1 or greater than 1) not hours.

**Geriatric:** Was defined as persons equal to or greater than 65 years of age.

**Geriatric fragility fracture:** Was defined as a long bone or joint fracture that resulted from a low impact fall (a fall from standing height or lower and not coded as trauma) in a person who is 65 years old or older. These diagnoses (outlined in appendices D and E) included the SPARCS codes of: Fracture of pelvis 808.x, Fracture of clavicle 810.x, Fracture of scapula 811.x, Fracture of humerus 812.x, Fracture of radius and ulna 813.x, Fracture of arm 818x, Fracture of arm with rib fracture 819x, Fracture of neck of femur 820.x, Fracture of other and unspecified parts of femur 821.x, Fracture of patella 822.x, Fracture of tibia and fibula 823.x, Fracture of ankle 824.x (Canter & Caffrey, 2013).

**Mortality:** Was defined as the in-hospital expiration of a patient who was alive at the time of surgical intervention. Mortality is identified in SPARCS as one of many possible discharge dispositions. Discharge dispositions are entered into SPARCS as Uniform Data Set (UDS) numbers: Expired = 20.

**Post Surgical (procedure) length of stay (PPLOS):** Was defined as the time of the in-patient hospital stay measured in days from the day of surgery to the day of discharge from the hospital. The measure PPLOS will be calculated from the date of the surgery to the date of discharge from the hospital. The SPARCS dataset only records the dates of admission, procedures, and discharge. No times of day are included in the dataset; therefore, the most detailed calculation available was number of days.
Present on Admission: Certain medical conditions and complications can be hospital acquired complications or co-morbidities that are present at the time of admission. Hospitals are required to assess the patient at the time of admission for the presence of these conditions. They are coded with an extra letter or digit in the SPARCS database (Commission on Professional and Hospital Activities, 1986). Therefore, Present on Admission was defined as one of these conditions that is coded in the SPARCS database with the indicator that upon admission assessment the patient was found to have the condition.

Pressure (Decubitus) Ulcer: Was defined as skin breakdown that developed over the body’s bony prominences in the presence of moisture, friction, shearing forces, and pressure (Rothschild, Bates, & Leape, 2000). The pressure ulcer code was measured as a complication only if it did not have the prefix in SPARCS that would indicate that it was present on admission (POA). The SPARCS codes for pressure ulcer that were included are: Pressure ulcer stage III 707.x, Pressure ulcer stage IV 707.x, Pressure ulcer unstageable 707.x, and Pressure ulcer 707.x (Quan et al., 2005).

Proxy severity of illness: Severity of illness, or patient condition on admission, is important to assess because variations in patients’ baseline statuses could be an important factor in differences in patients’ outcomes (Li, Evans, Faris, Dean, & Quan, 2008). Appropriate risk adjustment is a complicated and much debated process often accomplished only with proprietary algorithms that measure co-morbid conditions. For this study, the proxy severity illness measure was the score from a modified Charlson Co-Morbidity Index. A modified Charlson Co-Morbidity Index was used to score the co-morbid conditions coded, in addition to the primary diagnosis, in the SPARCS database to estimate a patient’s severity of illness.
In-hospital Total Charges: Total Charges were considered pertinent in the resource-challenged environment of healthcare, as a measure of efficiency. Total charges were defined and the amount billed from each hospital for each subject’s hospital stay; that amount may not represent the hospitals’ costs and does not reflect the amount reimbursed by the payer for the patients’ stays.

Co-morbidity assessment as a proxy measure for severity of illness or pre-surgical risk assessment

Assessment of the patient’s health status at the time of any intervention, or at the time of measurement, may be as important in health research as the demographic descriptors (Elixhauser, Steiner, Harris, & Coffey, 1998) of a sample or population. It is a requirement of validity and generalizability that if research is to compare the effects or outcomes of interventions, it must start with an understanding of the attributes and health variances of the subjects (Elixhauser et al., 1998). Health status, however, is very difficult to evaluate. Consensus has not been achieved on what constitutes health and what factors should be included when one assesses and reports health status. There is no one scale upon which human health is standardly reported.

The literature describes many ways to measure a patient’s health status, his or her severity of illness, and quality of life (Charlson, Pompei, Ales, & MacKenzie, 1987; Deyo, Cherkin, & Cioi, 1992; Perkins et al., 2004; Southern, Quan, & Ghali, 2004). In order to proceed with research, some measure of co-morbid conditions is frequently used by researchers as a proxy measure for health status (Southern et al., 2004). There are various scales and methods currently in use to achieve a proxy measurement that can be included in statistical analyses.
(Charlson et al., 1987; Deyo et al., 1992; Perkins et al., 2004; Southern et al., 2004). The scale chosen should depend on the level of research and the type of data available for measurement. Much greater detail can be extracted from a complete medical record than from an administrative or financial database, but the complete medical record may not be available or the desired sample size may make individual chart abstraction prohibitively time consuming and expensive.

The Charlson Index listed in chapter three, and used for this study, was modified to adjust for the age of the geriatric population (Deyo et al., 1992). The original Charlson Index only scored peoples’ ages up to 80 years. The score began at under 40 years (0 points) and ended at 80 years (4 points); there was no accommodation for the increasing percentages of the population who are greater than 80 years old. This study included people who are 65 years and older, with no upper age exclusion. This modification was deemed necessary for two major reasons. The first is the acknowledged correlation, regardless of intervention, between advancing age and mortality in the geriatric fragility fracture population (Grimes, Gregory, & Noveck, 2002; Haentjens, Lamraski, & Boonen, 2005; Hommel et al., 2008; Kristensen, Foss, Ekdahl, & Kehlet, 2010). The second is the general consensus that the very elderly, those over 85 years, are at increased risk for complications during hospitalization due to their reduced resiliency and increased frailty (Administration on Aging, 2012; Fried, Tangen, Walston, Newman, & et al, 2001; Mohandas, Reifsnyder, Jacobs, & Fox, 2011; Pel-Littel, Schuurmans, Emmelot-Vonk, & Verhaar, 2009).

The elements in the Charlson Index are codes that are available in the SPARCS database. Age is entered into SPARCS and was abstracted in years. The co-morbid conditions were identified by their International Statistical Classification of Diseases and Related Health
Conditions version 9 (ICD 9) codes as they exist in the SPARCS database. Each co-morbidity will be assigned the score identified in the Charlson model and added to the approved age score to compute the modified Charlson Index score. The modified Charlson Score for each person will be calculated as per the Charlson instructions and the score will become a demographic descriptor in the analysis.

**Surgical Intervention:** Was defined as a surgical repair or replacement of the fractured bones or joints. It may have been an open reduction and internal fixation or, in the case of joint fractures, a replacement of the joint with prosthesis. The procedure codes for the surgical interventions (in appendices D and E) are: Internal fixation of bone without fracture reduction 78.5x, open reduction of fracture with internal fixation 79.1-9x, arthrotomy 80.1-4x, Joint replacement of lower extremity 81.5x, Arthroplasty and repair of shoulder and elbow 81.8x.

**The Statewide Planning and Research Cooperative System (SPARCS):** SPARCS is a comprehensive data reporting system established in 1979 to unify the billing codes submitted by hospitals in New York State. The SPARCS database includes billing codes for patient level data on characteristics, diagnoses, treatments, services, and charges for every hospital discharge in New York State.
DEMOGRAPHIC INDICATOR DESCRIPTORS

**Age:** Age was measured as a continuous variable in years. Age is positively correlated with the dependent variable of mortality in most studies (Elliott et al., 2003; Holvik et al., 2010; Hommel et al., 2008).

**Sex:** Sex, also referred to in the literature as gender, was measured as male or female. Males are reported in some studies to have higher mortality rates than female hip fracture patients (Bass et al., 2007; Hommel et al., 2008).

**Race:** Race was measured as Caucasian or non-Caucasian. Although post-menopausal Caucasian women have the highest reported hip fracture rates, neither the NIH Consensus Panel (2001), or Cummings and Melton (2002), found differences in fracture prevalence when researchers controlled for body stature and weight. In addition, the researcher reasoned that the small percentage of non-Caucasians (6.2%) in the sample made further delineation of race unproductive to the intentions of the study. The focus of this study does not include differences in care access by race; therefore, the determination of race was generalized to Caucasian or non-Caucasian.

**Proxy Severity of Illness:** Proxy severity of illness (SOI) was used to account for the differences of patients’ health status condition on admission. Proxy SOI was measured by the modified Charlson Index score (Charlson, Szatrowski, Peterson, & Gold, 1994; Charlson et al., 1987; Deyo et al., 1992).

CONCEPTUAL MODEL

This secondary data analysis study used the framework of comparative effectiveness research (CER) within the structure of health services research (HSR) (Bauer & Chaippelli,
2011; Hastings-Tolsma, Matthews, Nelson, & Schmiege, 2013) to investigate the influence of the independent variable of surgical intervention within twenty-four hours of admission to the hospital, on the in-hospital outcomes for the geriatric fracture population.

**Figure 1 Concept Model**

The model for this health services study followed the concepts of comparative effectiveness research in the realist evaluative setting of usual hospital care (Pawson & Tilley, 1997; Porter & O'Halloran, 2012). The dataset was subjected to a statistical analysis that sought to identify the patient centered outcomes, as they were evidenced by the different demographic attributes of the sample. This researcher-developed concept (Råholm, 2010a; Råholm, 2010b) is within the realm of health services research: a research study design that has multiple layers and
is increasingly specific as the results of the research approach the patient. This study investigated the (CER) level and is an analysis of the “hospital own datasets” (HOD); this is identifiable data for specific indicators and was used to assess the influence of the independent variable (rapid surgical intervention for the geriatric fragility fracture patients) on a large sample. The most detailed level, patient centered outcomes research (PCOR) in this model, is a recommendation for further research.

**Figure 2 Concept Diagram**

**Health Services Research**

HSR is broad-scope research and is applicable for population interventions and policy (Bradford, Gusmano, & Collins, 2003). This research level takes information on efficacy down from the global paradigms of health preservation to health enhancement for populations.
Research at this level has received 1.1 billion dollars in funding from the American Recovery and Reinvestment Act for interdisciplinary research to investigate the structure, processes, and effects of health services (O'Leary, Slutsky, & Bernard, 2010; VanLare, Conway, & Sox, 2010). Appropriate questions for research at this level would include how to design more effective systems of care and if there are relationships between the cost of care and patient outcomes (Horn & Gassaway, 2007).

**Comparative Effectiveness Research**

The level of Comparative Effectiveness Research (CER) is appropriate to establish the efficiency of interventions for disease states and treatment guidelines (Stubenrauch, 2009). CER has been placed within the realm of Translational Research with a priority in Dissemination and Implementation (D&I) research (Hastings-Tolsma et al., 2013); highlighting its possibilities for improving the delivery of information that supports health decision making by practitioners and patients (Bauer & Chaippelli, 2011). Research questions identified by the 2002 American Academy of Nursing Expert Panel (Lamb, Jennings, Mitchell, & Lang, 2004) at the CER level included connecting nursing interventions to patient outcomes, assessing the core of quality problems in healthcare, and developing effective strategies for the dissemination of information to stakeholders.

**Patient Centered Outcomes Research**

Patient-Centered Outcomes Research seeks to answer the questions about what are the most specific causative influences on an individual’s health status and what are the most effective and efficient treatment regimens (Patient-centered outcomes research | patient-centered outcomes research institute.). This level of research recognizes the variation around the means in
populations and that those variations, personified in people, change how and what is most effective care for an individual. PCOR, like CER has become federally funded. The Patient Protection and Affordable Care Act of 2010 mandated the creation of a Patient-Centered Outcomes Research Institute (Titler & Pressler, 2011). PCOR brings to healthcare the concepts of the sociological methods of Realistic Evaluation (Pawson & Tilley, 1997), and PCOR questions must consider the context and the methods employed when testing theoretical assumptions for individuals as they are applied from HSR and CER. This is the research level that asks questions about what treatments work for whom and when.

**Secondary Data Analysis Research**

Secondary data analysis (SDA) is the analysis of data that was originally collected for a different reason or to answer a different research question (Kiecolt & Nathan, 1985; Smith et al., 2011). This method of research accesses large datasets that allow investigations on data that would otherwise be prohibitively expensive and excessively time consuming to collect (Mainous III & Hueston, 1997). The SDA research method has become increasingly important as the amount of information that healthcare generates is enormous and increasing exponentially as electronic medical records become minable for discrete and aggregate data on diseases, treatments, and outcomes (Lockwood, 2006; Magee, Lee, Giuliano, & Munro, 2006). It has become impossible for an individual practitioner to read and evaluate the published literature in any area of practice (Hey, Tansley, & Tolle, 2009). This has resulted in a widening gap between the slow pace of practice change in healthcare and the rapid accumulation of knowledge in the field (Berwick, 2005).
Even if it were possible to assimilate all the new knowledge generated, clinicians seem disinclined to change their practice based on the published studies of research, results of randomized controlled trials, or practice guidelines based on meta-analyses (Dentzer, 2011). Many reasons, to be sure, account for this reluctance. In addition to the commonly acknowledged conservative nature of practitioners based on their recognition of the high stakes involved, there exists doubt that the results they read about in peer-reviewed journals are applicable outside of the tightly controlled subjects and regimented interventions of traditional research (Mushlin & Ghomrawi, 2013).

There is a great requirement for knowledge based on real world results from real populations of people, and the use of large datasets that house the information from the clinical environment can fill that need. These results must be rigorously reviewed (Smith et al., 2011), and the information regarding the populations studied must be reported and valid (Magee et al., 2006). The complexity of the human life however, and the variability of the circumstances and diagnoses that require treatment decisions are far beyond the execution of most traditional empirical research (Apte et al., 2011; Mainous III & Hueston, 1997). It is in part to fill this need that researchers undertake the method of large secondary data analysis (SDA).

The possible advances for nursing knowledge in theory and practice from secondary analyses of large data sets were the subject of the American Academy of Nursing’s Expert Panel in 2002 (Lamb et al., 2004). Although this was far from the first foray of nursing research into secondary analyses (Kovner, 1989; Mainous III & Hueston, 1997), the panel’s recommendations had an incentivizing and mainstreaming effect that encouraged investigation into the methods. In fact, some nursing researchers now recommend secondary analysis as a preferable method if
the question of interest can be answered with the data in a large, already collected and valid database (Doolan & Froelicher, 2009). The principles of quality research remain intact for this method. The researcher must ask appropriate questions, have a clear vision of the relevant terms and variables, and apply rigorous techniques to avoid errors (S. Lee & Abbott, 2003). SDA has added advantages that include: the availability of large samples that meet the power requirement of sample size, the reduction of data collection time, costs, and errors, and the increased replicability of reported findings (Wells, 1988). There are now detailed reports in the literature of how to conduct high quality research through SDA (Apte et al., 2011; Boo & Froelicher, 2013; Smith et al., 2011) and examples of nursing research using this method (M. Lee, 2008; Lockwood, 2006; Magee et al., 2006).

The SDA method is a good fit for the research questions: (1) What is the relationship between rapid surgical intervention for the geriatric fragility fracture population and their in-hospital outcomes? and (2) Does RSI reduce negative outcomes and cost for geriatric patients with fragility fractures (covaried by age, race, gender, fracture site)? This method is a good fit for two primary reasons. First, the data are available in a rigorously reviewed database (SPARCS). The state-sponsored reviews to which SPARCS data are subjected reduce the concerns of data validity and the problems of large amounts of missing data. Secondly, prior studies in the literature have identified that the complexity and diversity of the fragility fracture population required large sample sizes; a large sample would only be available to this researcher in an established database. Recognized is the limitation that the SPARCS database is an administrative, not a clinical, database that was initially developed for billing purposes. It has been used, however, to answer questions in nursing research (Kovner, 1989), and will be an
appropriate source until nursing interventions and processes can be more adequately captured in electronic documentation systems.

**SUMMARY**

Recent legislation (Health and Human Services United States Government, 2013) and the many publications from the Institute of Medicine (Institute of Medicine U.S., Committee on the Learning Health Care System in America, 2012) continue to call for improved healthcare in the U.S. through a changed healthcare system. Care for the increasing percentage of the population that is elderly is among the priorities set forth for intense research (Iglehart, 2009; O'Leary et al., 2010). In the elderly population, fragility fractures are common and cause immense morbidity and mortality (Kates et al., 2010; Ström et al., 2011).

This research evaluates whether the rapid surgical intervention (< 24 hours from presentation to surgery) for the elderly patient who suffers a fragility fracture is a significant improvement in their care. Using a comparative effectiveness model, the research completes a secondary analysis of the NYS SPARCS database to answer the research questions concerning the dependent variables of post-procedure length of stay, total charges, mortality, and the post-admission development of delirium and pressure ulcers. This study contributes to knowledge in the realms of clinical practice and SDA research.
CHAPTER 2

LITERATURE REVIEW

Introduction

The purpose of this research study is to evaluate the effects of rapid surgical intervention (RSI) on the reduction of the morbidity, mortality, length of stay, and costs associated with treatment and hospitalization in the geriatric fragility fracture population. The population that experiences a geriatric fragility fracture is known to be diverse and the literature has only reported on outcomes from the subset of this group that has experienced a hip fracture. In spite of that attempt to limit the variability in the population, the literature reflects a lack of consensus regarding what treatment regimens are most effective in preserving function and preventing negative sequelae from the fracture event.

This research study applies a comparative effectiveness approach and a secondary data analysis (SDA), using the principles of health services research, to describe the effects of RSI on a population that experienced the treatment differences of RSI vs. usual care within the real world of clinical care. The first section of the literature review provides insight into health services research (HSR) and comparative effectiveness research (CER). Following that overview, the literature on how these research models support the groundwork for patient centered-outcomes research is surveyed.

The evidence from HSR and CER is used to inform healthcare policy decisions in many disciplines and throughout the world (Bauer & Chaippelli, 2011; Johnson, Crown, Martin, Dormuth, & Siebert, 2009; Titler & Pressler, 2011; Umscheid, Williams, & Brennan, 2010). If the U.S. health leaders would use the information from CER and SDA to answer questions about
which care regimens work most effectively, when, and for whom, then decision-makers could concern themselves with the next level of oversight, the Microsystems of care coordination. Nursing has been and will be the discipline that coordinates and implements care. Therefore, the last focus area in this section of the literature review includes a brief overview of principles and implications as nursing leaders position the discipline to interact within a patient-centered healthcare system.

The second section of the literature review outlines several aspects of how using a secondary data analysis can provide answers to research questions. This includes discussions of the limitations of randomized controlled trials, the strengths and limitations associated with large healthcare databases, and principles for conducting rigorous secondary analyses. Included here is a review of techniques used in the literature to assess co-morbid conditions that was important for this study. The section concludes with recommendations from the literature for nursing research using secondary analyses and some examples of published studies.

Finally, the literature review will focus on concepts pertinent to geriatric care. This section will discuss the literature in the areas of interest surrounding care for the geriatric fragility fracture population; these concepts provide the foundations for the foci of this research proposal. The care decisions pertinent for this population, the complications associated with their hospitalizations, and the outcomes from treatment are the central questions for this study.

HEALTH SERVICES RESEARCH

The call for health reform is not new in the United States (Reid, 2009), neither is the concept of interdisciplinary investigation and assessment of the ethics and effectiveness of health care availability and delivery (Daniel, 2008). More recent are the discussions and the opinions
that health care requires different methods of research in order to reform (Walley, 2012). Among these newer methods is the translational science of health services research (Olvey, MacDonald, & Abraham, 2012). The Institute of Medicine (IOM) defines health services research as: “a basic and applied field that examines the use, costs, quality, accessibility, delivery, organization, financing, and outcomes of health care services to increase knowledge and understanding of the structure, processes, and effects of health care services for individuals and populations” (Institute of Medicine U.S., Committee on the Learning Health Care System in America, 1995, p. 1). For many reasons however, there remain barriers to accepting health services research (HSR) as a basis for health care policy generation in the U.S., and these barriers have prevented the mainstream acceptance and implementation of HSR as a basis for clinical and policy decision-making (Walley, 2012). Britain, Australia, and Canada, along with most western countries who have reformed their health care systems, have used comparative effectiveness information, based in the principles of health services research, to inform policy principles (Mushlin & Ghomrawi, 2013). Unless the U.S. changes its reluctance to research informed decision-making, Mushlin and Ghomrawi (2013) caution that the U.S. health care system, which is destined for change, will be at the mercy of regulatory and financial pressures rather than experiencing change driven by clinically focused and research vetted conclusions.

Gray, Gusmano, and Collins (2003) do an admirable job of framing the political landscape through which HSR has traveled since its emergence as a recognized discipline. The research presented in the article reviews the governmental schism between enthusiastic support for basic biomedical research at the National Institutes for Health versus the lack of funding commitment for research into the structure, processes, and effects of the health care system at the
Agency for Health Care Policy and Research (now the Agency for Healthcare Research and Quality AHRQ). The federally funded capital investments from 1980 through 2003 are compared in this article and the insights into the political challenges and successes that are reviewed set the stage for the HSR advances made since that era.

Shekelle, and an impressive list of colleagues sponsored by The Agency for Healthcare Research and Quality (AHRQ), updated the debate on the maturation of HSR and its role in patient safety, and the reform of U.S. health care, with an article that outlines the AHRQ panel’s recommendations (Shekelle et al., 2011). The recommendations focus on what processes within HSR the authors believe would improve the government’s willingness to make policy inferences from the research. The endorsements include: improvements in the enhancement and description of research theories and logic models, detailed descriptions of safety practices, and assessing the influence of contexts on why, and for whom, care regimens work.

Dr. Berwick dedicated his 2005 John Eisenberg lecture to health services research (Berwick, 2005). This influential lecture proposed HSR as a vehicle to overcome the health care status quo. He posited that the forces within health care that have insisted on formal, evaluative experimental designs (which have been largely unhelpful) in determining advantageous courses of action for safe and effective care have resulted in endless defenses for the status quo. Berwick’s criticisms of health care in the U.S. included: that it is highly variable, that overuse, misuse, and underuse, of care are frequent, that there is little correlation between cost and quality, and that there are predictable and serious defects in all the IOM domains of care (Committee on Quality of Health Care in America, Institute of Medicine, 2001).
Berwick continued his appraisal with the assertion that traditional health care research has focused on establishing the efficacy of treatment interventions under pristine research conditions without including due diligence on the effectiveness of interventions in the context of clinical settings (Berwick, 2005). In the Eisenberg lecture, Berwick advocated for rigorous, innovative, and interdisciplinary HSR endeavors. His statements indicate that he trusts that HSR would accelerate knowledge generation as well as the delivery, and the adoption, of that new knowledge at the micro-system, macro-system, and environmental-system levels of health care.

In spite of the information chronicled above, there remains much confusion about and many labels for HSR. Whether it is referred to as translational research (Olvey et al., 2012), dissemination and implementation research (Hastings-Tolsma et al., 2013), or clinical evaluative science (Berwick, 2005), various thought leaders recommend HSR’s observational model as the suitable partner to randomized controlled trials (RCTs) for many of the questions facing health care today. Where RCTs are the preferred method to establish efficacy, they may be too costly, time consuming, and in certain circumstances unethical, for establishing the efficiency of, and evidence for, patient-centric care within the clinical context of the real world. The science of HSR holds promise, but remains immature. Advances in theory development and statistical processes are needed before HSR can completely fulfill its potential contribution to patient care and health system reform.

COMPARATIVE EFFECTIVENESS RESEARCH

The U.S. economy currently staggers under $2.5 trillion in annual health care costs that consume 18% of the gross domestic product (GDP), with predictions that the cost could be $4.4 trillion and 20% of GDP by 2018 (Stubenrauch, 2009). These estimates have incited broadly
based demands for reforms to reduce health care costs, not only from economic necessity, but also from a realization that these costs have not resulted in universally improved health. Toward that goal, the American Recovery and Reinvestment Act (ARRA) of 2009 allotted $1.1 billion for comparative effectiveness research (CER) focused on health care reform. The law also created the Federal Coordinating Council, charged with recommending a strategic research structure (VanLare et al., 2010), and directed the Institute of Medicine (IOM) to develop an agenda of research priorities (Stubenrauch, 2009).

The ARRA stimulus legislation has been successful in generating interest and action. The IOM endorsed 100 initial primary research areas; health care delivery systems (#1), geriatrics (#5), and musculoskeletal disorders (#10), have been among the most frequently researched topics from that list (Iglehart, 2009). The IOM defined CER as:

“The generation and synthesis of evidence that compares the benefits and harms of alternative methods to prevent, diagnose, treat and monitor a clinical condition, or to improve the delivery of care. The purpose of CER is to assist consumers, clinicians, purchasers, and policy makers to make informed decisions that will improve health care at both the individual and population levels” (Committee on Comparative Effectiveness Research Prioritization Institute of Medicine, 2009, p. 29).

VanLare and colleagues (2010) succinctly outlined the cooperative efforts of the Federal Coordinating Council, the Department of Health and Human Services, and the IOM, that have achieved a structure for a national system for CER, criteria for research prioritization, and goals for a future system in which patient-centered health care takes precedence.

The lead taken by these central agencies has also inspired much interest and work in the area of CER. Morton and Ellenberg (2012) outline what they consider to be the goals of all CER in health care, and bullet them in their article on infusing statistical science into this area of research. The goals include that CER should: inform clinical decisions for screening, diagnosis,
and treatment; compare at least two alternatives (usual vs. new) among treatments, measure outcomes of importance to patients (at the population, sub-group, and individual levels), generate and analyze new evidence through secondary data analysis and synthesis, and finally, focus on effectiveness instead of efficacy. The authors continue after outlining the goals, by describing the dissimilarities between efficacy (RCT) and effectiveness (CER) studies and recommending processes to ensure rigor in CER. The dissimilarities between the two research methodologies include the differences in design, patient populations, sites, sample sizes, study ends, comparators, data collection, and appropriate analyses. Salient points concerning the broad applicability of CER findings, and that treatment decisions should be made from the totality of evidence available, are made by referencing the writings of experts in policy such as Carolyn Clancy and outcomes researchers such as Sir Michael Rawlins (Morton & Ellenberg, 2012).

While medical and nursing science have demonstrated some reluctance to embrace CER (DeMaria, 2009), pharmaceutical science has been a proponent of the method for some time. In 2007, the International Society of Pharmacoeconomics and Outcomes Research (ISPOR) Health Science Policy Council established a task force on CER that was charged with recommending design protocols, research practices, and processes for the retrospective analysis of databases. International groups were formed to investigate the three domains of design, practice, and analysis. In 2009, ISPOR published an extensive three part article (Part I, Part II, and Part III) in *Value in Health* (Berger, Mamdani, Atkins, & Johnson, 2009; Cox et al., 2009; Johnson et al., 2009) that encompassed the recommendations from the task force groups.

Part I addressed “good research practices” for the definition, interpretation, and reporting of nonrandomized studies that used secondary data sources (Berger et al., 2009). The authors
began the article by discussing the importance of an a priori articulation of the study objective and the plan for analysis. They recommended that the research question and hypothesis should: (a) include the relevance and rationale for the study, (b) be specific and concise, (c) identify what the study will add to existing knowledge, and (d) the design should address the feasibility of completion and appropriateness of data sources. They continued by reporting that research design should be appropriate for the question of interest and the question should dictate the data source chosen. Finally, results interpretation was addressed; the expected spectrum of limitations and cautions were included, but of particular interest was that the authors recommended that all findings should be presented within an appropriate context directed at informing policymakers. A detailed table was included that reviewed steps toward comprehensive and interpretable result reporting.

Part II reported on ways non-randomized CER studies could mitigate bias and confounding issues that limit the ability to make causal inferences (Cox et al., 2009). The limitations of knowing, especially when data are derived from administrative and financial databases, the details of treatment exposure and the nuances of outcomes, were acknowledged as problems for the method. Recommendations to overcome these issues were the use of sampling restrictions and detailed causal diagrams that illustrate any theoretical frameworks. In the conclusion of part II, the authors compared the advantages of secondary data analysis to the limitations of RCTs. The lower cost, the more efficient time to analysis, the enhanced representativeness to routine clinical care, and the ability to study large cohorts over time were included as benefits of the secondary data analysis method.
Part III described the task force’s recommended analytic methods, including stratification and advanced regression modeling (Johnson et al., 2009). Stratifying the sample and/or the data was considered by the authors to be a valid intuitive step. Stratification was recommended prior to the design of any advanced statistical modeling because the stratification (of the sample or the data) could help to identify covariates and inform regression model optimization. Propensity score analysis, marginal structural models, and structural equation modeling were discussed in detail. The full disclosure of methods and analyses was judged to be essential in the validation and defense of any conclusions from the research.

The ISPOR council articles provide a peer-reviewed and comprehensive overview of the methods for, implications of, and challenges facing CER. In spite of the complexity of the issues, the CER paradigm was thoroughly vetted and whole-heartedly endorsed as a tool to generate knowledge and inform policy decisions. The consensus was that “Valid findings of causal therapeutic benefits can be produced from non-randomized CER studies using an array of state-of-the-art analytic techniques. Improving the quality and uniformity of these studies will improve the value to patients, physicians, and policymakers worldwide.” (Johnson et al., 2009, p. 1,062).

The literature on CER is plentiful and it can be found in the journals of most health care disciplines. The articles discuss broad ranges of topics, including the controversies, methods, and areas of interest. An exhaustive recounting of all the literature is beyond the scope of this study. This review has sought to create some historical background and to focus on CER information that was directly applicable to the researcher’s study. To be more complete, in spite of it not being the current method for the study, a review of CER literature should address the
third method employed by CER researchers alongside observational studies and secondary analyses, that of meta-analysis.

A meta-analysis is a subset of systematic review that quantifies the results of multiple studies (that meet the inclusion criteria set by the researchers) through statistical pooling and intervention effect estimates to develop a conclusion with greater statistical power than the studies achieve individually (Study design 101 - meta-analysis.2013). Katapodi and Northouse (2011) have contributed a comprehensive algorithm for meta-analyses that can guide researchers as they access, evaluate, and synthesize large groups of studies on heterogeneous populations (Committee on Comparative Effectiveness Research Prioritization Institute of Medicine, 2009) during CER research. These nurse researchers from the University of Michigan’s School of Nursing include recommendations for excellence in the meta-analysis of CER research studies by addressing: (a) the formation of the research question, (b) inclusion and exclusion criteria for target populations, (c) guides for obtaining relevant studies, (d) methods of data extraction and coding, (e) methods for data synthesis, and (f) guidelines for assessing bias and reporting results. After explaining the processes for the steps in a rigorous meta-analysis, the authors frame the possible contribution of this method by recommending that systematic reviews should be interfaced with economic decision modeling to establish clinical and cost effectiveness (Katapodi & Northouse, 2011).

Katapodi and Northouse’s work can serve as a foundation from which some of the other nursing literature on CER can be reviewed. Edwardson (2007), from the University of Minnesota School of Nursing, examined the role of theory (to infuse order and logic, and to limit the number of variables considered) in CER and HSR projects. AHRQ-funded nursing research
studies were reviewed to report which theoretical frameworks were most often applied. In addition to researcher-developed theories, Donabedian’s Healthcare Organization and Delivery Model, Roger’s Diffusion of Innovation Theory, Reason’s Human Error Framework, and Anderson/Aday’s Model of Health Care Access were popular choices of the time (Edwardson, 2007). Edwardson (2007, p. 226) regarded the variations in frameworks as appropriate to the clinical focus of the nursing research, and as additions to the “richness of nursing health services research.” These nascent examples of applying conceptual frameworks to new areas and methods of research were recommended as guides to improve future congruence in nursing HSR.

Titler and colleagues from the College of Nursing at the University of Iowa, provided an example of nursing CER based on a researcher developed framework in their work on the cost of care for geriatric patients hospitalized for hip fracture surgery (Titler et al., 2007). The electronic medical record documentation from 523 patients across nine hospitals over a four-year period was combined to form one data set; this data set was extracted from a larger set that was originally part of a National Institute of Nursing Research (NINR) grant. The subset of records was retrospectively studied to discover what nursing factors were correlated with increased costs during hospitalization. The authors comment on the importance of the cost findings (for every 20% reduction of proscribed staffing levels there was a $1,505 increase in the hospital stay regardless of length of stay), but report that the more global success of the study was to demonstrate the importance of CER to nursing and to encourage other nursing researchers to use CER (Titler et al., 2007).

Titler has continued to be a proponent of CER in nursing. In 2011, Titler and Pressler published an editorial in the Research and Theory for Nursing Practice journal that highlighted
opportunities for effectiveness science in nursing. This editorial discussed the skill sets of nurse scientists and advocated for their leadership positions in the national movement for CER, at the Patient Centered Outcomes Research Institute, to inform health care reform. The authors encouraged health care and educational institutions to participate in the Clinical and Translational Science Awards (CTSAs) and proposed that education and training in CER become foci for graduate nursing education programs.

The final review in the timeline is an article by Hastings-Tolsma and interdisciplinary colleagues from the University of Colorado (Hastings-Tolsma et al., 2013). This is a broad overview of CER that places effectiveness research within implementation and dissemination science. Its contribution is both as an introduction to the discipline for those not familiar with the intent and processes of CER and an exhortation to those who know CER to move the method forward, and to study ways of evidence-based and proactive dissemination of CER findings. Much of the information reviewed, although helpful, is repetitive and can be found elsewhere; but the inclusion of a concept diagram that illustrates efficacy, effectiveness, and value within the paradigms of Health Technology Assessment (HTA), Evidence Based Practice (EBP), and Comparative Effectiveness Research (CER), is a unique contribution (Hastings-Tolsma et al., 2013). These authors also conclude with recommendations for education. They advocate for doctoral program restructuring to promote inter-professional, academic-industrial partnerships that focus on evidence generation to inform policy decisions.

PATIENT CENTERED OUTCOMES RESEARCH

Astute clinicians have regularly recognized that it was not appropriate or effective to administer the exact same treatment, medication, or therapeutic regimen to all patients with the
same diagnosed illness. There was a recognized variation in patient response to the average recommended treatment that required judgment, observation, and adjustment in order to be successful. Historically, professionals have depended on their education, experience, and frequently on their intuition, as well as trial and error methods to make decisions on what to recommend. This hit or miss health care has been recognized as lacking value, and the goals of CER have included adding research-based evidence to the clinicians’ practice resources. Patient Centered Outcomes Research (PCOR) advances the goals of CER, so that evidence-based treatment recommendations become personalized and patient centric (Institute of Medicine U.S., Committee on the Learning Health Care System in America, 2012).

The resistance to CER in the U.S. has been discussed earlier in this thesis and it was with some surprise that funding for CER survived the maelstrom surrounding the Patient Protection and Affordable Care Act (ACA) in 2010. The federally-funded CER method endured as Patient Centered Outcomes Research at the Patient Centered Outcomes Research Institute (PCORI), a nongovernmental agency under the directorship of Dr. J. Selby (Dentzer, 2011). The Institute made the engagement of stakeholders a priority as a conscious choice to promote success and began its work by defining PCOR as the following:

“Patient Centered Outcomes Research (PCOR) helps people and their caregivers communicate and make informed healthcare decisions, allowing their voices to be heard in assessing the value of healthcare options. This research answers patient-centered questions such as: (1) Given my personal characteristics, conditions and preferences, what should I expect will happen to me? (2) What are my options and what are the potential benefits and harms of those options? (3) What can I do to improve the outcomes that are most important to me? (4) How can clinicians and the care delivery systems they work in help me make the best decisions about my health and healthcare?” (Patient-Centered Outcomes Research | Patient-Centered Outcomes Research institute, para. 1.).
To answer these questions, PCOR: (1) “Assesses the benefits and harms of preventive, diagnostic, therapeutic, palliative, or health delivery system interventions to inform decision making, highlighting comparisons and outcomes that matter to people, (2) Is inclusive of an individual’s preferences, autonomy and needs, focusing on outcomes that people notice and care about such as survival, function, symptoms, and health related quality of life, (3) Incorporates a wide variety of settings and diversity of participants to address individual differences and barriers to implementation and dissemination, and (4) Investigates optimizing outcomes while addressing burden to individuals, availability of services, technology, and personnel, and other stakeholder perspectives” (Board of Trustees Patient Centered Research Institute, March 5, 2012, para. 2).

Beyond a definition, the PCORI work has continued the prioritization of research topics and the creation of database links and unified data platforms. The goal is to link existing health care databases so that the data in them can be retrieved for valid synthesis and analysis. The achievement of data synthesis across databases would facilitate research across large populations and maximize the knowledge creation possible through CER (Dentzer, 2011).

The benefits of the information gathered during CER can potentially be applied at the population, sub-group, and individual levels of health care decision-making. This research on RSI in the geriatric fragility fracture population sought to answer the research question of the identified effects of RSI at the sub-group level as delimited by the demographics of age, race, fracture site, and gender. This level of question does not take the decision process to the level of PCOR, however the very brief review of PCOR above was considered appropriate for a few reasons. There is much literature concerning the emerging science of CER and PCOR and much
of it varies in the use of the terms, which has led to some confusion as to the definitions of each. The PCORI has identified this confusion, and the definition from them clarifies their position that PCOR concerns health care decisions for individuals. This research project therefore is CER. In addition however, it would be a future recommendation to apply the findings from this project in a PCOR project to question whether individual, as well as group differences influenced the outcomes of RSI or non-RSI treatment.

In conclusion, one example of a mixed method research project that took established knowledge on geriatric hip fracture treatment and studied the effects on one patient is offered. Hung and colleagues (2012) performed a meta-analysis of literature in the Cochrane database on geriatric fracture care, then used a narrative approach (Creswell, 2013) to follow one 89-year-old veteran (Mr. W), as he was cared for after a hip fracture. The authors make a unique contribution by combing information from the meta-analysis on the evidence for care decisions with descriptions of the course of Mr. W’s hospitalization (Hung et al., 2012). The Hung article is an example of applying treatments based on CER knowledge and focusing the study of those treatment effects drilled-down to a PCOR level.

**CARE COORDINATION**

Care coordination is not a new term in health care, and nursing alongside the patient functions at the center of the care coordination processes (Clinch, 2012; Furlong & Smith, 2005). As a core competency of registered nurses (American Nurses Association, 2001), the concept of care coordination has become a topic of enormous interest because its potential contribution as a solution to the problems of the fragmented and high cost U.S. health care system has been recognized (Congress on Nursing Practice: American Nurses Association, 2012a; Yen & Lo,
Both the Agency for Healthcare Research and Quality (AHRQ) and the National Quality Forum (NQF) have published definitions of care coordination within the context of the ACA (Patient Protection and Affordable Care Act, 2010). The American Nurses Association (ANA), aligning the discipline with the ACA, has adopted the essence of the definitions from the AHRQ and the NQF. The section of the lengthy ANA definition that is pertinent to this literature review is the following: “Care Coordination involves deliberately organizing patient care activities and sharing information among all of the participants concerned with a patient’s are to achieve safer and more effective care.” (AHRQ, October 2014, para. 1).

Care coordination is not the specific subject of this research project, and it is beyond the scope of this review to provide an extensive recounting of the care coordination literature. The implementation of a Rapid Surgical Intervention (RSI) program for the geriatric fragility fracture population however, is an interdisciplinary endeavor whose success would depend on care coordination (Kates et al., 2010; Sander et al., 2008; Vidan et al., 2005). In addition, if patients’ outcomes are influenced by RSI, nursing could more accurately predict staffing needs based on anticipated (RSI or non-RSI) patient postoperative presentations. Maher and colleagues (2012; 2013) have published comprehensive care guidelines for fragility fracture patients based on the consensus of international expert panels (Maher et al., 2012; Maher et al., 2013). Both pressure ulcers and the recognition and treatment of delirium are prominently featured as nurse-sensitive outcomes for this population. Basic research into which patients are more likely to experience these phenomena would support nursing’s ability to plan for, and intervene with, appropriate interventions. Therefore, within the context of this research proposal, a brief review of current publications from the ANA and selected researchers are included.
Cropley and Sanders (2013) maintain that in health care, “quality improvement and cost control rely on effective coordination of patient care” (Cropley & Sanders, 2013, p. 189). Nursing’s holistic approach to the patient and nursing’s unique skill sets are proposed to provide the framework from which new processes can be developed. Putting patient and family preferences at the center of decision-making, the authors claim, is the key to improved outcomes and greater efficiencies. The commentary details the role of the care coordinator, as developed by the Texas Nurses Association, and delineates the role into competencies and functions that are associated with many of the essential core competencies of nursing (Cropley & Sanders, 2013). The authors contribute further to the discussion of care coordination across the continuum by recommending care coordination priorities for small, medium, and large inpatient facilities, as well as outpatient settings.

Schultz and colleagues (2013) presented the findings and their conclusions from a systematic review of the care coordination literature that focused on measurement instruments. They reviewed 96 instruments: 88% of the instruments were surveys; 93% of these instruments measured aspects of communication; 81% focused on information transfer; and very few, only 11%, concentrated on coordination care needs and changing requirements. Most of the instruments were applicable to primary care settings and nearly half (49%) surveyed the patient/family perspective of the care coordination they received (Schultz et al., 2013). The authors recommended research into the development of instruments that broaden the scope of inquiry. Home health, end-of-life care, and the changing care coordination environment, are endorsed as appropriate avenues for further study.
The ANA has published comprehensive white papers that examine the value and measurement of nursing care coordination. In these white papers on care coordination, the ANA reports on the background, definitions, roles and processes, and establish the framework and proposed models for the practice and the measurement of care coordination activities within nursing (American Nurses Association, 2012; ANA Care Coordination Quality Measures Professional Issues Panel, 2013). The framework consists of three elements: (a) guiding principles, (b) structural components, and (c) measurement contexts. The guiding principles are described as aspirational ideals that, if implemented, would achieve high-value care. The structural components are comprised of 13 constructs derived from the NQF framework, the AHRQ Atlas, and the current scholarly literature. The purpose of these components is to create the platform for reporting nursing’s care coordination activities and the measurement of resultant patient outcomes. The context for measurement includes processes at the system, population/individual, institutional, and personal preference levels. Reviews of the published and gray literature, as well as diagrams of many conceptual models for the delivery of care coordination conclude the paper (American Nurses Association, 2012; ANA Care Coordination Quality Measures Professional Issues Panel, 2013).

The information in the ANA publications and many discussions of the issues raised in the white papers are found in multiple current publications (Cipriano, 2012). These discussions have contributions of value; however, for the purposes of this literature review they do not add essential information. The literature review on care coordination will conclude with the addition of one final publication. The ANA has contributed an annotated bibliography of the nursing literature on care coordination (Congress on Nursing Practice: American Nurses Association,
This bibliography is a valuable resource that compiles the literature from a wide range of nursing disciplines and sources. It includes government policy publications, and research reports from nursing journals and interdisciplinary literature, that cover the continuum of care settings and reflect varied perspectives on the topic of care coordination. It would be advisable to begin a thorough investigation of care coordination with the ANA publications and annotated bibliography. Informed with the information in the publications above, nursing can structure organized programs for the interdisciplinary management of patients. This would apply to the RSI program for the execution of coordinated pre-procedure orders and the complimentary post-operative care management.

SECONDARY DATA ANALYSIS

Data Sources

One initial demand that engages SDA researchers is to decide what data source is most appropriate to answer the research inquiry. After formulating a question and regarding it from an applicable theoretical basis, the responsibilities are to identify the most appropriate data source and assess its suitability. There are many public and private health care databases available, and the emerging digital age of electronic health records will bring an unprecedented wealth of information for SDA researchers. Boslaugh’s (2007) “Practical Guide” would be a useful starting point for researchers unfamiliar with the database selection and accessing process. Databases from federal, consortium, and web-based sources are reviewed by the author, and important information on the specialized data in each, as well as contact addresses and websites are included. The federal database categories of Research Identifiable Files (RIFs) containing personal health and demographic information, Beneficiary Encrypted Files (BEFs) containing
limited personal data, and Public Use Files (PUFs) containing only aggregate data are clearly explained. Any guide to database sources is subject to becoming obsolete, as the landscape of what is available may change over time; however the guide offered by Boslaugh remains a valuable resource (Boslaugh, 2007).

In addition to publications dedicated to accessing databases, reading SDA research in the field of inquiry is a recommended way to learn about data sources. There are a number of reports on geriatric fragility fracture patients that have used SDA as the research method. The ANA annotated bibliography (American Nurses Association, 2012) contains SDA studies about nursing interventions and examples of care coordination. Of particular assistance to this research on the geriatric fragility fracture population has been an SDA dissertation on the clinical effectiveness of nursing care in the hip fracture population (M. Lee, 2008). Lee used an available large dataset from a community hospital in the Midwest that included nursing interventions documented in the electronic medical record. The design was a retrospective and descriptive analysis that tested associations between nursing interventions and complication occurrence rates, length of stay, and hospital costs. Lee found that the number of nursing interventions required during the patients’ hospital stays were more explanatory for outcomes and length of stay than the patients’ severity of illness scores on admission. Lee (2008) details the course of accessing and analyzing the database, which serve as a guide to accessing and reviewing database validity. In addition to discussing her research topic, the author provides a navigation guide through the SDA process.
**Recommendations for Conducting SDA**

The recommendations in the interdisciplinary literature on how to conduct rigorous and valid SDA research consistently reference the same cautions and recommend the same processes. These principles, supported by consensus, will be discussed in general and any unique contributions from different authors will be noted.

Mainous III and Hueston (1997) from the discipline of medicine address the types of questions appropriate for SDA and focus primarily on steps in preparing and analyzing the data. Data availability, whether the data is in a suitable format, and the completeness of the data set, are discussed in this paper. Of interest, due to the 1997 date of the publication, is the discussion of computing power; cautioning researchers that before committing to obtain a database they should assess whether or not they have access to a computer powerful enough to manage the size of the database (Mainous III & Hueston, 1997).

Magee and associates (Magee et al., 2006), discuss the generation of knowledge using SDA research through the examination of the methods from three different nursing research projects. SDA was of interest to these nurse researchers as it enabled them to ask complicated questions with many variables that were assessed over long timeframes. The three projects all demonstrated a strong connection between a conceptual model and the research question. This use of a conceptual model was recommended to establish a perspective from which the researcher posed the questions and examined the data. Secondly, strategies to minimize error, of importance in using large data sets due to the lack of any prior control of the sample, were discussed. Errors recommended avoiding included threats to external validity. Threats to external validity, the authors comment, could be present when the researcher applies a question
to the sample in a database unless the data set represents the population to which the findings would be generalizable. Conversely, if the researcher first finds the data set and then begins asking questions, internal validity may be an issue of concern. The authors also address data preparation and appropriate statistical analysis. They recommend engaging a statistician early in the research process to manage the data transformation into a statistical package and to oversee the proper analyses (Magee et al., 2006).

Doolan and Froelicher (2009) have published a primer on conducting SDA that begins with a discussion of the advantages of the method. SDA research allows researchers to answer questions in less time, with lower costs than primary data collection, and the method poses no risk to patients. The article contributes a checklist for researchers that compare the proper SDA steps with that of prospective study designs. Ethical, legal, and data security issues are reviewed for SDA scholars and a caution to investigate whether the regulatory guidelines for research at the time the primary data collection occurred were consistent with current requirements is included. The authors include recommendations for how the methods section of a research report should be written for an SDA project and conclude with a compelling case for the merits of the method (Doolan & Froelicher, 2009).

Smith and colleagues (2011) also present a comprehensive overview of how to conduct SDA research. This article however, focused on the unique research questions that can be addressed with SDA that would be inappropriate, prohibitively expensive, or unethical to pursue with prospective research. These research questions are termed high-impact questions, and the authors recommend that the findings should be presented in clinically meaningful ways that go beyond the reporting of statistical significance (Smith et al., 2011).
Apte and colleagues (2011) join the consensus as to what constitutes quality SDA research and contribute further by recommending how to combine data from different databases into one set for comprehensive analysis. In the original project, data from disparate electronic medical record systems were combined with administrative and billing data to study the cost of resistant infections in patients from four different hospitals within a large system in New York. The researchers report that they have continued to add data to the algorithms that were written and shared their plans for further, more clinically focused research (Apte et al., 2011).

Perhaps the seminal discussion on the merits of SDA comes from the Harveian Oration entitled De testimonio (Rawlins, 2008). Rawlins traces the history of randomized controlled trials (RCTs) in health care and describes how RCTs have come to head (what he considers to be) the illusionary hierarchy of evidence generation. Rawlins provides a detailed analysis that compares the components of RCTs to observational studies and highlights the strengths and weaknesses of each method. The premises that support the null hypothesis, the establishment of probability, the assertion of generalizability, and the resources consumed in RCTs are all examined and critiqued. In comparison, examples of observational historical controlled trials, non-randomized contemporaneously controlled trials, and before and after designs are defended as valid research methods to inform clinical decision-making. Rawlins explains the collective roles that experiments, observations, and mathematics appropriately contribute to the generation of knowledge. In conclusion, he proposes that researchers, while embracing a diversity of methods, continue to search for improved ways of information syntheses (Rawlins, 2008).

The literature reviewed unanimously concluded that SDA is a cost-effective and valid method of research inquiry. The benefits however, must be considered against methodological
concerns that include selection bias and confounding (Hsu, Banarjee, & Kuschner, 2008). These factors may be unknown to the researcher using a database in a secondary analysis, and appropriate design and statistical approaches should be incorporated to minimize these risks. Rawlins (2008) recommends that diverse research methods be combined according to their strengths to generate new knowledge and that researchers continue to seek new methods that incorporate the best features of each approach.

**Secondary Data Analysis (SDA) in Nursing**

The pioneers of SDA as a research method in nursing include Christine Kovner. Early on, Kovner (1989) was writing about the advantages, difficulties, and database sources that nurse researchers could access for intra- and interdisciplin ary investigations. Kovner quotes Polit and Hungler from 1978 as describing the term secondary analysis and delineating required processes and uses. The article lists the two major advantages of SDA as decreasing data collection times and decreasing data entry errors (Kovner, 1989).

In 2002, an expert panel from the American Academy of Nursing (AAN) convened to discuss the state-of-the-science in quality research. Lamb and colleagues (2004) report the recommendations from that panel focused on the following five areas: (1) contexts for quality agendas, (2) database issues, (3) advancing research, (4) development of clinical information systems, and (5) public visibility. Research in nursing, the panel concluded, would increasingly be theory-based and modeled on processes familiar to the social sciences and evaluative researchers (Berwick, 2005). National databases were cited as rich repositories of information and recognized as valid sources from which SDA research could generate knowledge (Lamb et al., 2004). Strategic action steps and priorities were combined to form a template for action that
aligned nursing research with the national agenda to streamline and improve the delivery of U.S. health care. The AAN conference recommendations became a welcome validation and call to action for SDA in nursing; those have yet to be fully realized.

Much progress has been achieved however, and researchers such as Titler, Dochterman, and others (Dochterman, Titler, Wang, Reed, & et al., 2005; Titler, Dochterman, Xie et al., 2006) began publishing the findings of rigorous SDA research. The 2005 work of Dochterman and others described the most frequent nursing interventions for three groups of patients, those with congestive heart failure, hip fractures, and fall prevention patients (Dochterman et al., 2005). The authors studied thousands (81,193) of patient records from 1998-2002 from a large tertiary center, using the Nursing Interventions Classification (NIC). The goal was to establish how nursing data could be included in effectiveness research if interventions were built in the coding schemas of the electronic medical record. Titler’s 2006 work focused on the predictors of discharge disposition in hip fracture patients (Titler et al., 2006). A total of 116 variables from 524 patient records were retrospectively compared to examine predictors of discharge disposition. The work of Titler and Dochterman, as well as other nursing researchers that have used large databases (Lockwood, 2006), has contributed to the design and methods for the project of this proposal.

**ASSESSMENT OF CO-MORBID CONDITIONS IN CER**

With the current challenge to create a more effective health delivery system and thereby improve healthcare to individuals, health services research has embraced some pragmatic and informative methods that vary from the traditional experimental designs of the past (Berwick, 2005). These methods (observational studies and SDAs) are more inclusive and less controlled
than the randomized controlled trial (RCT) and their designs include the diverse populations that represent more closely the actual target individuals and clinical settings within which care is delivered. Pawson and Tilley (1997) call these methods realist evaluations, others may consider them branches of translational research (Olvey et al., 2012), clinical evaluative science (Berwick, 2005), or comparative effectiveness research (Edwardson, 2007; Titler & Pressler, 2011). The common ground among these methods is that they are designed to make health care better, and people safer, by acting on evidence gathered within the context of the real world (Shekelle et al., 2011).

One of the challenges in these types of research is how to account for the variations in peoples’ health status at the start of any intervention. Unlike the rigorously matched samples of an RCT, these methods include patients with diverse health statuses when studying subjects in the areas of interest. There is no broad agreement on a best method to assess human health, and the system chosen in individual research studies frequently depends on the source of the data, the type of research, or the resources available. Researchers have used many different methods to approximate the severity of illness (or health status) of their subjects. If researchers have contact with subjects, they may combine clinical assessment with questionnaires, and if the design is chart review, they can abstract co-morbidities from the medical record. Much of comparative effectiveness research however, is conducted on existing administrative databases that do not contain clinical detail. This problem has led to the development of various scales to measure the concept of health status, (also referred to as severity of illness, or co-morbidities). These scales are added to, or used in parallel to, the pertinent demographic measures of the sample.
participants thereby attempting to separate the effects of interventions from the possible background variations in subjects.

In the 1980s, Charlson and colleagues (Charlson et al., 1987) investigated a way to include patients with co-morbid diseases in their long-term studies of therapeutic intervention effects. They studied the mortality rates of 604 hospitalized patients for over a year. After study, they assigned patients to four different groups based on the numbers and types of their co-morbid conditions, and matched these categories to the mortality rates. They found increased mortality rates with each increasingly severe index group (p. < 0.0001) (Charlson et al., 1987). This seminal effort has been the basis of decades of work to design an improved method for the assessment of individuals’ health status (severity of illness or co-morbid conditions) at the start of any research investigation.

Richard Deyo’s name is added to the Charlson Co-morbidity Index (Southern et al., 2004) secondary to the work he and colleagues accomplished in adapting the Charlson scoring mechanisms for use with International Classification of Diseases (ICD-9) coding data in administrative databases (Deyo et al., 1992). These researchers studied 27,111 Medicare beneficiaries who underwent spinal cord surgeries in 1985. They adapted the co-morbidities from the Charlson Index to the ICD-9 codes and tested the scored levels to associations with complications, mortality, and discharge to a nursing home. The chi-square tests in that analysis were significant, and so were the regression analyses to length of stay and hospital charges. This adaptation is referred to in the literature as the Charlson/Deyo Method of Co-Morbidity Index.
In 1994, Charlson published a paper reporting on work that sought to combine the measure of co-morbidities and age into a single score that could be used in prognostic studies to stratify the confounding influences of patients’ varying health statuses (Charlson et al., 1994). They studied 226 diabetic patients who underwent surgery between the years of 1982 and 1985 and concluded that the new combined score was a reliable predictor of mortality risk at three and five years when modelled as a single covariant in the proportional hazards model (p. < 0.0001). This new combined (age and co-morbidities) scoring method was applied to a group of 685 breast cancer patients studied at 10 years length of time that included the original 604 patients. In this evaluation, age was an increasingly significant predictor of mortality and Charlson’s conclusion was that the combined index was valid for short timeframes, however in adult studies of greater than five years duration age and co-morbidities should be examined separately.

This research study examines a cross section of patients in the short-term hospitalization following surgery for a geriatric fragility fracture. Based on Charlson’s work reported above, this study will use a combined age and co-morbidity score to approximately establish the patient’s health statuses at the time of their hospital admission.

Once again, this additional contribution by Charlson (Charlson et al., 1994) ignited work by researchers to compare the Charlson Index to other methods of health assessment and stratification. The Charlson Index was compared to a method of counting ICD-9 codes using the count score as a mortality predictor (D’Hoore, Bouckaert, & Tilquin, 1996). The best results from this study occurred when the Index scores were grouped into four groups of increasing severity, with a receiver-operating curve (ROC) of 0.87. The original scores however were also consistently predictive of mortality. Another group of researchers compared the Charlson Index
to the Deyo and the Dartmouth-Manitoba versions without uncovering substantial improvements (Ghali, Hall, Rosen, Ash, & Moskowitz, 1996).

Elixhauser is another researcher who has reported extensive work in the development of a method to quantify health status (Elixhauser et al., 1998). In addition to the Elixhauser Scale, the work contributes a detailed operational definition of a co-morbidity that is useful for researchers: “Important comorbidities or conditions present on admission that are not related directly to the main reason of hospitalization, but that increase the intensity of resources used or increase the likelihood of a poor outcome.” (Elixhauser et al., 1998, p. 9)

The method developed by Elixhauser and colleagues in 1998 began as a straight count of coded co-morbidities, and the original conclusion was that it was advantageous to account for all co-morbid conditions separately. This was refined over time to include a set of specific co-morbid conditions that the researchers found to be valid and that streamlined their research work. Now that the work of Elixhauser, Charlson, and others have given researchers a choice of co-morbidity indexes, it is common to find the scales compared in the literature for different research circumstances and for different populations (Perkins et al., 2004; Rochon et al., 1996; Southern et al., 2004).

For this study, the Charlson Comorbidity Scale (Charlson et al., 1987) was used to compute the patients’ health status from the coded conditions in the SPARCS database. The Charlson Scale has been validated for use with ICD-9 administrative databases (Deyo et al., 1992; D'Hoore et al., 1996; Li et al., 2008). The scale was chosen for two reasons, first because it assigns different numerical scores (from one to six) based on the seriousness of the comorbid condition. This allows for more specificity than alternative methods such as the Elixhauser Scale.
(Elixhauser et al., 1998) that count all comorbid coded conditions the same (as one point each).

Secondly, the Charlson Index was chosen over others (Elixhauser) because it is the scale used by the original program for RSI known as the “Rochester Model” (Kates, Mendelson, & Friedman, 2010)

**CONCEPTS IN GERIATRIC HEALTH CARE**

**Frailty**

Frailty is an observed but ill-defined concept in geriatric health that is characterized by decreasing reserves and increasing vulnerabilities. Fried and colleagues (2001) advance the understanding of frailty, and propose a phenotype through an extensive study of 5,317 participants of community dwelling adults 65 years old and older. They define frailty as a syndrome that contains at least three of the following criteria: unintentional weight loss (≥ 10 pounds in the past year), self-reported exhaustion, weakness (grip strength), slow walking speed, and low physical activity. Many have considered frailty as synonymous with disability and illness, however this study (Fried et al., 2001) found only a 21% overlap between co-morbidities, disabilities, and frailty. Their proposed phenotype of three or more criteria was predictive of increased risks of hospitalization and mortality at p < .05 level of significance.

In 2009, a meta-analysis study examined the literature on frailty in an attempt to define and measure the concept (Pel-Littel et al., 2009). The same dimensions of advanced age, physical deterioration, poor nutrition, and reduced endurance, were found without an accompanying consensus for the definition. Sarcopenia and osteoporosis attributed for some, but not all, of the limitations imposed by frailty and many authors were reported to add social and cognitive aspects to the picture of frailty. The study also listed some one-dimensional
measurement scales for frailty, as well as definitions, however reported no comprehensive or validated and inclusive (Gold Standard) scale.

**Fragility**

The concept of fragility is associated with the aging population and it is appropriate for the implications of increasing fragility to inform healthcare for the elderly population. Mohandas, Reifnyder, Jacobs and Fox (2011) report that in spite of years of research into the dimensions, the concept of fragility is not well understood or defined in the literature. They reviewed the literature and concluded that a validated definition has not been developed from the observations to date. The interpretations in the literature include the dimensions of fragility related to biological markers, physical models, and cognitive impairments. These form a multidimensional phenotype consisting of multiple systems deteriorations. Depending on the systems that demonstrate deterioration, the picture for each individual may be different. The wide variations and lack of consensus has created difficulty in defining the concept and this has inhibited the development of assessment tools and treatment regimens. The authors recommend comparative effectiveness research methods to establish frailty models and the formation of functional ends for the timing and implementation of treatment regimens.

Rothschild, Bates, and Leape (Rothschild et al., 2000) report that geriatric patients (≥65 years) comprise 49% of hospital occupancies and suffer more injuries during hospitalizations than younger patients. They attribute this greater jeopardy to the decreasing physiologic reserves of the aging population and the authors review the literature for six categories of potentially preventable complications. The incidences rise from two-fold to ten-fold for the following complications: adverse drug events, falls, nosocomial infections, pressure sores, delirium, and
perioperative complications (Rothschild et al., 2000). Of particular interest to this research are
the recommended assessments and preventative interventions discussed for delirium, pressure
ulcers, and perioperative complications. The authors endorse the use of geriatricians,
coordinated care plans, and an age-adjusted approach to intraoperative management as important
steps in improving outcomes and reducing healthcare costs for this population.

**Osteoporosis**

The National Institute of Health (NIH) convened a consensus panel to help clarify the
information surrounding the prevention, diagnosis, and treatment of osteoporosis (NIH
Consensus Development Panel on Osteoporosis Prevention, Diagnosis, and Therapy, 2001). The
panel searched the MEDLINE database for the literatures from 1995 through 1999 and 2,449
references were reviewed. The panel focused on forming a consensus from the literature and
their experience regarding five questions: 1) What is osteoporosis and what are its
consequences? 2) How do risks vary among segments of the population? 3) What factors are
involved in building and maintaining skeletal health? 4) What is the optimal evaluation and
treatment of osteoporosis and fractures? and 5) What are the directions for future research?

The panel (NIH Consensus Development Panel on Osteoporosis Prevention, Diagnosis,
and Therapy, 2001. p. 786) defined osteoporosis “as a skeletal disorder characterized by
compromised bone strength predisposing a person an increased risk of fracture.” Osteoporosis
was reported to be measured in bone density and quality, and was a comparison of the
individual’s peak bone mass and amount of subsequent bone mass loss. Bone mass was
measured as grams of mineral per area/volume and quality was a measurement of structure and
architecture. They found no accurate overall measure of bone strength although bone mass density (BMD) was a frequent proxy measure.

Risk factors for osteoporosis (low BMD) can be from various causes: increased age, female gender, low body mass index, certain disease states, and gonadal insufficiency (NIH Consensus Development Panel on Osteoporosis Prevention, Diagnosis, and Therapy, 2001). The predisposing factors for osteoporosis can begin with prematurity and low birth weight in infants, childhood malnutrition, and lack of weight bearing exercise that prevent maximum bone development. Secondary causes are known to be results of celiac disease, cystic fibrosis, and other malabsorption syndromes in addition to medications for diseases such as chronic obstructive pulmonary disease (COPD) and inflammatory conditions.

Maintaining skeletal health was one of the challenging areas for the panel (NIH Consensus Development Panel on Osteoporosis Prevention, Diagnosis, and Therapy, 2001), as research has failed to reveal unequivocal results on what and how to influence the phenomena. Some, but not all, reports demonstrate improvements from calcium and vitamin D supplementation and although it is known that bed rest accelerates bone loss, the results of exercise have been difficult to quantify. Hormonal replacement has also not been uniformly successful and it has been largely discontinued since the early 2000 timeframe of the panel report. Other medications also have been problematic and results remain without universally efficacious outcomes (NIH Consensus Development Panel on Osteoporosis Prevention, Diagnosis, and Therapy, 2001).

This valuable NIH report remains pertinent in part due to its quality and depth, but also because the ensuing years have not brought great advancement in the knowledge surrounding
causation and prevention. The majority of osteoporotic fractures continue to be treated surgically and there has been no political consensus on investing in unproven and costly osteoporotic treatment regimens. The recommendations for future research were extensive, broad, and for the most part required large randomized controlled trials that would have been expensive, and have not been found in the subsequent literature.

Osteoporosis is a worldwide health problem whose main clinical consequences are bone fractures (Ström et al., 2011). Literally meaning “porous bone,” it is now commonly known that osteoporosis is not just a phenomenon of post-menopausal Caucasian women, with little that can be done, but also the subject of intense research into the causes, epidemiology, costs, life burdens, and treatment possibilities. Ström and colleagues (2011) have published an exhaustive study of osteoporosis that includes a primer on causes, definitions of osteoporotic fractures, diagnostic procedures, medical and surgical treatments, the global distribution of fracture volumes, and recommendations for further research.

The primary diagnostic criteria for osteoporosis is bone mass density (BMD) (Ström et al., 2011) that is measured in amount of bone mass per unit volume or per unit area. These measurements are obtained through radiographic or ultra-sonographic in-vivo testing that is sensitive to the presence of calcium in the bone. The loss of mineral deposits from bone results in a thinning of the trabecular elements and the resultant destruction of interconnecting structures; this results in weaker than normal bone (Ström et al., 2011). The risk of fracture, when osteoporosis is present, is calculated by the person’s number of standard deviations (SD) from normal.
The causes of osteoporosis are thought to be a combination of risk factors that include: advancing age, genetically inherited traits, health status, environmental influences, and lifestyle elements. Osteoporosis is classified as primary or secondary. Primary osteoporosis is considered to be age dependent and not influenced by other disease states. Current thinking includes information that the degree of osteoporosis manifested may be dependent on the attainment of an optimal bone density in early life (Ström et al., 2011). Secondary osteoporosis can be due to illnesses such as hyperthyroidism, malabsorption syndromes such as celiac disease, or the sequelae of medications such as glucocorticoids for rheumatoid arthritis and inflammatory bowel disease. No consensus has been obtained on definitive predictors; however, the incidence of primary osteoporosis increases with age and is most prevalent in Caucasian, post-menopausal women (Ström et al., 2011).

**Prevention of Recurrent Fractures**

All too often, a geriatric fragility fracture is a repeat event due to frailty and osteoporosis. The International Osteoporosis Foundation (IOF) has developed the Fracture Liaison, Capture the Fracture Services program to support appropriate assessment, intervention, and prevention, for geriatric fractures (Akesson et al., 2013). The aims of the “Capture the Fracture” program are: (a) to provide internationally endorsed best practice standards for the prevention of secondary fractures through osteoporosis treatment; (b) to encourage falls assessment and prevention, exercise and educational programs; (c) to facilitate change at the local and national levels through mentoring programs, guidelines and toolkits; and (d) to obtain grant funding for the development of systems to raise awareness of the problem through a global communications
plan, an anthology of literature, and an international coalition of partners in research and treatment.

Akesson and colleagues (2013) reviewed the international current practice in preventative care, reporting by nation on the percentages of in-hospital patients who received preventative care while in the hospital or upon discharge. The authors also reviewed the current IOF recommendations for what preventative care should include, recognizing that much research is yet to be done on efficacy and effectiveness. The IOF provides a central source for research, treatment, and international collaboration, to recognize that the fracture event in an individual is part of a systemic fragility and osteoporotic condition. The worldwide recommendations are that to alleviate the devastating sequelae the composite conditions of frailty and osteoporosis must be addressed.

GERIATRIC OSTEOPOROTIC FRAGILITY FRACTURE

Incidence of Geriatric Osteoporotic Fragility Fractures

The global burden from geriatric osteoporotic fragility fractures is difficult to quantify. Johnell and Kanis (2006) report that data are scarce from many sub-regions of the world, and even when incidence reporting is reliable, subsequent morbidity and mortality often cannot be attributed to just the fracture. The occurrences of osteoporotic fractures were estimated at nine million in 2000, with a cumulative worldwide incidence of 56 million who continue to suffer disability from fragility fracture (Johnell & Kanis, 2006). The authors estimate the global burden of disease from data originating in six sub-sections of the world. Of the nine million new fractures 1.6 million were at the hip, 1.7 million were at the forearm, and 1.4 million were vertebral fractures. The estimated worldwide fracture site frequencies are based on the ratios
reported in Sweden due to the lack of systematic data from other areas, and report the female to male occurrence ratio at 6:1. Disability after a fragility fracture was measured in disability-adjusted life years (DALY) and was found to outrank other chronic diseases such as hypertensive heart disease, rheumatoid arthritis, and all cancers except lung cancer (Johnell & Kanis, 2006).

The authors report that this review as the first to attempt a global estimation in occurrence and DALYs of fragility fractures. They point out the lack of information and reliable data on all fractures and note that although hip fractures account for only 60% of fractures, attention has focused on that population. The reasons for this disproportionate emphasis were reported to include the high morbidity associated with hip fractures and the fact that data from hospitals where hip fractures must be treated are more accessible. The authors make approximations of DALYs lost and associate cost to these estimates, however, they list the assumptions made in their limitations and acknowledge the lack of true worldwide data (Johnell & Kanis, 2006).

**Economic Cost and Quality of Life Impact of Geriatric Fragility (Osteoporotic) Fractures**

The literature that attempts to quantify the impact of osteoporotic fractures demonstrates that their impact on healthcare costs and quality of life are both of intuitive importance and very difficult to measure. In spite of these issues, international consortia have formed to find ways to measure the costs and quality of life impact. Some of that literature has attempted to compare expenditures, however payment models vary between countries and the limitations of inter-country comparisons have been documented by the researchers. In addition, models for healthcare reimbursement have changed in recent years. Therefore studies from earlier than 2000 have not been considered for this review.
Parsing out what is the percentage of healthcare costs that can be directly attributed to fracture care, and how to account for cost comparisons in those who expire during the post fracture measurement period have been problematic for most researchers (Bass et al., 2007; Haentjens et al., 2005). These issues, as well as the long-term nature of the consequences of geriatric fractures, have been considered limitations to the validity and generalizability of most findings. Although many authors comment that randomized controlled trials would be ideal, this population is not considered appropriate for that modality (Al-Ani et al., 2008) and no RCT studies were located (Haentjens et al., 2005).

The incidence and effect of osteoporotic fracture have been of historical concern for European healthcare; the Belgian Hip Fracture Study Group (Haentjens et al., 2001) reported a one-year prospective matched pair cohort study of 170 female fracture patients compared to 159 of their non-fracture counterparts. The total costs for healthcare in the year following a hip fracture were reported as $13,470 for the hip fracture group and $6,170 for the control group. The costs were attributed by percentages; 31% was for nursing home care, 31% from rehabilitation center stays, 16% from hospital costs, and 14% from home care costs. There were 11 expirations from the hip fracture sample, the authors attempted to cost out what would have been the expenditures if they had lived for the year, and report that the cost of care for a fracture event increases healthcare costs by three times over those without a fracture.

Haentjens, Lamraski, and Boonen (2005) reported a systematic literature search for studies conducted between 1984 and 2000 that summarized the short term and long-term healthcare costs in the elderly hip fracture population. They concluded that the costs for the hip fracture population are approximately three times higher than the costs for similar non-fracture
populations. The most influential drivers of costs in the hip fracture population were increased age and living in an institution at the time of the fracture. This review illustrates many of the challenges to estimating costs, for example, the authors raise the question of “costs for whom?”, and report that there is no universal agreement on how to measure direct and indirect costs. In addition, they review the methods used in the studies in the review. Many were comparisons of fracture versus non-fracture populations or historical before and after studies documenting healthcare costs in the same person. The limitations of these methods, the restrictions of studying only hip fractures, as well as the complexity of the issues, have hindered the advancement of knowledge surrounding the costs and impact on quality of life in this population.

Bass, French, Bradham, and Rubenstein (2007) reported a retrospective secondary data analysis of annual healthcare costs for 43,104 Medicare-eligible U.S. veterans treated for hip fractures in Veterans Health Administration (VHA) and other hospitals. The cost to Medicare for this cohort of patients between 1999 and 2002 was reported to average between $68 to $71 thousand per veteran per year and total approximately $3 billion. The estimation method employed was an ordinary least squares regression that controlled for age, gender, inpatient length of stay, co-morbid conditions, and 1-year mortality. The database used was from the Standard Analytical File (SAF) of Medicare utilization files for the admitting diagnosis of hip fracture (ICD-9 codes 820-820.9). The authors note limitations that the population studied was primarily male (87% of the sample) and that the costs were only estimated for those who survived for at least one year (13,881 of the 43,104 expired). Despite these limitations, Bass and colleagues (2007) consider the results to be a significant contribution to inform the planning and healthcare policy decisions for the geriatric fracture population.
The International Costs and Utilities Related to Osteoporotic Fractures Study (ICUROS) described the quality of life as reported by 2,808 patients from 11 countries (Borgström et al., 2013). Variations in the reduction in quality of life were found, with important factors including the country, and the quality of life reported prior to the fracture. ICUROS is an ongoing prospective study in which costs and quality of life information are collected in four segments over 18 months post osteoporotic fracture. Efforts are made to unify the data collection using the same instrument for quality of life (the EQ-5D) reporting in the three-fracture site sample that includes vertebral, hip, and forearm fractures. The study attempts to evaluate the cost and the consequences of osteoporotic fractures on an international scale. Although the authors report that it would be preferable to use country-specific information to advise economic and healthcare policy decision makers, they report that gaps in the data available from many countries require that expert opinion and international aggregate data must be used. Cost data were obtained from patient records in the categories of direct medical care, direct non-medical care, community care, and resources lost. These data were intended to be combined with the results of the quality of life reports to compare pre and post fracture burdens. Significant differences in estimated quality of life by country and pre-fracture reported quality of life were reported from the regression analysis; however, no cost data were presented in the article that would allow an estimation of overall burden. The ICUROS study to date has experienced a large attrition threat; of 3,915 originally enrolled subjects, only 1,943 remained as participants at the time of publication.

**Patient Outcomes Based on RSI or Non-RSI in Geriatric Fragility (Osteoporotic) Fractures**

What constitutes optimal hospital care for geriatric patients (Hung et al., 2012), and specifically the geriatric (osteoporotic) fragility fracture population, is the subject of a large body
of published research that recommends geriatrician-led teams to focus on the unique needs of the elderly (Adunsky et al., 2005; Beaupre et al., 2005; Kates et al., 2010). Much debated are these recommended components of care that may or may not improve short-term patient outcomes (Hommel et al., 2008). Also discussed is whether improved short-term outcomes influence the long-term sequelae in this complex population (Deschodt et al., 2011; Leigheb et al., 2012). There is little doubt that all patients would benefit from improved hospital care that is comprehensive, evidence based, safer, and coordinated (Institute of Medicine U.S., Committee on the Learning Health Care System in America, 2012). Unequivocal evidence, however, that the expense generated by highly coordinated and comprehensive care improves outcomes has been surprisingly difficult to obtain. Multiple studies report varying results on whether these resource-rich models of coordinated care are effective in improving outcomes and whether overall healthcare expenditures are reduced for the geriatric population (Pedersen et al., 2008; Vidan et al., 2005).

When the geriatric fragility fracture population requires surgical intervention for fracture repair, whether bringing them to surgery in less than 24 hours (and the resources required to accomplish that safely), is related to improved outcomes and reduced costs is of interest in this research. This component of the treatment, referred to as Rapid Surgical Intervention (RSI), is just one part of an optimal geriatric fracture care program and the literature to date does not report consensus or consistently positive outcome results (Beaupre et al., 2005). The literature reviewed in the following paragraphs reports on the influence of RSI in the hip fracture population, no literature was found reporting research on the effect of RSI in the totality of the geriatric fragility fracture population.
Al-Ani et al. (2008) conducted a prospective study of 850 consecutive hip fracture patients who were admitted to a university hospital in Sweden. Usual care was given to the patients; Al-Ani and colleagues measured the outcomes of pressure ulcers, length of hospital stay, ability to return to independent living, and mortality rates based on three cut off limits of time from admission to surgery (delays of > 24 hours, delays of > 36 hours, and delays of > 48 hours). Of the original 850 patients, 744 were included in the odds ratio (OR) and regression analyses. The ability to return to independent living was negatively affected only by surgical times greater than 36 hours (OR .44). Pressure ulcer incidence increased with each period of delay to surgery (OR 2.19, 3.42, and 4.34). A linear regression analysis demonstrated a significant relationship between waiting time to surgery and length of stay in the hospital (p < .01) after adjustments for pre-hospital condition, but no significant relationship was found between mortality and surgical delay. This study was rated at level II evidence; the authors comment that a RCT of surgical delay times would not be ethical and therefore this model of study was the best approach to answer the research questions.

Beaupre et al. (2005) conducted a systematic literature review of articles published between 1985 and 2004 to determine if there was evidence for best practices in care for the geriatric fragility fracture population. The author team selected 1,419 studies that met their review criteria and appraised the research for evidence of efficacy in many common perioperative practices. The results found concerning pressure ulcer prevention and minimizing surgical delay are pertinent to this research. Beaupre and colleagues report that RCTs found significant increases in pressure ulcer incidence with surgical delays of more than 48 hours. Cohort studies reporting the effects of delay to surgery were equivocal on its influence on
mortality; Grimes (2002) reported no significant effect but Hamlet et al. (1997), after adjusting for severity of illness preoperatively, found increased long-term mortality with patients who experienced surgical delays.

**COMPLICATIONS OF CARE**

This study will include in its appraisal of RSI effects, two potentially preventable complications of care that occur frequently in elderly patients (Rothschild et al., 2000). The first is post-operative delirium (Witlox et al., 2010) and the second is hospital acquired pressure ulcer (Baumgarten et al., 2012). De Brauwer and colleagues (2012) studied a cohort of 145 consecutive geriatric hip fracture patients over the age of 75 years admitted to a teaching hospital. Over the 18 month study (De Brauwer et al., 2012), they report the incidence of major behavioral problems to have occurred in 46% of patients and pressure ulcers to have occurred in 19% of the cohort. These two complications are considered important because in addition to the frequency the literature reports, their occurrence increases morbidity and mortality in geriatric fragility fracture patients (Witlox et al., 2010). These complications are also considered to be sensitive to care delivery (Phillips, 2013), and they are pertinent to nursing care (Rice et al., 2011).

**Delirium**

**Description**

Delirium is a factor that confounds the treatment and recovery of many hospitalized patients. Rice et al. (2011) report delirium to be the most common complication affecting the older patient in the United States. They chronicle its incidence at approximately 2.3 million patients per year, resulting in 17.5 million additional hospital days, which add billions of dollars
to healthcare costs annually (Rice et al., 2011). Delirium is defined in the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2000) as a disturbance of consciousness with reduced ability to focus, sustain, or shift attention; a change in cognition; or the development of a perceptual disturbance that occurs over a short period of time and tends to fluctuate over the course of the day. Holly, Cantwell, and Jadotte, (2012) reference the word delirium from the Greek de lira (off the path) and describe it as a fluctuating disturbance of consciousness with an acute onset and disorganized thinking. The condition can be divided into hyper, hypo, and mixed, with states based on presenting behaviors. Delirium is frequently under-recognized, under-reported, and is confused with depressive or dementia states by healthcare professionals (Lemiengre et al., 2006; Wong, Holroyd-Ledue, Simel, & Straus, 2010).

**Incidence and risk factors**

Rothschild et al. (2000) report delirium as one of the six most frequent and preventable complications for older patients. The condition is associated with increased lengths of stay in the hospital, increased morbidities, reduced functional recovery, and higher in-hospital mortality (Marcantonio, 2012). The occurrence of delirium is not completely understood, however endogenous and exogenous predisposing factors are recognized. Increased age, male gender, preexisting cognitive impairment, and substance abuse are among the endogenous predisposing factors reported (Edlund et al., 2001; H. Lee et al., 2011). The preoperative diagnosis of dementia, surgery lasting longer than two hours, and long waiting times between presentation at the hospital and surgical intervention, are reported as exogenous factors (Edlund et al., 2001; Rice et al., 2011).
Holly, Cantwell, and Jadotte (2012) quote the APA (American Psychiatric Association, 2000) in defining delirium as a disturbance of consciousness characterized by an acute onset of disorganized thinking. Delirium reportedly occurs commonly in intensive care and post-surgical patients; it is a predictor of increased mortality and associated with increased costs and length of stay in the hospital (Holly et al., 2012). The development of delirium is reported to be multifactorial and is not completely understood. It develops more often in the elderly, severely ill and injured patients, and is thought to involve predispositions in the patient.

Holly and colleagues (2012) report the causes and types of delirium based on Level I and Level II evidence from the literature. The causes are divided into modifiable circumstances and non-modifiable attributes. The more modifiable causes include environmental and acute illness sequelae such as lack of stimulation, fever, pain, and medications. The less modifiable causes are patient characteristics and chronic pathologies.

Types of delirium are categorized into hyperactive, hypoactive, and mixed, based on the variations in presentation (Holly et al., 2012). These dissimilarities in symptoms contribute to the confusion among health care professionals concerning the diagnosis, assessment, and treatment for delirium. The authors recommend initial and ongoing assessments for delirium and list a variety of screening tools available.

The study (Holly et al., 2012) is an extensively-referenced article that is frequently cited in the nursing literature. It provides a comprehensive primer on the topic of delirium, its causes, types, assessment and treatments. The article stresses the importance of delirium recognition and that prevention can reduce the morbidities to patients and the associated increased costs to the healthcare system. (Holly et al., 2012)
Phillips (2013) focuses on delirium in the geriatric patient in an article that reviews the causes, incidence and prevalence, identification of symptoms, and prevention and treatment strategies. The diagnostic dilemma that dementia presents is discussed and Phillips reports that with early recognition of symptoms delirium could be reduced by 30% (Phillips, 2013). She concludes that nurses are in the best position to recognize and mitigate delirium symptoms due to their continuous presence at the bedside. This article contributes to the nursing literature by reporting recommended nursing actions to identify, reduce, and treat delirium.

Predisposing factors and whether they influenced delirium occurrence after hip surgery were investigated by Lee et al. (2011) in an academic medical center using the Confusion Assessment Method (CAM) developed in 1990 for use by non-psychiatric caregivers to identify delirium (Wei, Fearing, Sternberg, & Inouye, 2008). The patients were assessed by a research nurse on admission, post operatively, and repeatedly until hospital discharge. Delirium occurred more frequently, at 56% of the time in the patients with dementia and probable dementia than other patients, (26% of the time) in the post-operative period (p < .001). Odds ratios (OR) for the development of delirium were reported as increased for male gender, increased co-morbid conditions, and longer surgery duration. In the group with dementia (and probable dementia), even when adjusted for other factors, surgical delay after admission was positively associated with delirium. The study emphasizes the complexities of the many factors that influence delirium development. The authors recommend replication of the study on a larger sample to better understand the relationships and predisposing factors to delirium development in hospitalized patients.
Witlox et al. (2010) reported a systematic search of the literature for observational studies on elderly in-patients who developed delirium and rates for mortality, institutionalization, and development of dementia, during a three-month follow-up period. To be included, the studies had to control for age, sex, co-morbidities, severity of baseline illness, and dementia. The original search resulted in 2,939 studies; of these, 51 relevant articles were chosen for analysis. Positive correlations were found between the development of delirium during hospitalization and all the dependent variables of mortality, institutionalization, and the subsequent development of dementia. Mortality was analyzed using Hazard Ratios; all were reported as positive within a 95% confidence interval (CI). Institutionalization and dementia were reported as positive odds ratios (95% CI), with one study reporting a neutral (crossing 1.0). Although the authors report limitations due to the use of English language observational studies that used different definitions of delirium, they conclude the results support the importance of delirium as a predictor of poor patient outcomes and negative long-term prognoses.

**Recognition and Assessment**

Wong, Holroyd-Ledue, Simel, and Straus (Wong et al., 2010), reported a meta-analysis that studied 3027 patients and the assessment of delirium by 11 validated instruments. Their search identified 79 studies using the terms confusion and delirium; 25 studies that met the inclusion criteria were reported in the article. Many instruments resulted in likelihood ratios of detection at >5.0; however several of the instruments took extensive time to administer and required detailed education for the providers. The authors concluded that the Confusion Assessment Method (CAM) was reliable, easy to understand and administer, and took only five minutes of caretaker time.
Rice and colleagues (2011), using the Confusion Assessment Method (CAM), contribute to the knowledge about nurses’ recognition of delirium by comparing expert diagnostician and nurse agreement on whether patients >65 years old had delirium. The study reports on a convenience sample of 170 patients and 167 nurses that included multiple assessments of the patients. The diagnosticians identified delirium in 7% of the patients. The nurses failed to recognize the delirium in 75% of those patients. Rice et al. (2011) concur with other findings that delirium is under-recognized, described, and treated by usual care methods.

In a prospective descriptive study from Belgium, Lemiengre et al. (2006) assessed the diagnostic validity of the Specific (SPEC) and the Sensitive (SENS) scoring methods for the CAM scale. All consecutive admitted patients (n = 258) had the CAM administered by bedside nurses over a 5-month period and these results were compared to the results of trained researchers. Nurses were accurate 95% of the time in deciding which patients did not have delirium but had much greater difficulty in recognizing the symptoms displayed as delirium in patients who were identified by the researchers as positive for delirium. Of the two scoring methods, the SENS method had a higher accuracy, with 90.7% specificity and 66.7% sensitivity in recognizing the features of delirium. With the SPEC method, delirium was not recognized 76% of the time. This percentage was reduced to 33% diagnoses missed with the SENS method. As a precursor to treatment, early recognition of delirium is an important nursing skill; the authors recommend enhanced education and heightened scrutiny of the geriatric in-patient population with the SENS CAM scale. As a secondary data analysis, this study did not include any patient contact or use of tools to assess delirium. The presence of delirium not POA was included in the analysis as it was coded in the SPARCS database.
Pressure Ulcers

The etiology and incidence of pressure ulcers developed during hospitalizations for geriatric fragility fractures include intrinsic and extrinsic factors. The elderly are a widely heterogeneous group that suffers from varying degrees of fragile skin, nutritional deficiencies, and co-morbid illnesses. These can constitute a geriatric syndrome that increases their vulnerability to the development of pressure ulcers (Jaul, 2010). When these vulnerabilities are combined with the extrinsic factors of immobility, shearing, pressure, and friction common to bed rest, the incidence of pressure ulcer development is estimated to occur in between 8.8% and 55% of geriatric hip patients (Lindholm et al., 2008).

Jaul (2010), in a detailed review article, outlines the pathogenesis of pressure ulcers in the elderly and includes a survey of the current management recommendations. Intrinsic mechanisms such as degenerative changes of body systems, inflammatory processes in blood vessels, and metabolic derangements which predispose the patient to ulcer development when they experience immobility or incontinence, are summarized. The comprehensive ulcer assessment and management techniques contained within the article are beyond the focus of interest for this study. The extensive care needs required, however, point to the impact on resource utilization, length of stay, and morbidity caused by the development of a pressure ulcer for any patient.

The Pan-European Pressure Ulcer Study (Lindholm et al., 2008) surveyed hip fracture patients’ hospitalizations throughout Europe to describe the effects on pressure ulcer development by differences in patient logistics, times to surgeries, and care procedures. Designated research coordinators studied at least 20 consecutive patients from each European
country involved; 635 patients were included in this prospective study. Patient factors that positively correlated to ulcer development included: increased age (p = 0.02), diabetes and pulmonary disease (p = 0.006), and poor nutrition (p = 0.02). If the patient developed incontinence (p = 0.004), or dehydration (p = 0.005), they were also more likely to acquire an ulcer. Time to surgery (p = 0.34) and duration of surgical times were not found to significantly correlate with ulcer development. The authors describe this study as the largest prospective study of hip fracture patients in Europe. The patients were followed from admission to seven days post discharge by skilled investigators who were trustees of the European Pressure Ulcer Advisory Panel (EPUAP) and each patient was assessed for pressure ulcers multiple times during and after the hospital stay. The methods, statistical analyses, and results of this study (Baumgarten et al., 2012) were reported in detail that enhanced comprehension of the issues involved in pressure ulcer development in this patient population.

The current literature includes patient factors when discussing the occurrence of pressure ulcers, but traditionally it has been considered a care dependent complication associated with neglect or lack of proper care. Baumgarten and colleagues (2012) report a prospective cohort study from nine hospitals in the Baltimore Hip Studies network that included repeated skin assessments of 658 hip fracture patients. The surprising results found inverse or no relationships between the development of pressure ulcers and the care-related factors usually considered to be important such as emergency department waits, timing of transport to the hospital, or duration of surgery. There was however, a positive relationship between pressure ulcers and time between admission and surgery. If the surgery was delayed beyond 24 hours the incidence of pressure ulcers rose (the adjusted incidence rate ratio - aIRR = 1.62, 95% CI = 1.24-2.11, p. < .001).
Overall, 14.6% of the participants developed a pressure ulcer and those patients had a higher severity of illness, poorer nutrition and mental status (p. < .001); however the relationship between time to surgery remained significant after adjusting for these risk factors. The authors report the large sample size and the expert researchers who evaluated the patients as study strengths. They challenge the premise of pressure ulcers as always preventable and recommend rigorous investigations into the effectiveness of pressure relieving patient platforms and frequent turning and positioning. The high morbidity associated with hip fractures is in part due to the occurrence of pressure ulcers after surgery.

Whether delayed mobilization after surgery was affected by the time from admission to surgery and contributed to the development of post-operative pressure ulcers was studied on a large (722) patient population between 1995 and 2001 (Rademakers, Vainas, van Zutphen, Brink, & van Helden, 2007). This retrospective study of hip surgery patients at least 60 years old found that time to surgery was an independent predictor of pressure ulcer development and hospital length of stay. The research of Rademakers (Rademakers et al., 2007) and his colleagues separated patients by time to surgery of before or after 12 hours. This aggressive time to surgery measurement resulted in the < 12 hour group having 19% pressure ulcer development compared to 30% development in the > 12 hour group. The authors acknowledge that other factors, including age, were also independently associated with increased pressure ulcer development and length of stay; however, they conclude that the lower ulcer rates (p. = .008) warrant the investment necessary in care coordination to achieve arrival to surgery times under 12 hours.
In 2010, Simunovic and colleagues reported a meta-analysis of the literature on the effects of RSI on mortality and complications (Simunovic et al., 2010). They chose 16 observational studies that included 13,478 patients for whom mortality data were complete at 30 days, six months, and one year. Within the risk-adjusted patients in all the studies, time to surgery regardless of the time (24 to 72 hours) was associated with lower mortality rates only at the one-year mark. When the researchers removed the one study of the group that included only medically complex patients, there was a significant mortality reduction at six months in the earlier surgery group (RR 0.66, 95% CI .50-.88, p = .005). Three of the studies that were included evaluated the effect of RSI on pressure ulcer development. Of those 3,023 patients, early surgery (undefined by the authors) was related to a 52% reduced pressure ulcer rate (RR .48, 95% CI 0.34-.69, p. < .001). This study did not discuss limitations; however a detailed explanation of the screening and eligibility of the studies was included, as well as a review of the methodological quality and extraction of the data in the studies. This meta-analysis contributes to the scholarly discussion surrounding the effects of RSI and demonstrates that further work needs to be done in the attempt to quantify the effect of RSI on the fragility fracture population.

SUMMARY OF LITERATURE REVIEW

Secondary data analysis (SDA) research enables complex questions with multiple variables to be addressed in order to compare the effectiveness of new treatment regimens as compared to usual (traditional) care. The knowledge from this kind of research is designed to inform health care decision-making that improves both patient outcomes and value in health care. This study describes the effectiveness of rapid surgical intervention in the geriatric fragility fracture population by comparing the hospital outcomes and costs for those patients who did and
did not have their fractures surgically repaired within 24 hours of hospital arrival. This observational retrospective cross-sectional study uses the New York State SPARCS database to describe variables of interest in the patient population of a five-hospital system that includes both tertiary and community hospitals. The literature considered pertinent to this study included publications on the comparative effectiveness research framework, the SDA method, the clinical concepts in geriatric fracture care, and the nursing care coordination required to implement any new process of interdisciplinary care.
CHAPTER 3

RESEARCH METHODS

Introduction

This chapter on research methods includes an overview of the research project and processes. It includes descriptions of the design and the study intentions, the data source and the database for secondary analysis, the sample and the human subjects’ protections and permissions, and the plan followed for the statistical analyses. This chapter provides an outline of processes to demonstrate the rigor and validity of the study and serves as a study map that would allow for replication of the research.

Purpose

The purpose of this study was to describe and explore the relationship between rapid surgical intervention in the geriatric fragility fracture population and their in-hospital patient outcomes. The study investigated a large sample population from a group of hospitals using the hospitals’ own datasets (HOD) of the New York State Statewide Planning and Research Cooperative System (SPARCS) database. The secondary analysis of the SPARCS administrative database compared subjects who did and did not receive RSI, and used the demographic, diagnosis, and procedure information to compare patient results for post-procedure length of stay, total charges, mortality, and the post admission development of pressure ulcers and delirium. The dependent variables and outcomes of interest for the study population include:

- In-hospital post-procedure length of stay (PPLOS).
- The development of the in-hospital acquired complications of delirium and pressure ulcers.
- In-hospital mortality.
- In-hospital charges.

**Hypotheses for Testing**

The following hypotheses of the research questions were tested:

1. $H_0$: There is no relationship between rapid surgical intervention for the geriatric fragility fracture population and their in-hospital outcomes.

   $H_1$: There is a relationship between rapid surgical intervention for the geriatric fragility fracture population and their in-hospital outcomes.

2. $H_0$: Patient characteristics (age, race, gender, fracture site) do not predict outcomes (length of stay, charges, complications, mortality) for patients with rapid surgical intervention (RSI).

   $H_1$: Patient characteristics (age, race, gender, fracture site) do predict outcomes (length of stay, charges, complications, mortality) for patients with rapid surgical intervention (RSI).

3. $H_0$: Proxy severity of illness does not influence the outcomes (length of stay, charges, complications, mortality) for patients with rapid surgical intervention (RSI).

   $H_1$: Proxy severity of illness does influence the outcomes (length of stay, charges, complications, mortality) for patients with rapid surgical intervention (RSI).

4. $H_0$: There is no difference in outcomes (length of stay, charges, complications, mortality) for patients between RSI (surgery in < 24 hours) and non-RSI (surgery in > 24 hours) by fracture site (hip versus all other sites).
H₁: There is a difference in outcomes (length of stay, charges, complications, mortality) for patients between RSI (surgery in < 24 hours) and non-RSI (surgery in > 24 hours) by fracture site (hip versus all other sites).

5. H₀: RSI does not reduce negative outcomes and charges for geriatric patients with fragility fractures (covaried by age, race, gender, fracture site).

H₁: RSI does reduce negative outcomes and charges for geriatric patients with fragility fractures (covaried by age, race, gender, fracture site).

**Design**

The design of this research is a descriptive cross-sectional study accomplished through a retrospective secondary analysis of the NYS SPARCS database.

**Sample**

The sample included geriatric patients (65 years or older) who were identified in the SPARCS database from five acute care suburban hospitals who, during the timeframe from January 1, 2010 through June 30, 2013, were admitted for a geriatric fragility fracture of the upper or lower extremity and who were treated surgically for that fracture. The fracture sites included were fractures of the upper body (arm and shoulder), lower leg, and femur/hip. Patients with vertebral fractures were not included because their treatment is frequently non-surgical and because that population may represent those with oncologic pathological fractures. Other general exclusions were patients who were not treated surgically due to their underlying conditions or type of fracture.

The hospitals are from a suburban hospital system in New York State in the United States. Within that group, the hospitals are somewhat diverse. They include one tertiary cardiac
hospital (>350 beds), two mid-sized community general hospitals (200-300 beds), one community hospital with a specialty in orthopedics and rehabilitation (>200 beds), and one large (>400 beds) high acuity community teaching hospital. All the hospitals perform orthopedic surgery and the population served resides across multiple counties within the state. The counties are located within driving and commuting distance to a major city. Most, if not all population diversity demographics of race, ethnicity, religion, and socio-economic status are represented within the millions of people who live in the counties served by the hospital system. The original sample included 1,984 subjects. The subjects were relatively evenly distributed throughout the time span; there were 537 subjects from 2010, 587 subjects from 2011, 572 subjects from 2012, and 288 subjects from the first six months of 2013. The large community teaching hospital treated 38.46% (763) of the subjects, the orthopedic specialty hospital treated 25.25% (501) of the subjects, the tertiary cardiac hospital treated 14.72% (292) of the subjects, and the two smaller community hospitals treated 11.34% (225) and 10.23% (203) of the subjects. A breakout of the sample sizes per hospital per year is provided in Appendix G.

The power for this sample and study was set at .80. The alpha for all significance was set at .05. A large data set sample can be assumed to meet the requirements for power. However, a power analysis was performed on the Power and Precision software and the power for the minimum sample in any analysis of n=1,970 met the .80 requirement.

**Human Subject Protection**

This study accessed the SPARCS records for patients. The following measures were adopted to protect the subjects. No patient names, dates of birth, or social security numbers were included in the HOD databases sent from NYS and therefore were not part of the data cleaning
or merging of the records. Patients’ dates of admission to the hospital, dates of surgery, and dates of discharge from the hospital are considered identifying data by NYS. Therefore, the dates were only used to compute the variables of interest. For example, if a patient’s date of surgery was 1/1/2010 and the discharge date was 1/10/2010, the dates were computed to the variable post-procedure length of stay and entered into the database as nine days. Diagnosis codes, and dates of (and codes for) surgeries were included in the original database and were necessary for the inclusion and exclusion of subjects. The original Excel database has been kept in secure locations, on password-protected computers to be available for checks of data accuracy and integrity. No dates of or specific surgical interventions were reported except in aggregate in the study.

The researcher received permission to use the SPARCS HODs from the healthcare system’s corporate Executive Risk Manager and Privacy Officer and from the Senior Vice President and Chief Medical Officer for this research. The Letter delineating that permission is in the Human Subjects Permission appendix, (Appendix A). The researcher was granted exempt status approvals from the Molloy College Institutional Review Board (IRB), (Appendix B) and from the IRB that represented the health system’s hospitals (Appendix C).

The encrypted SPARCS undeliminated American Standard Code for Information Interchange (ascii) flat file with the patient-level data was sent to the researcher from the Healthcare Association of New York State (HANYS) SPARCS vendor. The password for the identifiable flat file was sent to the health system’s corporate Director of Health Information Management (HIM) and shared with the researcher. The files were kept on two password-protected computers that remained in a locked office when not in the direct possession of the
researcher. When the sample subjects’ data were entered into the SPSS statistical software program (Version 22, Chicago, IL, U.S.), each subject was assigned a unique non-identifiable code number as an identifier for analyses. The crosswalk document from patient identifier to unique data identifier has been kept in a secure location under lock and key. No patient identifier data elements will be disclosed or identified in the dissertation paper or any subsequent publications.

**Procedures for Sample Data**

The NYS SPARCS database collects administrative and billing information from all hospitals in NYS. By regulation, hospitals and hospital systems are able to have access to the complete and identifiable indicators in their own SPARCS datasets. These are named “hospital own data sets” (HODs). The Health Insurance Portability and Accountability Act (HIPAA) Officer and the Chief Medical Officer from the five-hospital system in NYS have granted this researcher access to the system’s hospital own datasets (HOD) database. The researcher used the “hospital own dataset” version of the NYS SPARCS database for the years 2010 through quarter two of 2013 inclusive. The HANYS had been contacted, and after confirming the permission from the hospital system, sent the HOD SPARCS files to the researcher as encrypted undeliminated ascii flat files. Personnel from the hospital system converted the SPARCS files into Excel files. Each file represented one hospital for one year (2013 was a half year) and included the patients 65 years or older who had a primary diagnosis of a fracture as included in Appendix E and described in the introduction.
Definition of the SPARCS Database

“The Statewide Planning and Research Cooperative System (SPARCS) is a comprehensive data reporting system established in 1979 as a result of cooperation between the health care industry and government. Initially created to collect information on discharges from hospitals, SPARCS currently collects patient level detail on patient characteristics, diagnoses and treatments, services, and charges for every hospital discharge, ambulatory surgery patient, and emergency department admission in New York State” (New York State, 2013, p. 1). All hospitals in New York State are required to upload patient level data elements as delineated in the database dictionary before billing for an in-patient hospital stay. The database contains ICD 9 and DRG codes that identify in numbers the data elements of the patient level detail information. SPARCS publishes a data dictionary that contains a crosswalk of codes to definitions; this provided the code level detail for the researcher (New York State, 2013).

Oversight of the SPARCS Database

SPARCS publishes information for researchers and submitting hospitals on its website (New York State, 2013). NYS in cooperation with HANYS oversees the protection of the data as evidenced by this quote on responsibilities and security: “The responsibility for protecting the confidentiality and privacy of data related to patient care resides with the Commissioner of Health. The responsibility for tracking and monitoring the technical functioning of SPARCS directly resides with the SPARCS Administrative and Programming Units. SPARCS staffs are available to assist with every phase of the SPARCS data system” (New York State, 2013, p. 2).
Data Integrity of the SPARCS Database

Areas requiring special attention in Secondary Data Analysis (SDA) research are the integrity, validity, and completeness of the data set used. The SPARCS database is highly regulated by NYS and HANYS and they employ skilled personnel to monitor the data submitted by the NYS hospitals. The following quote is from the SPARCS website that is maintained for hospitals and researchers (New York State, 2013).

“SPARCS Administrative staff, working with the Bureau of Biometrics' Data Quality Unit, review the quality and completeness of data reported by each hospital. When a review of a facility's data indicates the possibility of a significant data problem, the facility is contacted and a copy of the findings is provided to the facility for their review and confirmation. Very often an analysis might compare SPARCS information with information reported on a separate document such as the Institutional Cost Report (ICR). Such a comparison might reveal differences that suggest the need for further investigation. The maintenance of quality data is critical to the use of SPARCS data for reimbursement purposes as well as to the growing use of data for health care research”. (New York State, 2013. p. 10).

The SPARCS database subjects used for this research study was limited to geriatric patients who presented to the five-hospital system in NYS for the treatment of an upper or lower extremity geriatric fragility fracture and who received surgical treatment for that fracture. This included fractures of the arm, shoulder, leg, and hip. Vertebral fractures were excluded because their treatment is frequently non-surgical and because the population may represent those with oncologic pathological fractures.

Data Preparation

The data preparation in the early stages of a secondary data analysis is essential to the integrity of the research study. The literature on recommended steps, techniques, and processes were studied in the groundwork for this research and are outlined in the literature review. The
data analysis follows the steps recommended in quantitative analysis texts (Polit & Hungler, 1978; Polit & Beck, 2014; Wood & Ross-Kerr, 2011), and outlined in this study’s statistician’s manual on data analysis “The Seven Steps of Data Analysis” (Bannon Jr., 2013). The reliability and completeness of the SPARCS database have also been reviewed. All the variables of interest were complete with no missing data; also all data had been validated through the NYS DOH procedures. No database however, is perfect and SPARCS is subject to the variations in medical care documentation and coding that exist in human endeavors. In addition, although SPARCS records the total charges from each hospital in NYS, the methods used to calculate hospital charges are internal processes that vary substantially from hospital to hospital. Therefore the charges used in this research cannot be assumed to represent hospital costs or reimbursement received for patient stays from other hospitals or from other geographic locations.

Once the SPARCS data were entered into individual Excel spreadsheets, the tasks of converting the variables to forms that allowed for merging the individual hospitals’ files, and eventual statistical analysis were performed in painstaking detail (Jelen, 2010). An ongoing data log diary was kept and examples of the transformations include the following:

- Unique identifiers were created for each hospital and each study subject. This protected identities and allowed for ongoing checks of data value correctness as sorts and merges took place.

- ICD 9 and UDS values were changed to dichotomous dummy codes for analysis as necessary.

- Diagnosis and procedure codes were abbreviated to three digits to allow for sorting and analysis. Checks and comparisons to the ICD 9 data dictionary were made for all codes to ensure that no needed codes were eliminated or inappropriate codes included (Hart, 2013).
• Length of stay and post-procedure length of stay were computed and entered as days for the continuous variables or dummy coded to 0 and 1 for categorical variables from the dates of admission, surgery, and discharge.

• The Modified Charlson Index score was computed for all subjects via the online version offered by Hall (Hall, Ramachandran, Narayan, Jani, & Vijayakumar, 2004).

• Checks and re-checks were performed at regular intervals and colleagues were recruited to randomly check data elements against the original files to ensure that no data copying or merging errors had occurred.

• During the univariate analysis the independent variable of the Modified Charlson Index score (MCS), and the dependent variables of post-procedure length of stay (PPLOS) and total charges (TC) were not normally distributed. They did not meet the criteria for homoscedasticity and linearity. The initial regression models were not performing robustly, therefore four high outliers (> 3 SD above the mean) for PPLOS and TC were eliminated from the sample. In addition, only for the analysis of the dependent variable PPLOS, nine subjects with a PPLOS of zero were deselected to reduce the negative skew of that variable. The variables of MCS, PPLOS, and TC underwent a Log Transformation. This resulted in the variables MCS, PPLOS, and TC becoming non-significant in the Levene’s test for homogeneity of variance thereby meeting the parametric testing assumptions.

• When the final data set for all five hospitals was merged and aligned, it was sent to the committee chair and an independent statistician for review. The Excel spreadsheet was imported into SPSS version 22.
• All variables were named, data types were entered, labels were assigned, and any additional elements were completed. The SPSS file was sent to an independent statistician prior to an in-person meeting for the data analyses.

**Instruments**

Charlson Comorbidity Index (modified for age and for use with electronic databases) (Charlson et al., 1994; Charlson, 2013; Charlson et al., 2008; Hall et al., 2004) was used to compute the Modified Charlson Score (MCS) variable by adopting the scale and modifying it for use with the geriatric population of this study and the electronic database (Hall et al., 2004). The scoring used added years, as the original scale scoring ended at 80 years of age. The Index and the scoring is included as Appendix F. Permission to use the score has been requested from Dr. Charlson. At the time of this writing no response to telephone calls to her medical office, or emails to her Weil-Cornell address have been received.

**Interpretation**

The Modified Charlson Comorbidity Index score was calculated by adding the assigned values for comorbid conditions to the assigned values for age. This resulted in a single score that is equal to the sum of the two categories.

1. Calculate Charlson Score or Index
2. Add comorbidity score to age score
3. Sum scored and entered into SPSS database for each subject.

**METHODS SUMMARY**

This study uses a large database for a secondary analysis to describe the relationship of rapid surgical intervention for the geriatric fragility fracture patient to clinical and economic outcomes. The additional predictor variables were chosen based on the literature review and
clinical evidence that they were influencers of patient outcomes. The relationships between the independent, covariate, and dependent variables were analyzed using the appropriate bivariate testing. The minimum significance set for all testing was \( p < .05 \).

There was no significant relationship found between the dependent variable of delirium and any of the independent or covariate variables. The possible reasons for this finding is complex and addressed in Chapter Five.

For the relationships between variables that met the minimum level of significance of \( p < .05 \), and that were important based on clinical evidence and prior reporting in the literature, multivariate analyses were performed. For the categorical dependent variables of in-hospital mortality and the development of pressure ulcer, a binary logistic regression analysis was completed. For the continuous dependent variables of PPLOS and total charges a linear regression was performed. All processes and results were verified with an independent statistician for correct processes and interpretations.

The study has answered the research questions through rigorous univariate, bivariate, and multivariate statistical analyses. The findings of the research are further discussed to contribute to the body of clinical nursing knowledge and to add to the growing expertise in the field of comparative effectiveness research methodology.
CHAPTER 4

FINDINGS OF DATA ANALYSIS

Introduction

The primary purpose of this study is to describe the relationship of the independent variable of rapid (within one day) surgical repair (RSI) to identified patient outcomes in the low-trauma geriatric fracture population. The primary independent variable in this study is the RSI, covariates of interest are the patients’ condition on admission (measured by the combined age and comorbidity score of the Modified Charlson Index) (MSC), race (Caucasian and all others), gender (male or female), and fracture site. The outcomes of interest are the patients’ post (surgical) procedure length of stay (PPLOS), total hospital charges (TC), in-hospital mortality (MORT), and the in-hospital development of the complications of delirium (DEL) and pressure ulcer (PU).

Univariate Analyses of the Variables

Descriptive statistics were computed to illustrate the aggregate characteristics of the sample subjects and variables. There is one categorical independent variable, the rapid surgical intervention (RSI) and one covariate continuous variable, the modified Charlson Index score (MCS). There are three covariate categorical variables; 1) fracture site in the upper body, lower leg, or femur/hip, 2) gender (male or female), and 3) race (Caucasian or all others). There are two continuous dependent variables; 1) the post-procedure length of stay (PPLOS) and 2) the total charges (TC). There are three categorical dependent variables; 1) in-hospital mortality, 2) the development of delirium not present on admission, and 3) the development of pressure ulcer not present on admission. Table 1 illustrates the frequencies for the independent variable and the
categorical covariate and dependent variables. Table 2 illustrates the descriptive
properties of the continuous covariate and dependent variables.

Table 1 Descriptive Analysis of the Categorical Variables
(N=1,979)

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>FREQUENCY</th>
<th>PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Independent Variable</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RSI within one day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1,039</td>
<td>52.5</td>
</tr>
<tr>
<td>No</td>
<td>940</td>
<td>47.5</td>
</tr>
<tr>
<td><strong>Covariate Variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>440</td>
<td>22.2</td>
</tr>
<tr>
<td>Female</td>
<td>1,539</td>
<td>77.8</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>1,859</td>
<td>93.8</td>
</tr>
<tr>
<td>All other races</td>
<td>123</td>
<td>6.2</td>
</tr>
<tr>
<td>Fracture Site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Body</td>
<td>203</td>
<td>10.3</td>
</tr>
<tr>
<td>Lower Leg</td>
<td>44</td>
<td>2.2</td>
</tr>
<tr>
<td>Femur/Hip</td>
<td>1,732</td>
<td>87.5</td>
</tr>
<tr>
<td><strong>Dependent Variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discharged Alive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1,923</td>
<td>97.2</td>
</tr>
<tr>
<td>No</td>
<td>56</td>
<td>2.8</td>
</tr>
<tr>
<td>Delirium developed in hospital</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>125</td>
<td>6.3</td>
</tr>
<tr>
<td>No</td>
<td>1,854</td>
<td>93.7</td>
</tr>
<tr>
<td>Pressure Ulcer developed in hospital</td>
<td>41</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td>1,938</td>
<td>97.9</td>
</tr>
</tbody>
</table>

Table 2 Descriptive Analysis of the Continuous Variables
(N = 1,979 for MCS & TC) (N = 1,970 for PPLOS)

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>MEAN (SD)</th>
<th>MIN/MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modified Charlson Score</td>
<td>5.31 (1.88)</td>
<td>2-18</td>
</tr>
<tr>
<td>*Post-Procedure Length of Stay</td>
<td>6.11 (5.13)</td>
<td>1-72</td>
</tr>
<tr>
<td>Total Charges</td>
<td>70,742.72 (44,962.15)</td>
<td>11,473.00-75,8515.80</td>
</tr>
</tbody>
</table>

Note: This table represents the original values. For analyses, the variable underwent a log-
transformation.

The original continuous variables of the MCS, the PPLOS, and the TC did not meet the
assumptions of normal distribution. These variables were transformed using the Log
Transformation function in SPSS. After transformation, the variables met the Levene’s
test for the assumption of normal variation for parametric testing. There were no issues of multicollinearity among any of the independent or covariate variables.

**Bivariate Analyses of Continuous Dependent Variables**

*Post Procedure Length of Stay*

The relationship of the independent variable RSI, the continuous covariate variable MCS, and the categorical covariate variables gender and fracture site to the dependent variable of PPLOS were analyzed by appropriate statistical testing and are illustrated in Tables 3 and 4 following this section. The relationship of the independent variable RSI to the continuous dependent variable of PPLOS was analyzed by the independent samples t-test. The mean score for the log transformed-dependent variable PPLOS was significantly lower among study participants who had their surgical intervention within one day (RSI) \( (M=.66, SD=.28) \) compared to those study participants who did not have RSI \( (M=.73, SD=.28) \), \( t(1,968)=-5.69, p<.001 \). The effect size for this analysis was measured with the Cohen’s \( d \) test, \( d = 0.25 \) indicating a small to medium magnitude of effect of RSI on PPLOS.

Pearson product-moment correlation coefficients were computed to assess the relationships between the covariate variable MCS and the dependent variable of PPLOS TC. There was a positive correlation between the MCS and PPLOS, \( (r = 0.35, n = 1,970, p = .001) \). These results indicate that there is a significant (small to moderate effect size) correlation between the predictor and dependent variables, representing that higher (greater age and more comorbidities) MCS scores of the study subjects were correlated to longer PPLOS in the subjects.
The relationship of the covariate variable gender to the dependent variable of PPLOS was analyzed by independent samples t-test. The mean score for the log-transformed dependent variable PPLOS was significantly lower among study participants who were female \((M=.67, SD=.27)\) compared to those study participants who were male \((M=.76, SD=.29)\), \(t(668)=-5.57, p<.001\). The effect size for this analysis was measured with the Cohen’s d test, \((d = 0.32)\) indicating a medium magnitude effect of gender on PPLOS.

The relationship of the covariate variable race to the dependent variable of PPLOS was analyzed by independent samples t-test. The mean score for the log-transformed dependent variable PPLOS was not significantly different among study participants who were Caucasian \((M=.69, SD=.28)\) compared to those study participants who were other races \((M=.70, SD=.31)\), \(t (1,968)= -.48, p = .63\). Therefore, the variable race will not be included in the multivariate analysis.

A one-way between subjects ANOVA was conducted to compare the effect of fracture sites (upper body, lower leg, and femur/hip) on the log-transformed dependent variable of PPLOS. There was a significant effect of fracture site (Fx Site) on PPLOS among the three conditions \(F(2, 1,967) = 147.07, p <.001\). A Bonferroni post hoc test indicated that the score for femur/hip \(M =.73, (SD=.26)\) was significantly higher \(p <.001\) than the scores for upper body \(M=.42, (SD=.30)\) and lower leg \(M=.42 (SD=.30)\). There was no significant difference in the scores of the upper body and lower leg \(p = 1.00\). The \textit{Eta-squared} = .04 indicating a small to medium effect size of fracture site on PPLOS.
Table 3: Bivariate Analyses of PPLOS by RSI, Gender, and Fx Site
(N = 1,970)

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>n</th>
<th>MEAN (SD)</th>
<th>t/F (df)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Independent Variable</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RSI within one day</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1,035</td>
<td>.66 (.28)</td>
<td>-5.69 (1,968)</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>No</td>
<td>935</td>
<td>.73 (.28)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Covariate Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1,531</td>
<td>.67 (.27)</td>
<td>-5.58 (668)</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Male</td>
<td>439</td>
<td>.76 (.29)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fracture Site**</td>
<td>1,970</td>
<td>147.06 (2/1,967)</td>
<td>p &lt; .001</td>
<td></td>
</tr>
<tr>
<td>Upper Body</td>
<td>199</td>
<td>.42 (.30)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower Leg</td>
<td>44</td>
<td>.42 (.30)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Femur/Hip</td>
<td>1,727</td>
<td>.73 (.26)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: log-transformation of variables to meet parametric assumptions
**Bonferroni post hoc test indicated the mean scores for femur/hip were significantly higher than those for upper body and lower leg. There was no significant difference in the mean scores of upper body and lower leg.

Table 4: Bivariate Analysis of PPLOS and MCS
(N = 1,970)

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>Modified Charlson Score</th>
<th>Post-Procedure Length of Stay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modified Charlson Score</td>
<td>--</td>
<td>.352**</td>
</tr>
<tr>
<td>Post-Procedure Length of Stay</td>
<td>.352**</td>
<td>--</td>
</tr>
</tbody>
</table>

**Correlation is significant at the <.001 level (2-tailed)
Note: log-transformation of variables to meet parametric assumptions

Total In-Hospital Charges

The relationship of the independent variable RSI, the covariate continuous variable MCS, and the categorical covariate variables gender and fracture site to the dependent variable of in-hospital total charges (TC) were analyzed by appropriate statistical testing and are illustrated at the end of this section in Tables 5 and 6. The mean score for the log-transformed dependent variable of TC was significantly lower among study participants who had the RSI (M=4.73, SD=.21), compared to those study participants who did not have RSI, (M=4.86, SD=.19), t (1,976)= -14.15, p<.001. The
effect size for this analysis was measured with Cohen’s d, \( d = 0.64 \) indicating a medium to large magnitude of effect of RSI on TC.

There was a positive correlation between the MCS and TC \( (r = 0.39, n = 1,978, p = .01) \). These results indicate that there is a significant (small to moderate effect size) correlation between the independent and dependent variables, representing that higher (greater age and more comorbidities) MCS were correlated with greater total charges for the study subjects’ hospital admissions.

The relationship of the covariate variable gender to the dependent variable of TC was analyzed by independent samples t-test. The mean score for the log-transformed dependent variable of TC was significantly lower among study participants who were female \( (M=4.78, SD=.21) \), compared to those study participants who were male, \( (M=4.84, SD=.22) \), \( t(655) = -5.38, p<.001 \). The effect size for this analysis was measured with Cohen’s d, \( d = 0.30 \) indicating a small magnitude effect of gender on total charges.

The relationships of the covariate variable race to the dependent variable of TC was analyzed by independent samples t-tests. The mean score for the log-transformed dependent variable of TC was not significantly different among study participants who were Caucasian \( (M=4.80, SD=.21) \), compared to those study participants who were other races, \( (M=4.80, SD=.22) \), \( t(1,976) = -.636, p = .53 \). Because no significant relationship was demonstrated by the bivariate analysis, the covariate of race will not be included in the multivariate analysis for the dependent variable of TC.

A one-way between subjects ANOVA was conducted to compare the effect of fracture sites (upper body, lower leg, and femur/hip) on the log-transformed dependent
variable of TC. There was a significant effect of fracture site on total charges among the three conditions $F(2, 1,975) = 115.58, p < .001$. A Bonferroni post hoc test indicated that the score for femur/hip $M=4.82, (SD=.20)$ was significantly higher $p < .001$ than the scores for upper body $M=4.62, (SD=.24)$ and lower leg $M=4.79 (SD=.21)$. There was no significant difference in the scores of the upper body and lower leg $p = .12$. The $\eta^2 = .11$ indicating a large effect size of fracture site on total charges.

Table 5 Bivariate Analyses of Total Charges by RSI, Gender, and Fx Site
$(N = 1,979)$

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>n</th>
<th>MEAN (SD)</th>
<th>t/F (df)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Independent Variable</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RSI within one day</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1,039</td>
<td>4.73 (.21)</td>
<td>-14.15 (1,976)</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>No</td>
<td>939</td>
<td>4.86 (.19)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Covariate Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1,539</td>
<td>4.78 (.21)</td>
<td>-5.38 (655)</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Male</td>
<td>439</td>
<td>4.84 (.22)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fracture Site**</td>
<td>1,978</td>
<td></td>
<td>115.58 (2/1,977)</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Upper Body</td>
<td>203</td>
<td>4.62 (.24)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower Leg</td>
<td>44</td>
<td>4.79 (.21)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Femur/Hip</td>
<td>1,731</td>
<td>4.82 (.20)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: log-transformation of variables to meet parametric assumptions

** Bonferroni post hoc test indicated the mean scores for femur/hip were significantly higher than those for upper body and lower leg. There was no significant difference in the mean scores of upper body and lower leg.

Table 6 Bivariate Analysis of Modified Charlson Score and Total Charges
$(N = 1,979)$

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>Modified Charlson Score</th>
<th>In-Hospital Total Charges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modified Charlson Score</td>
<td>--</td>
<td>.388**</td>
</tr>
<tr>
<td>In-Hospital Total Charges</td>
<td>.388**</td>
<td>--</td>
</tr>
</tbody>
</table>

**Correlation is significant at the .01 level (2-tailed)**
Bivariate Analyses of the Categorical Dependent Variables

Mortality

The relationship of the independent variable RSI, the covariate continuous variable MCS, and the covariate categorical variables gender and fracture site to the dependent variable of in-hospital mortality (discharged alive or discharged not alive) were analyzed by appropriate statistical testing. The significant (p < .05) relationships are illustrated at the end of this section in Tables 7 and 8. The categorical independent variable RSI was analyzed with the Chi-square test and compared to the dependent categorical variable of mortality. The Chi-square analysis indicated that there was not a significant relationship between the RSI intervention and in-hospital mortality \( \chi^2(1, N=1,979) = 3.02, p = .08 \).

The relationships of the covariate log-transformed continuous variable MCS to the categorical dependent variable of mortality was analyzed by independent samples t-test. The mean score for the dependent variable mortality was significantly lower among study participants whose MCS was lower \( (M=.70, SD=.16) \), compared to those study participants whose MCS was higher \( (M=.81, SD=.14) \), \( t(1,977)=5.30, p<.001 \). The effect size for this analysis was measured with the Cohen’s d test, \( d = 0.77 \) indicating a medium to large magnitude of effect of MCS on mortality.

The covariate categorical variable of gender was analyzed with the Chi-square test and compared to the categorical dependent variable of Mortality. The Chi-square analysis indicated that there was a significant relationship between gender and in-hospital mortality \( \chi^2(1, N=1,979) = 4.56, p = .03 \). Female study subjects experienced in-hospital
mortality in 2.4% of hospitalizations compared to 4.3% of male study subjects. Magnitude was measured with the Cramer’s $V = .048$ indicating a minimal to small effect size.

The covariate categorical variable of race was analyzed with the Chi-square test and compared to the categorical dependent variable of mortality. The Chi-square analysis indicated that there was not a significant relationship between race and in-hospital mortality $\chi^2(1, N=1,979) = .073, p = .79$. Caucasian study subjects experienced in-hospital mortality in 2.9% of hospitalizations compared to 2.4% of study subjects of all other races. With no significant relationship discovered in the bivariate analysis, race will not be included in the multivariate analysis for mortality.

The categorical covariate variable of fracture site (Fx Site) was analyzed with the Chi-square test and compared to the dependent categorical variable of mortality. The Chi-square analysis indicated that there was not a significant relationship between Fx Site and in-hospital mortality $\chi^2(2, N=1,979) = 4.61, p = .100$. Study subjects with upper body fractures experienced 0.5% in-hospital mortality compared to 3.1% of study subjects with femur/hip fractures and 2.3% of study subjects with lower leg fractures. With no significant relationship discovered in the bivariate analysis, fracture site will not be included in the multivariate analysis for mortality.

### Table 7 Bivariate Analysis of Modified Charlson Score to In-Hospital Mortality

(N = 1,979)

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>n</th>
<th>MEAN (SD)</th>
<th>t (df)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td></td>
<td>5.30 (1,977)</td>
<td>p &lt; .001</td>
<td></td>
</tr>
<tr>
<td>Discharged Alive</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1,923</td>
<td>.70 (.16)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>56</td>
<td>.81 (.14)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 8 Bivariate Analysis of Gender to In-Hospital Mortality
(N = 1,979)

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>Discharged Alive</th>
<th></th>
<th></th>
<th>χ² (df)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>n</td>
<td>(%)</td>
<td>No</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1,502</td>
<td>97.6</td>
<td>37</td>
<td>2.4</td>
</tr>
<tr>
<td>Male</td>
<td>421</td>
<td>95.7</td>
<td>19</td>
<td>4.3</td>
</tr>
</tbody>
</table>

**p = .03

Pressure Ulcer

The relationship of the independent variable RSI, the covariate continuous variable MCS, and the covariate categorical variables gender and fracture site to the dependent variable of in-hospital development of pressure ulcer were analyzed by appropriate statistical testing. The significant (p <.05) relationships are illustrated at the end of this section in Tables 9 and 10. The Chi-square analysis of the independent variable of RSI and the in-hospital development of pressure ulcer indicated that there was a significant relationship between the RSI intervention and the development of pressure ulcer $\chi^2(1, \text{N}=1,979) =11.07, p = .001$. Subjects who received the intervention of RSI were less likely to develop a pressure ulcer. Subjects in this study who received the RSI developed pressure ulcers in 1.1% of their hospitalizations as compared to 3.2% of subjects whose surgical intervention was delayed beyond one day. Magnitude was measured with Cramer’s V (which in a 2x2 Chi-square table is equal to the Phi), Cramer’s V = .08 indicating a minimal to small effect size (Pallant, 2013).

The relationships of the covariate log transformed continuous variable MCS to the dependent categorical variable of pressure ulcer was analyzed by independent samples t-test. The mean score for the dependent variable of in-hospital development of pressure...
ulcer was significantly lower among study participants whose MCS was lower (M=.70, SD=.16), compared to those study participants whose MCS was higher, (M=.76, SD=.15), t(41.97)=2.52, p =.02). The effect size for this analysis was measured with Cohen’s d, (d = 0.38) indicating a small magnitude effect of MCS on the development of pressure ulcer during hospitalization.

The covariate categorical variable of gender was analyzed with the Chi-square test and compared to the dependent categorical variable pressure ulcer. The Chi-square analysis of the covariate variable of gender and the in-hospital development of pressure ulcer indicated that there was a significant relationship between gender and the development of pressure ulcer $\chi^2(1, N=1,979) =14.07, p < .001$. Female subjects in this study developed pressure ulcer in 1.4% of their admissions compared to males who developed pressure ulcer in 4.3% of their admissions. Magnitude was measured by Cramer’s V = .08 indicating a minimal to small effect size.

The covariate categorical variable of race was analyzed with the Chi-square test and compared to the dependent categorical variable pressure ulcer. The Chi-square analysis of the covariate variable of race and the in-hospital development of pressure ulcer indicated that there was not a significant relationship between race and the development of pressure ulcer $\chi^2(1, N=1,979) =2.78, p = .096$. Caucasian subjects in this study developed pressure ulcer in 2.2% of their admissions compared to all other races who developed pressure ulcer in 0% of their admissions. With no significant relationship discovered in the bivariate analysis, race will not be included in the multivariate analysis for mortality.
The categorical covariate variable of fracture site (Fx Site) was analyzed with the Chi-square test and compared to the dependent categorical variable pressure ulcer. The Chi-square analysis of the covariate variable of Fx Site and the in-hospital development of pressure ulcer indicated that there was not a significant relationship between Fx Site and the development of pressure ulcer $\chi^2(2, N=1,979) = 5.97, p = .051$. Study subjects with upper body fractures experienced zero percent in-hospital pressure ulcer compared to 2.4% of study subjects with femur/hip fractures, and 2.1% of study subjects with lower leg fractures. With no significant relationship discovered in the bivariate analysis, fracture site will not be included in the multivariate analysis for pressure ulcer.
**Table 9 Bivariate Analysis of Modified Charlson Score to Pressure Ulcer**
(N = 1,979)

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>n</th>
<th>MEAN (SD)</th>
<th>t (df)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure Ulcer</td>
<td></td>
<td>2.52 (41.97)</td>
<td>p = .016</td>
<td></td>
</tr>
<tr>
<td>Developed in hospital</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>41</td>
<td>.76 (.15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1,938</td>
<td>.70 (.16)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 10 Bivariate Analysis of RSI, Gender and Fx Site to Pressure Ulcer**
(N = 1,979)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pressure Ulcer Developed in Hospital</th>
<th>( \chi^2 ) (df)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>RSI</strong></td>
<td>11</td>
<td>1,028</td>
</tr>
<tr>
<td>Yes</td>
<td>11</td>
<td>1,028</td>
</tr>
<tr>
<td>No</td>
<td>30</td>
<td>910</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>22</td>
<td>1,517</td>
</tr>
<tr>
<td>Male</td>
<td>19</td>
<td>421</td>
</tr>
<tr>
<td><strong>Fx Site</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Body</td>
<td>0</td>
<td>203</td>
</tr>
<tr>
<td>Lower Leg</td>
<td>0</td>
<td>44</td>
</tr>
<tr>
<td>Femur/Hip</td>
<td>41</td>
<td>1,691</td>
</tr>
</tbody>
</table>

* \( p = .001 \), ** \( p < .001 \), *** \( p = .051 \)

**Delirium**

The analyses for the dependent variable of delirium (DEL) were performed on 1,979 study subjects. Of those 1,979 subjects, 125 were coded as developing delirium during their hospitalization that was not associated with delirium or dementia present on admission. The analyses were performed with the same procedures as the other categorical dependent variables. The results indicated that none of the independent or covariate variables had a significant relationship to the dependent variable of delirium. The independent categorical variable RSI was analyzed with the Chi-square test and compared to the dependent categorical variable of Delirium. The Chi-square analysis
indicated that 5.8% of study participants who had RSI developed delirium compared to 6.9% of study subjects who did not have an RSI. There was not a significant relationship between the RSI intervention and the in-hospital development of delirium $\chi^2(1, N=1,979) = 1.08, p = .30$.

The results of the T-test analysis for MCS and delirium indicated that the mean scores of the MCS variable were not different for those study participants who did not develop delirium during hospitalization ($M=.70, SD=.16$), compared to those who did develop delirium during their hospitalization ($M=.72, SD=.17$), $t(1,977)=1.79, p =.30$.

The categorical covariate variable of gender was analyzed with the Chi-square test and compared to the dependent categorical variables of Delirium. The Chi-square analysis indicated that there was not a significant relationship between gender and the in-hospital development of delirium $\chi^2(1, N=1,979) = .24, p =.62$. Female study subjects developed in-hospital delirium at a rate of 6.2% compared to a rate of 6.8% for male study subjects.

The Chi-square analysis of the covariate variable of race and the in-hospital development of delirium indicated that there was not a significant relationship between race and the development of delirium $\chi^2(1, N=1,979) =2.62, p = .11$. Caucasian subjects in this study developed delirium in 6.1% of their admissions compared to all other races who developed delirium in 9.8% of their admissions.

The Chi-square analysis of the covariate variable of Fx Site and the in-hospital development of delirium indicated that there was not a significant relationship between Fx Site and the development of delirium $\chi^2(2, N=1,979) =2.74, p = .25$. Study subjects with upper body fractures experienced 4.4% in-hospital delirium compared to 6.6% of
study subjects with femur/hip fractures, and 2.3% of study subjects with lower leg fractures.

**Multivariate Analyses**

**Analysis of the Significant Independent Variable and Covariate Variables to PPLOS**

Bivariate analyses indicated that the independent variable RSI and the covariate variables of MCS, gender, and fracture site were significantly related to post-procedure (surgical intervention) length of stay PPLOS. Therefore, a multiple linear regression was used to test the significance and contribution of the independent variable RSI and the covariate variables of the MCS, gender, and fracture site on the study subjects’ PPLOS. Results indicated that the overall model was statistically significant $F(5, 1,964)=103.60$, $p < .001$. The model explained approximately 20% ($R=.457, R^2=.209, adjusted R^2=.207$) of the variance in the dependent variable of PPLOS (Pallant, 2013).

The individual predictor results indicated that subjects with fracture sites of the upper body ($B= -.24, SE=.02, \beta= -.26, p<.001$) and the lower leg ($B= -.22, SE=.04, \beta= -.11, p< .001$) had significantly lower PPLOS than subjects whose fractures were of the femur or hip. Lower lengths of stay were also shown for study subjects who received RSI ($B= -.03, SE=.01, \beta= -.05, p=.02$) and for subjects who were female ($B= .05, SE=.01, \beta= .07, p< .001$). Higher PPLOS was associated with study subjects who had higher Modified Charlson scores ($B= .47, SE=.04, \beta= .26, p< .001$). The Beta squared value of the MCS (.076), identified it as the highest contributor to the overall model at approximately 7% (Pallant, 2013).
Table 11 Multiple Linear Regression Analysis of Rapid Surgical Intervention, Modified Charlson Score, Gender, and Fracture Site to Post-Procedure Length of Stay (N = 1,970)

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>B</th>
<th>SE</th>
<th>β</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSI</td>
<td>-0.03</td>
<td>0.01</td>
<td>-0.05</td>
<td>= .02</td>
</tr>
<tr>
<td>MCS</td>
<td>0.47</td>
<td>0.04</td>
<td>0.26</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Gender</td>
<td>0.05</td>
<td>0.01</td>
<td>0.07</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Fx Site</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Femur/Hip (Reference Group)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Body</td>
<td>-0.24</td>
<td>0.02</td>
<td>-0.26</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Lower Leg</td>
<td>-0.22</td>
<td>0.04</td>
<td>-0.11</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

* For model: $R^2 = .209$, adjusted $R^2 = .207$, $F(5, 1,964) = 103.60$, $p < .001$

Analysis of the Significant Independent Variable and Covariate Variables to TC

Bivariate analyses indicated that the independent variable RSI and the covariate variables of MCS, gender, and fracture site were significantly related to TC. Therefore, a multiple linear regression was used to test the significance and contribution of the independent variable RSI and the covariate variables of the MCS, gender, and fracture site on the study subjects’ total charges. Results indicated that the overall model was statistically significant $F(5, 1,972) = 135.39$, $p < .001$. The model explained approximately 25% ($R = .506$, $R^2 = .256$, adjusted $R^2 = .254$) of the variance in the dependent variable of TC (Pallant, 2013).

The individual predictors results indicated that subjects with fracture sites of the upper body ($B = -0.13$, $SE = 0.014$, $β = -0.19$, $p < .001$) and the lower leg ($B = -0.17$, $SE = 0.03$, $β = -0.11$, $p < .001$) had significantly lower TC than subjects whose fractures were of the femur or hip. Lower lengths of stay were also indicated for study subjects who received RSI ($B = -0.10$, $SE = 0.01$, $β = -0.23$, $p < .001$) and for subjects who were female ($B = 0.03$, $SE = 0.01$, $β = 0.06$, $p = .002$). Higher TC were associated with study subjects who had higher
Modified Charlson scores ($B = .38, SE = .03, β = .28, p < .001$). The Beta squared value of the MCS (.09), identifies it as the highest contributor to the overall model at approximately 9%. The Beta squared value of (.05) for the independent variable of RSI indicates it as the second strongest contributor to the model at 5% (Pallant, 2013).

Table 12 Multiple Linear Regression Analysis of Rapid Surgical Intervention, Modified Charlson Score, Gender, and Fracture Site to Total In-Hospital Charges
(N = 1,979)

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>B</th>
<th>SE</th>
<th>β</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSI</td>
<td>-.10</td>
<td>.01</td>
<td>-.23</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>MCS</td>
<td>.38</td>
<td>.03</td>
<td>.28</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Gender</td>
<td>.03</td>
<td>.01</td>
<td>.06</td>
<td>= .002</td>
</tr>
<tr>
<td><strong>Fx Site</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Femur/Hip (Reference Group)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Body</td>
<td>-.13</td>
<td>.01</td>
<td>-.19</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Lower Leg</td>
<td>-.17</td>
<td>.03</td>
<td>-.11</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

* For model: $R^2 = .256$, adjusted $R^2 = .254$, $F(5, 1,972) = 135.39$, $p < .001$

Analysis of the Significant Independent Variable and Covariate Variables to Mortality

Bivariate analyses indicated that the covariate variables of the MCS and gender were significantly related to the study subjects’ in-hospital mortality. A binary logistic regression was performed to test the significance and impact of the MCS and of gender on the dependent variable mortality. The full model containing the two predictors was statistically significant $\chi^2(2, N = 1,979) = 31.46, p < .001$. The model as a whole explained between 1.6% (Cox & Snell R square) and 6.9% (Nagelkerke R square) of the variance in mortality (Pallant, 2013), and correctly classified 97.2% of the cases. Only one of the predictor variables, the MCS, made a unique statistically significant contribution to the model. The odds ratio for MCS ($OR = 143.31$) indicated that study subjects with higher MCS were more likely to die. The large confidence interval (95%
CI = 20.25-1014.41) may indicate this as an unstable finding. The confidence interval value is a reflection of the 95% possibility of the range of the true value of the OR in the population and should guide interpretation of the results from the sample (Pallant, 2013). The wide variation in the CI indicates a broad number of possible true values in the population.

**Table 13 Binary Logistic Regression Analysis for Mortality**  
(N = 1,979)

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>B (SE)</th>
<th>Wald</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>.35 (.26)</td>
<td>1.41</td>
<td>1.42 (.80 – 2.53)</td>
</tr>
<tr>
<td>Modified Charlson Score</td>
<td>4.97 (.10)</td>
<td>24.73</td>
<td>143.31 (20.25 – 1,014.41)*</td>
</tr>
</tbody>
</table>

*Note: for Model χ²(2)= 31.46, p= .235, *p< .001

**Analysis of the Significant Independent Variable and Covariate Variables to Pressure Ulcer**

Bivariate analyses indicated that the independent variable of RSI and the covariate variables of the MCS and gender were significantly related to the study subjects’ in-hospital development of pressure ulcer. A binary logistic regression was performed to test the significance and impact of the RSI, the MCS, and gender on the dependent variable pressure ulcer. The full model containing the predictors was statistically significant χ²(3, N= 1,979)= 24.09, p< .001. The model as a whole explained between 1.2% (Cox & Snell R square) and 6.6% (Nagelkerke R square) of the variance in pressure ulcer development (Pallant, 2013), and correctly classified 97.9% of the cases. The independent variable of RSI and the covariate of gender both made a unique statistically significant contribution to the model. The odds ratio for RSI (OR= .37, 95% CI= .18-.75) indicated that study subjects who did not receive the RSI were 2.7 times
more likely to develop a pressure ulcer. Male study subjects were 2.7 times more likely to develop a pressure ulcer than female subjects (OR = 2.75, 95% CI = 1.46-5.18). These relatively narrow confidence intervals indicate stable findings, indicating that the OR from the population closely resembles that of the sample.

Table 14 Binary Logistic Regression for Pressure Ulcer with RSI, MCS, and Gender (N = 1,979)

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>B (SE)</th>
<th>Wald</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapid Surgical Intervention</td>
<td>-.10 (.36)</td>
<td>7.67</td>
<td>.37 (.19 - .75)</td>
</tr>
<tr>
<td>Modified Charlson Score</td>
<td>1.53 (1.08)</td>
<td>2.01</td>
<td>4.62 (.56 – 38.28)*</td>
</tr>
<tr>
<td>Gender</td>
<td>1.01 (.32)</td>
<td>9.79</td>
<td>2.75 (1.46 – 5.18)**</td>
</tr>
</tbody>
</table>

Note: for Model $\chi^2(3) = 24.09$, $p = .006$, *$p = .156$, **$p = .002$

**SUMMARY OF FINDINGS**

The analyses of the data were designed to provide answers to the research questions of interest. The research questions are:

1. What is the relationship between rapid surgical intervention for the geriatric fragility fracture population and their in-hospital outcomes?
2. Which patient characteristics (combined age and comorbidity score, race, gender, fracture site) predict outcomes (length of stay, charges, complications, mortality) for patients with rapid and without surgical intervention (RSI)?
3. Does the proxy score for the severity of illness (MCS) on admission influence the outcomes (length of stay, charges, complications, mortality) for patients with and without rapid surgical intervention?
4. Is there a difference in outcomes (length of stay, charges, complications, mortality) for patients between RSI (surgery in < 24 hours) and non-RSI (surgery in > 24 hours) by fracture site (hip versus all other sites)?

5. Does RSI reduce negative outcomes and charges for geriatric patients with fragility fractures (covaried by MCS, race, gender, and fracture site)?

**RSI and Covariates on Post Procedure Length of Stay**

In order to better isolate the influence of the independent variable of rapid surgical intervention (RSI) on the dependent variables of interest, each study subject’s state of health on admission to the hospital was approximated through the application of the Modified Charlson Index score (MCS). This MCS became a continuous predictor variable in the analysis. The other predictors of interest were the categorical variables of gender, race, and fracture site. This study was designed to describe relationships between these predictors and the dependent variables of interest of post-procedural length of stay (PPLOS), total in-hospital charges (TC), in-hospital mortality, the in-hospital development of delirium, and the in-hospital development of pressure ulcer.

Bivariate analyses were performed between all the predictor variables and each of the dependent variables of the study. For the dependent variable of PPLOS the predictors of significance from the bivariate analyses were the study subjects’ MCS, their gender, the fracture site, and RSI as illustrated in Figure 3 below.
116

RSI and Covariates on Total Charges

For the dependent variable of TC the predictors of significance from the bivariate analyses were the study subjects’ MCS, their gender, the fracture site, and RSI as illustrated in Figure 4. These results, which are almost identical to the results from the PPLOS analysis, may in part, be due to the general relationship of overall length hospital stay to total hospital charges.
Covariates Modified Charlson Index Score (MCS) and Gender on Mortality

For the dependent variable of mortality, the predictors of significance from the bivariate analyses between all the independent and covariate variables were the study subjects’ MCS and their gender. This is illustrated in Figure 5 below.

![Diagram for Mortality]

Figure 5 Bivariate Analysis Mortality

Rapid Surgical Intervention (RSI) and Covariates on Pressure Ulcers

For the dependent variable of pressure ulcer, the predictors of significance from the bivariate analyses were the study subjects’ MCS, their gender, and RSI. Fracture site approached significance at \( p = .051 \). These are illustrated in Figure 6 below.

![Diagram for Pressure Ulcer]

Figure 6 Bivariate Analysis Pressure Ulcer
Non-Predictors (Race)

The study subjects’ race was not found to be statistically significantly related to any of the dependent variables. None of the non-significantly related predictor variables were included in the regression models for the dependent variables of PPLOS, TC, mortality, and pressure ulcer. Also important to record here, is that the independent variable of RSI was not, and none of the covariate variables of MCS, gender, or fracture, were significantly related to the dependent variable of delirium in the bivariate analyses. Therefore, as the study progressed to the multivariate level of analysis, further analysis on their relationships to delirium were not pursued.

Multivariate Predictors

The multivariate analyses of linear regression for the continuous variables of PPLOS and TC informed the researcher that for PPLOS, RSI, MCS, gender, and fracture site all significantly contributed to the overall model. The PPLOS model reflected approximately 20% of the difference in PPLOS between the RSI and non-RSI population. MCS was the strongest predictor of a longer PPLOS and fracture site of the upper body was the strongest contributor to a shorter PPLOS. The data responded in a similar, but not exactly the same, manner for the dependent variable of TC. The TC model reflected approximately 25% of the difference in TC between the RSI and non-RSI population. RSI, MCS, gender, and fracture site also were all statically significant contributors. For TC, MCS was the strongest predictor of higher charges. An important difference is that the RSI was the strongest contributor variable to lower overall in-hospital charges (TC).

The binary logistic regression analyses of the remaining categorical dependent variables of in-hospital mortality and the development of pressure ulcers did not have
similar outcomes. The mortality model reflected between 1.6% and 6.9% of the factors influencing in-hospital mortality as measured by the Cox & Snell R square and the Nagelkerke R square tests. The only predictor variable that was significantly related to the outcome of mortality was the MCS; higher MCS was related to higher mortality rates but the confidence interval from the odds ratio was large (95% CI = 20.2-1,014.41) indicating this finding as unstable.

The results of the model for the dependent variable of pressure ulcer development were interesting. The model accounted for between 1.2% and 6.6% of the factors influencing pressure ulcer development. Although bivariate analysis indicated that MCS, RSI, and gender were significant predictors, in the regression model only RSI and gender achieved statistical significance. Males were 2.7 times more likely than females to develop a pressure ulcer (95% CI = 1.46-5.18) and study subjects who received RSI were 2.7 times less likely to develop a pressure ulcer than subjects who did not receive a surgical intervention in one day (95% CI = .18-.75).

**Conclusion**

In conclusion, the independent variable of RSI was a statistically significant predictor of lower post-procedure length of stays, lower total inpatient hospital charges, and lower rates of in-hospital development of pressure ulcer. High scores on the Modified Charlson Index, incorporating the study subjects’ ages and comorbidities upon admission, were predictive of higher mortality rates, longer lengths of stay and higher total charges. Gender was significant for higher lengths of stay, total charges and more frequent pressure ulcer development in males. The analyses of fracture sites indicated that femur/hip fractures were significantly related to longer lengths of stay and higher
total in-hospital charges than upper body or lower leg fractures, but not a predictor of mortality or pressure ulcer development.

Overall, the data results support the rejection of the null hypothesis that RSI has no relationship to in-hospital patient outcomes. The null hypothesis that age had no relationship to patient outcomes was not directly tested, as it was included into the MCS; however, the MCS was influential in all patient outcomes except pressure ulcer development. Gender was significant for males having higher lengths of stay, charges, and pressure ulcers therein rejecting the null that they were not related. The null hypothesis can be rejected for PPLOS and charges by fracture site but supported for pressure ulcer and mortality outcomes. Finally, the null hypothesis that race was not related to the outcomes of interest was accepted due to the lack of any statistically significant findings in the bivariate analyses between race and the dependent variables.

The significance level for all analyses was set at $p < .05$. Important to note, considering the large sample size, is that the significance levels between the RSI and the dependent variables were all well below that level. This finding supports confidence in the inferences based on these results.
CHAPTER 5
DISCUSSION, LIMITATIONS, AND RECOMMENDATIONS

Discussion

This secondary data analysis (SDA) study used the comparative effectiveness research method to investigate different delivery models for an efficacious medical treatment regimen (surgical repair for fractures). The research investigated, within the real clinical world, whether rapid surgical intervention (RSI) in the geriatric fracture population was a more effective method of surgical intervention delivery (Morton & Ellenberg, 2012; Stubenrauch, 2009) than usual care models. The comparative effectiveness research method was enhanced in this study by applying a validated risk stratification scoring, the Modified Charlson Index (Charlson et al., 1994; Deyo et al., 1992; D’Hoore et al., 1996) to the sample study subjects. Applying the Modified Charlson Index score (MCS) assisted in reducing some of the variation that is inevitable in research based in the context of the practice environment by incorporating patients’ age and health status into the analyses. Specifically, this study compared the usual care process of extensive pre-operative examinations to a change in the care delivery process, RSI that brought the patient to surgery within 24 hours of arrival. Based on previous literature on the topic, economic impact variables and selected clinical results were chosen for the evaluation of their relationship to the RSI intervention.

This study is based in the microsystem of hospital processes and clinical care decisions for hospital patients. Regardless of macro or micro levels, once Health Services Research and CER studies report positive or negative relationships between variables, and if those relationships can be quantified, healthcare practitioners,
administrators, and policy makers can make informed decisions (Committee on Comparative Effectiveness Research Prioritization Institute of Medicine, 2009). In this instance, implementing the pre-operative steps for RSI, there are certain clinical risks to the patient and economic risks to the hospital. Implementing RSI is expensive; it requires a high degree of responsiveness and collaboration among physicians, it uses expensive resources, and necessitates the coordination of operative suite availability. These are in addition to the critical assessment, the clinical management, and the oversight needed in order to safely treat the patient. RSI’s success depends on intense care coordination by nursing, because care regimens need to be implemented in parallel not sequential paradigms, while the patients’ responses are monitored, managed, and communicated (Care Coordination Measures Atlas | Agency for Healthcare Research & Quality AHRQ.). If these investments are related to improved outcomes, the new processes can become usual care. Then when practitioners know whether the patient received an RSI, and if research has informed them of possible outcome consequences, improved care decisions can be customized to achieve the best clinical outcomes.

For the geriatric fracture population, based on their clinical presentation, co-morbidities, and medications, the pre-operative period may involve rapid reversal of anticoagulation, fluid resuscitation, cardiac function optimization, or infection risk reduction. This is in addition to the coordination of physicians and operative suite scheduling. Based on the relationships between RSI and post-procedure outcomes, nursing would be essential to customize pressure ulcer prevention measures for the patient, as well as planning other appropriate recovery measures (Cho et al., 2009;
Rapid Surgical Intervention Impact and Related Variables

The study found that RSI was associated with lower post-procedure lengths of stay (PPLOS), lower total charges (TC), and lower rates of in-hospital pressure ulcer development. The economic implications of those findings may support the investments needed to implement RSI programs in hospitals that do not yet treat geriatric fracture patients with RSI. The finding that RSI was related to lower pressure ulcer development confirms similar results reported by Al-Ani, et al. (2008), Baumgarten, et al. (2012) and Beaupre, et al. (2005) and contribute to the growing body of research that endorses RSI as an effective contributor to reducing the incidence of pressure ulcer. This knowledge can alert nursing to the increased vulnerability of patients who did not receive RSI and inform customized care to focus additional preventative measures to that population.

The analysis for this study did not find RSI significantly related to in-hospital mortality (p. = .082) and therefore the independent variable (RSI) was not included in the final regression model for mortality. These findings add to the literature by including all geriatric fracture sites, but not to any conclusions on the topic of RSI and mortality. Hip fracture researchers have continued to report differing findings. Holvik and colleagues reported a 23.5% overall mortality rate one-year post hip fracture and noted wide variation influenced primarily by age, gender and admission from a nursing home, but not related to time from admission to surgery (Holvik et al., 2010). Grimes and associates studied 8,383 hip fracture patients during their hospitalization and for 30 days post discharge. They also reported no relationship between RSI and mortality (Grimes et
Elliot and colleagues reported however, that moderate and high risk patients in their study would have had lower one-year mortality rates if the surgeries had been performed within 24 hours of admission (p. < .001) (Elliott et al., 2003). While the findings from this sample are not significant with the alpha set at <.05, they ought to be interpreted cautiously. The length of time from surgery to discharge may be too short for the complete effects of RSI or no RSI to become apparent. The factors influencing mortality are complex and may be affected by factors set in motion during the patient’s hospitalization, but further study is needed to determine any unequivocal conclusions for the outcome of mortality.

Higher scores on the MCS were positively related to longer PPLOS, and higher TC and mortality rates. These findings support the intuitive clinical perspective that greater age and more (risk-stratified) comorbid conditions would contribute to longer lengths of stay (higher costs) and increased risk of mortality. This research excluded a prior challenge to the influence of RSI and length of stay by computing both the MCS and the PPLOS. First, by computing and including the MCS, the study accounted for challenges in the literature that patients who were older or sicker on admission had longer pre-surgical lengths of stay and thereby longer total lengths of stay. Then secondly, statistical analyses were applied to just the duration of a patient’s stay after the surgical procedure (PPLOS) while adjusting for the baseline severity of illness for each study subject through the addition of the MCS in the linear regression.

The findings that male study subjects were more likely to develop pressure ulcer and had higher lengths of stay and charges is consistent with results reported elsewhere (Bass et al., 2007; Hommel et al., 2008). Under the auspice of CER, this replication of
findings in different populations contributes to the dependability of information that clinicians require in order to change practice based on research. For policy-makers, if these findings were further validated, reimbursement adjustments might be considered based on gender. More specifically, when nurses customize care for male geriatric fracture patients they can have a heightened sensitivity to the possibility of pressure ulcer development.

One of the unique interests in this research was to investigate the outcomes of concern by variations in fracture site. The literature had addressed the outcomes for hip fracture patients and this researcher desired to begin a dialog that included all fracture sites. For this study’s 1,979 subjects, there was a significant difference between the PPLOS and TC for femur/hip sites compared to fractures of the upper body and lower leg. These findings were significant in the linear regression when adjustments for MCS, gender, and RSI were included. These results are of interest for reimbursement and hospital volume and length of stay planning based on diagnoses. More noteworthy may be that fracture site was not significant for predicting which subjects would develop pressure ulcer (p. = .051) or experience an in-hospital mortality (p. = .1). The sample sizes for the three groups were not equal with 10.3% having upper body fractures, 2.2% having lower leg fractures and 87.5% having femur/hip fractures. These frequency differences are not unexpected because many upper body (arm and shoulder) and lower leg fractures can be repaired without an inpatient hospitalization. These results should be considered with caution because the results did approach significance. Further study into this outcome is recommended, perhaps a larger and more diverse sample would have different results, and perhaps studying the outcomes of pressure ulcer and mortality in the
geriatric fracture population after hospital discharge would reveal results that were not evident during the brief hospital period.

Race, categorized in this study as Caucasian or not Caucasian, was not a major focus of this research and was not found to be a significant predictor of any of the dependent variables of PPLOS, TC, mortality, pressure ulcer, or delirium. Fragility fractures are most common in Caucasian females in the post-menopausal period; however, occurrence variations were not explained by race-specific differences in bone densities when skeletal size was accounted for in analysis by Cummings and Melton (2002). It is possible that the unequal distribution 93.8% were coded as Caucasian and 6.2% as any other race, contributed to the lack of findings. The sample did not represent the reported race distribution for the geographical areas of the study hospitals. It is unknown at present whether the difference is due to more Caucasian people experiencing geriatric fractures or some discrepancy in coding race.

The clinical dependent variable of delirium was not found to be significantly related to any of the predictor variables of RSI, MCS, gender, race, or fracture site. In the study sample, only 6.3% of study subjects were coded with delirium that was not present on admission. This is a lower incidence than is reported in the literature. Rothschild and colleagues (2000) report delirium as one of the six most frequent preventable complications for older patients and Holly, Cantwell, and Jadotte (2012) report delirium as a frequent occurrence in intensive care units and post-surgical units. Nurses are considered the best profession to recognize delirium, however it is not well documented by nurses (Lemiengre et al., 2006; Rice et al., 2011), and these researchers recommend further education and assessment tools. Few hospitals support the identification of
delirium on admission with the use of validated assessment tools for delirium, and the syndrome itself is difficult to identify in part because it has varying presentations. The postoperative nurse, without an admission assessment tool to compare to the patients’ presentation, is subject to ignorance of the patient’s baseline and confusion about the observed symptoms. In addition, administrative database coding is driven by strict rules about sources and decision trees regarding financial reimbursement. Currently all codes that are entered into the SPARCS database must be based on physician documentation. The nurse may have identified the patient as having delirium, and the patient’s behavior may have warranted medication or other interventions, but unless the physician documented the diagnosis in the progress notes, problem lists or discharge summary, it cannot be coded. Further research is recommended into this important complication of care with a larger sample or a different research method.

Limitations

All administrative databases are subject to the vagrancies of human error, variations in documentation between practitioners, and the lack of clinical subtlety. The SPARCS database, in spite of its high degree of regulation and validity, is subject to these limitations. Until electronic documentation systems mature to the stage of clinical tools, and nursing interventions are included, secondary data analysis research will be limited to the accuracy and completeness of the particular database. The SPARCS database includes dates and not times of day; therefore, the measurement of the independent variable of RSI was restricted to days rather than the more sensitive measure of hours. Also, the RSI was converted to a categorical variable (yes or no) to answer the
research questions. Future research may consider measuring RSI as a continuous
variable to achieve a more detailed description of the impact of RSI on patient outcomes.

This study sample was limited to an analysis of data extracted from the SPARCS
databases of five hospitals from a two year and six month period between 2010 and 2013.
It included 1,979 sample subjects from two counties adjacent to a major metropolitan
area in New York State. The sample was predominantly Caucasian and female, the
demographic distributions of the sample may not match other areas of the U.S. or the
world; this may limit the generalizability of the results. In addition, two of the dependent
variables (delirium and pressure ulcer) had lower than expected incidences (Grimes et al.,
2002; Jaul, 2010; Lindholm et al., 2008; Rice et al., 2011; Rothschild et al., 2000). It is
unknown if these variables were under reported in the population, reflect changes in
practice and incidence, or whether a larger or different sample would have different
findings.

The dependent variable of total charges is an important economic indicator. The
systems of cost and charge accounting vary widely among institutions, and geographic
areas. Therefore, caution is recommended concerning the generalizability of the total
charges outcomes. It cannot be assumed that charges equal costs or reimbursements, or
that these findings would be replicable in a different hospital system or geographical area.
**Recommendations**

This research contributes to the body of knowledge regarding the relationship between RSI and clinical and economic outcomes. In this study’s sample, patients who underwent surgery within one day had lower lengths of stay, charges, and pressure ulcer development than patients whose surgery was not completed within one day at levels that exceeded the significance set at p < .05. No assumption of causality is made between RSI and those outcomes; the complexity of patients, treatments, contexts and methods demands much larger samples, and study over time than were possible in this research.

Future study could be enriched by expanding the number of dependent variables that were analyzed in relation to the independent variable RSI. Pneumonia and the development of thromboembolism are of particular interest in the geriatric population and considered sensitive to extended immobility. Information also could be enhanced by quantifying the impact on the economic dependent variables of PPLOS and TC. Most hospitals currently estimate revenue by patient discharges, and although that paradigm is changing as pay for performance and outcome methods are employed at the federal level, it is still valid to assume that reductions in lengths of stay should be quantified. For this study’s subjects, RSI, TC, and PPLOS were negatively related; however, those revenue savings were not quantified. Lastly, replication of this study is recommended, perhaps in urban and rural hospital settings and from a sample of academic health science centers.

In part, the intention of this study was to contribute to the body of nursing research that uses CER and SDA. These methods are not new to nursing; references were discovered in Polit and Hungler from 1978, and in 1989 Christine Kovner was writing about the advantages, difficulties, and database sources for large data research. In 2002,
an expert panel from the American Academy of Nursing recommended national databases as rich repositories and valid sources for knowledge generation (Lamb et al., 2004). Much progress has been made since then, and this researcher is indebted to the large database research from Titler (Titler, Dochterman, Xian-Jin et al., 2006; Titler et al., 2007), Dochterman (Dochterman et al., 2005), and others for leading the way to this method of research in nursing. Databases in the future will become even richer sources of information and it is a recommendation from this study that nursing continue to pursue SDA and CER as mainstream research methods. That will require advanced nursing education to include these methods in curricula alongside the more traditionally-taught qualitative and quantitative methods.

The coding system in the US is (in 2015) scheduled to undergo a dramatic upgrade to ICD 10. This will provide both opportunities and challenges to SDA researchers. The ICD 10 system provides an extensive level of detail in coding that is not available in the ICD 9 version (Canadian Institute for, 2001; Sundararajan et al., 2004; Sundararajan et al., 2007). This will provide more detailed and exact information for researchers. It will however, make any historical comparison, or prospective longitudinal tracking a challenge. Crosswalks will be developed but assumptions based across the two systems will need to be cautious.

The coding paradigms within administrative databases were developed for billing and follow rules that are based on the assumptions that only physicians could generate data for billing. As the contributions of team-based care mature from the realms of patient safety, and as electronic documentation systems become capable of attributing outcomes to disciplines and individuals, it is recommended that coding for discipline-
sensitive diagnoses, treatments, and complications be included in all administrative systems. If or when administrative databases include information from nursing and other disciplines’ documentation, they would become more useful and complete. Then nursing could engage in research supported by richer information sources that capture the necessary complexities of care and outcomes.

**Future Research**

It has always been essential in healthcare to establish the efficacy of treatment regimens. Science has striven to answer related questions through various methods, including the concept of randomized controlled trials (RCTs) that compared treatments between equivalent samples of subjects. Those methods however have been questioned concerning the ability to replicate findings in varied populations and the effectiveness of findings under real-life conditions. Additionally, many populations and clinical situations have been identified as not appropriate for the RCT design for practical and ethical reasons. In those and other instances, the Comparative Effectiveness Research (CER) model is frequently recommended (Berwick, 2005) as an adjunct or alternate to RCTs to investigate questions of interest. Utilizing the CER method to query large databases in secondary analyses, allows decision-makers to compare at least two alternate treatment or delivery models from large populations who experienced care in real life situations.

This comparative effectiveness research serves as an example of how secondary data analysis can answer high impact questions related to the outcomes from different treatment regimens. In this instance, rapid surgical intervention for the geriatric fracture population was related to shorter post-procedure lengths of stay, lower total charges, and
the development of fewer pressure ulcers during hospitalization. This study was an analysis of data that reflect real-life methods within the context of actual hospital care. The research studied outcomes for a population that was not conducive to the randomized clinical trial method and informed the complex questions important to clinician decision-making. Studies using larger data sets may help to further confirm best practices for time to surgery in this large and high-risk population and thereby support policymaking based on evidence from patient outcomes.
REFERENCES


doi:http://dx.doi.org.molloy.idm.oclc.org/10.1016/j.outlook.2012.06.021


Commission on Professional and Hospital Activities. (1986). Annotated ICD-9-CM International Classification of Diseases, 9th Revision, Clinical Modification,


doi:http://dx.doi.org.molloy.idm.oclc.org/10.1111/j.1524-4733.2009.00601.x


Patient-centered outcomes research | patient-centered outcomes research institute Retrieved from http://www.pcori.org/research-we-support/pcor/


PCORI adopts definition of patient-centered outcomes research | patient-centered outcomes research institute Retrieved from http://www.pcori.org/2012/marchboardmeeting/


November 27, 2013

Susan Dries, Ph.D, R.N., M.S.
Vice President, Quality Care Management
Good Samaritan Hospital Medical Center
1000 Montauk Highway
West Islip, NY 11795

Dear Ms. Dries,

This letter is to confirm our previous conversation stating that you have the permission of Catholic Health Services of Long Island (CHSLI) for the use of the HIPAA database from five member hospitals (GSHMC, SCH, SFH, SCL, & MMC) of CHSLI. This acknowledges that the data may be used as part of the Good Samaritan Hospital Medical Center performance improvement Genetic Pugwash Project Program, as well as your Ph.D. dissertation research.

It is understood that all the data will be protected from unauthorized disclosure, HIPAA rules will be observed, and that you are registered for Human Subjects Protection, Collaborative Institutional Training Initiative (CITI) Reference Number 2665516.

Sincerely,

[Signature]

Lynn Janelle Taylor, RN, CPIM, JD
SVP Risk, Patient Safety & Chief Privacy Officer
Catholic Health Services of Long Island
APPENDIX B: Human Subjects Approval IRB Molloy College

Date: March 4, 2014
To: Susan Dries
From: Kathleen Maurer Smith, PhD
Co-Chair, Molloy College Institutional Review Board
Veronica D. Feeg, PhD, RN, FAAN
Co-Chair, Molloy College Institutional Review Board

SUBJECT: MOLLOY IRB REVIEW AND DETERMINATION OF EXEMPT STATUS
Study Title: A Comparative Effectiveness Secondary Data Analysis: What are the Results of Rapid Surgical Intervention in the Hospitalized Geriatric Fracture Population?

Approved: March 4, 2014

Dear Nikki:

The Institutional Review Board (IRB) of Molloy College has reviewed the above-mentioned research proposal and determined that this proposal is approved by the committee. With your approval from Good Samaritan Hospital, it is deemed EXEMPT at Molloy College from the requirements of Department of Health and Human Services (DHHS) regulations for the protection of human subjects as defined in 45CFR46.101(b).

You may proceed with your research. Please submit a report to the committee at the conclusion of your project.

Changes to the Research: It is the responsibility of the Principal Investigator to inform the Molloy College IRB of any changes to this research. A change in the research may disqualify the project from exempt status.

Sincerely,

Kathleen Maurer Smith, PhD

Veronica D. Feeg, PhD, RN, FAAN
APPENDIX C: Human Subjects Approval IRB of the Health System

February 27, 2014

Dear Ms. Ores,

The research activity that you submitted to the institutional Review Board (IRB) entitled "A Comparative Effectiveness Secondary Data Analysis: What are the Results of Rapid Surgical Intervention in the Hospitalized Geriatric Frailty Fracture Population?" was reviewed by the Office of the IRB and determined to be exempt.

This research activity involving human subjects meets the criteria for Exempt Category #4: Research involving the collection or study of existing data, documents, records, pathological specimens or diagnostic specimens, when these sources are publicly available or when the information is recorded in such a manner that the subjects cannot be identified, directly or through identifiers linked to subjects.

It is understood that the medical record number will be converted to a neutral number to remove PHI, and dates of admission/discharge will be accessed but converted to length of stay in order to remove PHI, as indicated on IRB Form 7 (HIPAA Privacy Rule Requirements).

Please note that all research deemed exempt is subject to the same policies and ethical principles governing all research at the institution. You must inform the IRB if there are any changes or modifications made to this protocol as submitted.

If you have any questions regarding this decision please contact the IRB Office at 631-376-3093.

Sincerely yours,

Linda Reuter, M.S., C.I.P.
Administrator
Institutional Review Board
## APPENDIX D: Definitions and Crosswalk TO ICD-9 Codes AND UDS Codes

<table>
<thead>
<tr>
<th>TERM</th>
<th>DESCRIPTION</th>
<th>AVAILABLE IN SPARCS AS</th>
<th>CLARIFICATION</th>
<th>APPLICABLE CODES IN SPARCS</th>
<th>DOES SPARCS CONSIDER IT IDENTIFYING?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of stay (LOS)</td>
<td>Defined as the time of the in-patient hospital stay measured in days.</td>
<td>Date of Admission to Date of Discharge</td>
<td>None</td>
<td>Not Applicable (NA)</td>
<td>Yes</td>
</tr>
<tr>
<td>Post Procedure length of stay (PPLOS)</td>
<td>Defined as the time of the in-patient hospital stay measured in days; from the day of surgery to the day of discharge from the hospital.</td>
<td>Date of Surgery to Date of Discharge</td>
<td>Days from admission to surgery will be subtracted from total LOS in days.</td>
<td>NA</td>
<td>Yes</td>
</tr>
<tr>
<td>Emergency department arrival to surgical procedure start time</td>
<td>Will be measured in days from the date of patients’ presentation to the emergency department to the date of the surgical procedure.</td>
<td>Date of Admission to Date of Surgery</td>
<td>None</td>
<td>NA</td>
<td>Yes</td>
</tr>
<tr>
<td>Geriatric fragility fracture</td>
<td>Defined as a long bone or joint fracture that results from a low impact fall in a person who is 65 years old or older.</td>
<td>ICD 9 codes</td>
<td>Excluding spinal fractures and compression disc fractures</td>
<td>808.x, 810x, 811x, 812x, 813x, 820x, 821x, 822x, 823x, 824x</td>
<td>No</td>
</tr>
<tr>
<td>Surgical Intervention</td>
<td>Operative repair procedure</td>
<td>ICD 9 codes</td>
<td>None</td>
<td>79.x, 79.x, 79.x, 81.x, 81.x</td>
<td>Yes</td>
</tr>
<tr>
<td>Delirium</td>
<td>Defined as a disturbance of consciousness characterized by an acute onset, disorganized thinking, and a fluctuating course of inattention.</td>
<td>ICD 9 Codes</td>
<td>Delirium included as a complication only when not ‘Present on admission’ (NPOA)</td>
<td>290.x, 292.x, 293.x, 780.x</td>
<td>No</td>
</tr>
<tr>
<td>Pressure Ulcer</td>
<td>Defined as skin breakdown that develop over the body’s bony prominences in the presence of moisture, friction, shearing forces, and pressure</td>
<td>ICD 9 codes</td>
<td>All Stage ulcers included as a complication only when not ‘Present on admission’ (NPOA)</td>
<td>707.x,</td>
<td>No</td>
</tr>
<tr>
<td>Discharge Alive or Not Alive</td>
<td>In-Hospital Mortality</td>
<td>UDS codes</td>
<td>Expired Versus all others</td>
<td>UDS 20</td>
<td>No</td>
</tr>
<tr>
<td>Age</td>
<td>In HOD all ages below 65 were not included.</td>
<td>By date of birth but modified before</td>
<td>None</td>
<td>NA</td>
<td>Yes</td>
</tr>
<tr>
<td>TERM</td>
<td>DESCRIPTION</td>
<td>AVAILABLE IN SPARCS AS</td>
<td>CLARIFICATION</td>
<td>APPLICABLE CODES IN SPARCS</td>
<td>DOES SPARCS CONSIDER IT IDENTIFYING?</td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>------------------------</td>
<td>---------------</td>
<td>----------------------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>Sex</td>
<td>Gender as male or female</td>
<td>M or F</td>
<td>None</td>
<td>NA</td>
<td>No</td>
</tr>
<tr>
<td>Race</td>
<td>Will be delineated as Caucasian and non-Caucasian</td>
<td>Numbers</td>
<td>Caucasian= 100s All other races</td>
<td>NA</td>
<td>No</td>
</tr>
<tr>
<td>Comorbidity Score</td>
<td>Modified Charlson Index adapted for electronic databases and modified to include ages &gt; 80 years</td>
<td>No</td>
<td>Charlson Index based on co-morbidities coded on admission</td>
<td>ICD 9 codes used to determine the co-morbidity score.</td>
<td>No</td>
</tr>
<tr>
<td>Hospital Charges</td>
<td>In dollars</td>
<td>Dollars and cents</td>
<td>None</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
APPENDIX E: Table with ICD 9 Codes

<table>
<thead>
<tr>
<th>TERMS USED IN STUDY</th>
<th>ICD 9 CODES</th>
<th>DEFINITION OF ICD 9 CODES</th>
</tr>
</thead>
<tbody>
<tr>
<td>GERIATRIC FRAGILITY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FRACTURE</td>
<td>08.x</td>
<td>Fracture of pelvis</td>
</tr>
<tr>
<td></td>
<td>10.x</td>
<td>Fracture of clavicle</td>
</tr>
<tr>
<td></td>
<td>11.x</td>
<td>Fracture of scapula</td>
</tr>
<tr>
<td></td>
<td>12.x</td>
<td>Fracture of humerus</td>
</tr>
<tr>
<td></td>
<td>13.x</td>
<td>Fracture of radius and ulna</td>
</tr>
<tr>
<td></td>
<td>18.x</td>
<td>Fracture of arm</td>
</tr>
<tr>
<td></td>
<td>19.x</td>
<td>Fracture of arm with rib fracture</td>
</tr>
<tr>
<td></td>
<td>20.x</td>
<td>Fracture of neck of femur</td>
</tr>
<tr>
<td></td>
<td>21.x</td>
<td>Fracture of other and unspecified parts of femur</td>
</tr>
<tr>
<td></td>
<td>22.x</td>
<td>Fracture of patella</td>
</tr>
<tr>
<td></td>
<td>23.x</td>
<td>Fracture of tibia and fibula</td>
</tr>
<tr>
<td></td>
<td>24.x</td>
<td>Fracture of ankle</td>
</tr>
<tr>
<td>SURGICAL INTERVENTION</td>
<td>8.5x</td>
<td>Internal fixation of bone without fracture reduction</td>
</tr>
<tr>
<td></td>
<td>9.1x</td>
<td>Closed reduction of fracture with internal fixation</td>
</tr>
<tr>
<td></td>
<td>9.2x</td>
<td>Open reduction of fracture</td>
</tr>
<tr>
<td></td>
<td>9.3x</td>
<td>Open reduction of fracture with internal fixation</td>
</tr>
<tr>
<td></td>
<td>9.5x</td>
<td>Open reduction of separated epiphysis</td>
</tr>
<tr>
<td></td>
<td>9.6x</td>
<td>Open debridement of open fracture site</td>
</tr>
<tr>
<td></td>
<td>9.8x</td>
<td>Open reduction of dislocation</td>
</tr>
<tr>
<td></td>
<td>9.9x</td>
<td>Operation on fracture and dislocation</td>
</tr>
<tr>
<td></td>
<td>0.1x</td>
<td>Arthrotomy: Incision and excision of joint structures</td>
</tr>
<tr>
<td></td>
<td>0.2x</td>
<td>Arthroscopy: Incision and excision of joint structures</td>
</tr>
<tr>
<td></td>
<td>0.4x</td>
<td>Arthroscopy: Division of joint capsule, ligament, or cartilage</td>
</tr>
<tr>
<td></td>
<td>1.5x</td>
<td>Joint replacement of lower extremity</td>
</tr>
<tr>
<td></td>
<td>1.8x</td>
<td>Arthroplasty and repair of shoulder and elbow</td>
</tr>
<tr>
<td>DELIRIUM</td>
<td>90.x</td>
<td>Dementias</td>
</tr>
<tr>
<td>TERMS USED IN STUDY</td>
<td>ICD 9 CODES</td>
<td>DEFINITION OF ICD 9 CODES</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td></td>
<td>92.x</td>
<td>Drug-induced delirium</td>
</tr>
<tr>
<td></td>
<td>93.x</td>
<td>Delirium due to conditions classified elsewhere, Acute: confusional state, infective psychosis, organic reaction, posttraumatic organic psychosis, psycho-organic syndrome, Acute psychosis a</td>
</tr>
<tr>
<td></td>
<td>93.x</td>
<td>Sub-acute delirium, Sub-acute: confusional state, infective psychosis, organic reaction, posttraumatic organic psychosis, psycho-organic syndrome, psychosis associated with endocrine or metabolic</td>
</tr>
<tr>
<td></td>
<td>80.x</td>
<td>Altered mental status</td>
</tr>
<tr>
<td>PRESSURE ULCER</td>
<td>07.x</td>
<td>Pressure ulcer stage III</td>
</tr>
<tr>
<td></td>
<td>07.x</td>
<td>Pressure ulcer stage IV</td>
</tr>
<tr>
<td></td>
<td>07.x</td>
<td>Pressure ulcer, unstageable</td>
</tr>
<tr>
<td></td>
<td>07.x</td>
<td>Pressure ulcer</td>
</tr>
</tbody>
</table>
### APPENDIX: F Charlson Comorbidity Codes and Definitions

(Some minor scoring modifications were required to allow for information available in the ICD 9 codes)

<table>
<thead>
<tr>
<th>TERMS</th>
<th>ICD 9 CODE</th>
<th>MODIFIED CHARLSON SCORE</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIDS</td>
<td>O42</td>
<td>6</td>
<td>Human immunodeficiency Virus Infection</td>
</tr>
<tr>
<td>Any tumor (within 5 years)</td>
<td>140-195</td>
<td>2</td>
<td>Malignant neoplasms, stated or presumed to be primary, of specific sites, except of lymphatic and hematopoietic tissue</td>
</tr>
<tr>
<td>Metastatic Solid Tumor</td>
<td>196-198</td>
<td>6</td>
<td>Malignant neoplasms, stated or presumed to be secondary, of specified sites</td>
</tr>
<tr>
<td>Any tumor (within 5 years)</td>
<td>199</td>
<td>2</td>
<td>Malignant neoplasms, without specification of site</td>
</tr>
<tr>
<td>Lymphoma/ Leukemia</td>
<td>200-208</td>
<td>2</td>
<td>Malignant neoplasms, stated or presumed to be primary, of lymphatic and hematopoietic tissue</td>
</tr>
<tr>
<td>Diabetes/ Diabetes with Organ Damage</td>
<td>250</td>
<td>2</td>
<td>Diabetes Mellitus with/without mention of complications and organ damage</td>
</tr>
<tr>
<td>Dementia</td>
<td>290, 294</td>
<td>1</td>
<td>Psychotic organic brain syndromes</td>
</tr>
<tr>
<td>Mod/severe Renal Disease</td>
<td>403</td>
<td>2</td>
<td>Hypertensive Renal Disease</td>
</tr>
<tr>
<td>Myocardial Infarction</td>
<td>410</td>
<td>1</td>
<td>Myocardial Infarction</td>
</tr>
<tr>
<td>Congestive Heart Failure</td>
<td>428</td>
<td>1</td>
<td>Congestive Heart Disease</td>
</tr>
<tr>
<td>Cerebrovascular Disease</td>
<td>430-437</td>
<td>1</td>
<td>Cerebrovascular acute incidences</td>
</tr>
<tr>
<td>Hemiplegia</td>
<td>438</td>
<td>2</td>
<td>Includes all late effects of cerebrovascular disease</td>
</tr>
<tr>
<td>Peripheral Vascular Disease</td>
<td>451-454</td>
<td>1</td>
<td>Inflammatory and Thrombotic Disease</td>
</tr>
<tr>
<td>Chronic Obstructive Pulmonary Disease</td>
<td>492</td>
<td>1</td>
<td>Emphysema</td>
</tr>
<tr>
<td></td>
<td>493</td>
<td>1</td>
<td>Asthma</td>
</tr>
<tr>
<td></td>
<td>496</td>
<td>1</td>
<td>Chronic Obstructive Disease</td>
</tr>
<tr>
<td>Chronic Obstructive Pulmonary Disease</td>
<td>518</td>
<td>1</td>
<td>Other Diseases of the Lung</td>
</tr>
<tr>
<td>Peptic Ulcer Disease</td>
<td>531-534</td>
<td>1</td>
<td>Ulcer Disease of Stomach and Intestines</td>
</tr>
<tr>
<td>Mod/severe Liver Disease</td>
<td>570-573</td>
<td>3</td>
<td>Cirrhosis, Necrosis, Failure of Liver</td>
</tr>
<tr>
<td>Mod/severe Renal Disease</td>
<td>580-586, 590-591</td>
<td>2</td>
<td>Nephritis, Nephrosis, Failure, and Infections</td>
</tr>
<tr>
<td>Connective Tissue Disease</td>
<td>710, 711</td>
<td>1</td>
<td>Diffuse disease associated with other conditions and infections</td>
</tr>
<tr>
<td>60-69</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>70-79</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>80-89</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>90-99</td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>100 &gt;</td>
<td></td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX G: Table Of Subjects by Hospital by Year

<table>
<thead>
<tr>
<th>Year</th>
<th>Hospital 1</th>
<th>Hospital 2</th>
<th>Hospital 3</th>
<th>Hospital 4</th>
<th>Hospital 5</th>
<th>Total Subjects per Year All Hospitals</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>228</td>
<td>69</td>
<td>49</td>
<td>122</td>
<td>59</td>
<td>537</td>
</tr>
<tr>
<td>2011</td>
<td>235</td>
<td>59</td>
<td>59</td>
<td>149</td>
<td>95</td>
<td>587</td>
</tr>
<tr>
<td>2012</td>
<td>199</td>
<td>62</td>
<td>66</td>
<td>150</td>
<td>95</td>
<td>572</td>
</tr>
<tr>
<td>2013</td>
<td>101</td>
<td>35</td>
<td>29</td>
<td>80</td>
<td>43</td>
<td>288</td>
</tr>
<tr>
<td>Total per Subjects per Hospital</td>
<td>763</td>
<td>225</td>
<td>203</td>
<td>501</td>
<td>292</td>
<td>1984</td>
</tr>
<tr>
<td>Percentage of Total Subjects</td>
<td>38.46%</td>
<td>11.34%</td>
<td>10.23%</td>
<td>25.25%</td>
<td>14.72%</td>
<td></td>
</tr>
</tbody>
</table>