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Pneumonia Readmissions in Older Adults with Dementia

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We hereby certify that this dissertation, submitted by Sara Knox, PT, DPT, GCS conforms to acceptable standards and is fully adequate in scope and quality to fulfill the dissertation requirement for the degree of Doctor of Philosophy in Health Science.

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Abstract

Objective: The purpose of this study was to investigate pneumonia readmissions of older adults with dementia. Readmission rates and predictive factors of older adults with and without dementia were compared in this study. ***Subjects:*** A nationally representative sample of 389,198 discharge records, representing 370,003 patients, was extracted from the 2013 Nationwide Readmission Database. ***Methods:*** Descriptive statistics were utilized to describe the demographics of the sample population. Differences between groups were analyzed using chi-square or *t* test statistics as appropriate. A generalized linear model was used to examine predictive factors for pneumonia readmissions. ***Results:*** Older adults with dementia had a readmission rate of 23.52% and were 2.9 times more likely to experience a pneumonia readmission than older adults without dementia. Significant differences in characteristics were found when comparing (a) older adults with and without dementia, (b) older adults with and without dementia who were readmitted, and (c) older adults with dementia who were and were not readmitted. Factors that significantly interacted with dementia included (a) discharge disposition, (b) number of chronic conditions, (c) risk of mortality, and (d) median household income. ***Conclusions****:* Classifying older adults with dementia as a high-risk group for pneumonia readmissions is supported by the findings of this study. More over, dementia diagnoses significantly affect discharge disposition, there are characteristic differences among older adults with dementia, and comorbidities and risk of mortality significantly affect pneumonia readmissions. Development of strategies to reduce pneumonia readmissions that are tailored to individuals with dementia should be considered.

Keywords: readmissions, pneumonia, dementia

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Chapter 1: Introduction

Introduction to Chapter

The American health care system has come under intense scrutiny and debate in the past several years. There has been an increased demand to implement reforms that decrease costs yet also improve quality of care (National Quality Forum, 2008; The White House, 2008, 2010; Ung & Mullins, 2015). In 2011, there were 3.3 million 30-day all-cause hospital readmissions in the United States (US) that cost 41.3 billion dollars (Hines, Barrett, Jiang, & Steiner, 2014). Medicare patients accounted for 1.8 million of these readmissions with an associated cost of 24 billion dollars (Hines et al., 2014) Many of these hospital readmissions are thought to be preventable (Medicare Payment Advisory Commission, 2011). Hospital readmissions cause distress and anxiety for patients and patients' families (Allaudeen, Schnipper, Orav, Wachter, & Vidyarthi, 2011; Fingar & Washington, 2015) and negatively affect providers and payers (Fingar & Washington, 2015; Hines et al., 2014). It has been suggested that implementing strategies to decrease hospital readmission rates has the potential to (a) improve quality of care, (b) decrease costs, (c) decrease unnecessary use of health care services, (d) promote patient centered care, and (e) increase the value in the health care system (Kulkarni, Smith, & Woeltje, 2015; Minott, 2008; Scott, Shohag, & Ahmed, 2014). Given this information, hospital readmissions have been targeted as a key area for reform. The Patient Protection and Affordable Care Act of 2010 (ACA) established the Hospital Readmission Reduction Program (HRRP) and established financial penalties for hospitals with readmission rates in excess of expected risk adjusted readmission rates beginning in 2013 (Axon & Williams, 2011; Cutler, 2010).

While various terms and definitions have been used to describe the event of a patient being readmitted to a hospital after having been discharged, it is now widely accepted that the term "hospital readmission" refers to a patient being readmitted to any hospital for any cause within 30 days of being discharged (Benbassat & Taragin, 2000; Centers for Medicare and Medicaid Services, 2016; Frankl, Breeling, & Goldman, 1991; Kelly, McDowell, Crawford, & Stout, 1992; National Quality Forum, 2008). The first 30 days after a hospital discharge is considered to be a time of heightened vulnerability for readmissions (Dharmarajan et al., 2013; Medicare Payment Advisory Commission, 2007). The first 30 days post-discharge have been shown to be the time when most readmissions occur (Frankl et al., 1991; Jencks, Williams, & Coleman, 2009; Sibbritt, 1995). Nearly 20% of Medicare beneficiaries are readmitted to an acute care hospital within 30 days of discharge (Dharmarajan et al., 2013; Jencks et al., 2009). The highest hospital readmission rates and costs have been observed in high risk or severely ill geriatric patients (Carey & Stefos, 2015). Many readmissions are considered preventable adverse events that are the result of poor quality of care (van Walraven, Bennett, Jennings, Austin, & Forster, 2011; van Walraven, Jennings, & Forster, 2012; Vest, Gamm, Oxford, Gonzalez, & Slawson, 2010). Improvements in the quality of (a) care processes, (b) discharge planning, and (c) transitions to community care have been proposed as potential strategies to decrease potentially preventable readmissions (van Walraven et al., 2012; Vest et al., 2010).

Pneumonia is the second most common primary diagnosis on hospital discharge records (Torio & Andrews, 2013) and accounts for nearly 30% of all potentially preventable hospital readmissions for all diagnoses (Medicare Payment Advisory

Commission, 2011). More than one in six Medicare patients with pneumonia are readmitted within 30 days of discharge resulting in an enormous expense for the Medicare system (Lindenauer et al., 2011). Pneumonia is also the primary cause of death for individuals diagnosed with dementia (Brunnström & Englund, 2009; Rudolph et al., 2010). Individuals with dementia have greater hospitalization rates and suffer more severe adverse events from hospitalization than age matched peers (Husaini, Gudlavalleti1, Cain, Levine, & Moonis, 2015; Rudolph et al., 2010). It has been suggested that identifying patients at high risk of readmission and focusing efforts towards these high-risk individuals could decrease readmission rates (Allaudeen et al., 2011). Given patients with dementia are known to have difficulties with pneumonia, it is plausible that these individuals may be at high risk of hospital readmissions when hospitalized for pneumonia.

The purpose of this study was to investigate the risk of readmission and associated risk factors for older adults (65 and older) with dementia after an index admission with a primary diagnosis of pneumonia. Pneumonia readmission rates and predictive factors of older adults diagnosed with dementia were identified and compared with pneumonia readmission rates and predictive factors of older adults without dementia. A retrospective analysis of publicly available secondary data was performed. This chapter addresses the (a) problem statement, (b) provides insight into the relevance of this study, (c) outlines the research questions, and (d) provides definitions to be used in this study.

Problem Statement

Pneumonia. Pneumonia is a respiratory infection caused by bacteria, fungi, or viruses that results in inflammation of the lungs (Centers for Disease Control and Prevention, 2014; U.S. National Library of Medicine, 2014). Pneumonia is the sixth leading cause of death (Centers for Disease Control and Prevention, 2015) and the primary cause of hospitalization in the United States (Pfuntner, Wier, & Stocks, 2013). There are approximately five to six cases per 1,000 adults per year with men and African-Americans experiencing higher rates than women and Caucasians (Marrie, 2015). The all-cause mortality for pneumonia is approximately 28% per year and is expected to increase with the aging population of the United States (Marrie, 2015).

Pneumonia is the seventh most expensive condition in the United States, representing 2.7% of total health expenditures and costing approximately 10.6 billion dollars (Torio & Andrews, 2013). For Medicare beneficiaries, pneumonia was the fifth most expensive condition, accounting for 3.7% of all Medicare expenditures and equating to approximately 6.7 million dollars (Torio & Andrews, 2013). It is also estimated that the total annual direct costs (health care and otherwise) of pneumonia exceeds $7 billion annually creating a significant burden for the U.S. society (Mandell et al., 2007; Thomas et al., 2012).

Patient factors that increase the risk of contracting pneumonia include (a) chronic lung diseases, (b) smoking, (c) brain disorders including dementia, (d) immune system problems, (e) other serious illnesses, and (f) recent surgery or trauma (Centers for Disease Control and Prevention, 2014; U.S. National Library of Medicine, 2014). In addition to these, risk factors for pneumonia for older adults include (a) heart disease, (b)

dysphagia, and (c) institutionalization (Schmidt-Ioanas & Lode, 2006; Wenisch et al., 2013). The rate of mortality for older adults with pneumonia increases with increasing age (over 65) and with comorbidities such as congestive heart failure and neurological diseases (Wenisch et al., 2013).

The clinical presentation associated with pneumonia includes (a) cough, (b) fever, (c) chills, (d) shortness of breath, (e) malaise, and (f) fatigue (U.S. National Library of Medicine, 2014). However, the clinical presentation of pneumonia in older adults is often more subtle, making detection more difficult (Schmidt-Ioanas & Lode, 2006; Wenisch et al., 2013). Typical symptoms associated with pneumonia are often absent in older adults; instead older adults with pneumonia present with altered mental status or delirium (Riquelme et al., 1997; Wenisch et al., 2013). Older adults are at an increased risk for dehydration due to pneumonia, and it is the dehydration in combination with the infection that can lead to delirium being the first symptom of pneumonia in older adults who are otherwise asymptomatic (Wenisch et al., 2013). This discrete manifestation and the fact that older adults often have an unclear pulmonary infiltrate on X-ray (Basi, Marrie, Huang, & Majumdar, 2004), often delays diagnosis and treatment by 72 hours or more (High, 2005; Riquelme et al., 1997). Similarly, the presence of common comorbidities in older adults, such as cardiovascular disease and congestive heart failure, often decreases the suspicion of pneumonia and further delays treatment (Waterer, Kessler, & Wunderink, 2006). In addition to delirium, older adults are also more likely to experience (a) dyspnea, (b) pleural effusion, (c) decreased renal function, and (d) decreased self-care activities as a result of pneumonia (Wenisch et al., 2013). Pneumonia has a more severe

impact on the health of older adults and increases their likelihood of hospitalization (Wenisch et al., 2013).

Pneumonia is treatable and curable in many cases. Current standard of care for individuals with pneumonia includes (a) blood cultures and microbial testing, (b) timely administration of antibiotics, (c) adherence to current antibiotic guidelines, and (d) adjunctive pharmacological interventions (File, 2015; Waterer, Rello, & Wunderink, 2011). Administration of appropriate antibiotics has been a key component of optimal care for pneumonia for more than 20 years (Mandell et al., 2007). For older adults with pneumonia, current care guidelines also include (a) strategies to minimize aspiration, (b) strategies to maximize nutrition and hydration (Schmidt-Ioanas & Lode, 2006), and (c) follow up chest X-rays 7 to 12 weeks after the initiation of interventions (File, 2015).

Pneumonia readmissions. Pneumonia is one of the diagnoses being tracked for excessive hospital readmissions under the HRRP (CMS, 2016; Hines et al., 2014). Pneumonia was selected due to its high prevalence and associated medical costs (CMS, 2016). Nationwide data are now being collected for pneumonia readmission rates for older adults (Agency for Healthcare Research and Quality [AHRQ], 2015c; CMS, 2016). Pneumonia readmission data is in the early stages of being analyzed, and the focus is on readmission rates and predictive factors for the older adult population (Dharmarajan et al., 2013; Hebert et al., 2014; Hines et al., 2014; Lee et al., 2014).

A wide range of all-cause pneumonia readmission rates (10%-30%) has been reported due to varied methods of determining readmission rates (Allaudeen et al., 2011; Dharmarajan et al., 2013; Epstein, Jha, & Orav, 2011; Hemenway & Naretta, 2015; Hines et al., 2014; Joynt, Orav, & Jha, 2011b; Lindenauer et al., 2011; Mather, Fortunato, Ash,

Davis, & Kumar, 2014; Navarro, Enguídanos, & Wilber, 2012; Shorr et al., 2013; Suter et al., 2014). However, the most commonly reported all-cause pneumonia readmission rate is approximately 18% (Allaudeen et al., 2011; Dharmarajan et al., 2013; Epstein et al., 2011; Hemenway & Naretta, 2015; Lindenauer et al., 2011; Suter et al., 2014). All-cause pneumonia readmission rates have been shown to vary across institutions (Epstein et al., 2011; Lindenauer et al., 2010; Lindenauer et al., 2011) and across regions (Lindenauer et al., 2010). MedPAC (2007) has suggested that 75% of readmissions are preventable. However, van Walraven, Jennings et al. (2012) found that only one in four (23%) readmissions were avoidable in their meta-analysis.

The primary diagnosis associated with all-cause pneumonia readmissions include (a) pneumonia (15%-30%), (b) chronic obstructive pulmonary disease (COPD; 21%), (c) congestive heart failure (CHF; 7%-10%), (d) cardiorespiratory failure and shock (4%), (e) renal failure (4%), and (f) aspiration pneumonitis (Dharmarajan et al., 2013; Jencks et al., 2009; Mather et al., 2014; Shams, Ajorlou, & Yang, 2015). Common comorbidities of all-cause pneumonia readmissions include (a) COPD, (b) CHF, (c) cardiorespiratory failure and shock, (d) diabetes mellitus, (e) lymphoma, (f) cancer, (g) respiratory disease, and (h) chronic lung disease (Mather et al., 2014; Navarro et al., 2012; Shams et al., 2015; Shorr et al., 2013).

Predictive factors for all-cause pneumonia readmissions have been examined in multiple studies. In a systematic review, Calvillo-King et al. (2013) found that the most predictive factors of all-cause pneumonia readmissions were (a) age, (b) socio-economic status, (c) neighborhood, (d) socio-cognitive status, and (e) social environment. The presence of multiple comorbid conditions has also been suggested to be a predictive

factor in multiple studies (Navarro et al., 2012; Neupane, Walter, Krueger, Marrie, & Loeb, 2010; Scott et al., 2014; Shams et al., 2015). Specific comorbidities increasing the risk of all-cause pneumonia readmissions include (a) cognitive impairment (Scott et al., 2014), (b) dysphagia (Cabré et al., 2014), and (c) anxiety and depression (Mather et al., 2014). Health care utilization factors that have been suggested to affect the risk of readmission include (a) a history of prior hospital admissions (Mather et al., 2014; Scott et al., 2014; Shorr et al., 2013), (b) administration of broad spectrum antibiotics prior to hospitalization (Shorr et al., 2013), (c) length of hospitalization (Navarro et al., 2012; Shams et al., 2015), and (d) discharge to home health or a skilled nursing facility (Navarro et al., 2012). The patient demographic factors linked to an increased risk of all-cause pneumonia readmissions are being male (Mather et al., 2014; Navarro et al., 2012; Neupane et al., 2010) and being African-American (Navarro et al., 2012).

Dementia. Dementia is the fifth leading cause of death in the United States and is the only cause of death on the top-ten list that cannot be prevented or cured (Alzheimer's Association, 2015). There are 5.4 million individuals in the United States who have dementia, and by the year 2050, this number is expected to rise to 16 million (Hebert, Weuve, Scherr, & Evans, 2013). Age is the primary risk factor for dementia, and the U.S. population is quickly aging (Alzheimer's Association, 2015). It is estimated that 96% of individuals with dementia are over the age of 65 (Alzheimer's Association, 2015), and the prevalence of dementia is approximately 14.7% for people over the age of 70 (Hurd, Martorell, Delavande, Mullen, & Langa, 2013).

While often mistaken for a disease, dementia is a clinical syndrome that includes (a) memory loss, (b) cognitive impairments, and (c) significant functional difficulties, and

although recognizable as a unique condition, dementia is caused by a variety of neurodegenerative diseases (McHugh & Folstein, 1977; U.S. National Library of Medicine, 2015). A consensus has not been reached regarding the diagnostic criteria for dementia, and criteria currently differ amongst diagnostic coding sources (American Psychiatric Association, 2013; Medicode (Firm), 1996). However, a clinical description of dementia is generally agreed upon (Breitner, 2006). The clinical description of dementia includes four factors (Breitner, 2006). First, dementia includes global deficits in cognitive abilities across multiple domains of cognitive activity. The most common cognitive impairment is memory deficits, but others include (a) language function, (b) coordination and movement, (c) object recognition, (d) reasoning and judgment, (e) calculations, and (f) executive function (Breitner, 2006). The second factor is that the deficits in cognitive abilities represent a decline from the prior abilities (Breitner, 2006). The third factor is that the deficits the individual experiences are severe enough to affect their usual social and occupational functions (Breitner, 2006). The fourth and final factor is that the deficits and changes cannot be attributable to a loss of consciousness (Breitner, 2006).

Dementia costs. Dementia is one of the most expensive chronic conditions affecting our nation with a total annual cost of approximately 226 billion dollars (Alzheimer's Association, 2015; Hurd et al., 2013). Medicare pays approximately 11 billion dollars of this amount (Hurd et al., 2013). At the individual level, total annual costs are estimated between $42,000 to $56,000 (Hurd et al., 2013; Schaller, Mauskopf, Kriza, Wahlster, & Kolominsky-Rabas, 2015). It is estimated that these costs will increase approximately 80% by the year 2040 due to the increases in the aging population

of the US (Hurd et al., 2013). By 2050, dementia-associated costs are expected to be approximately 1.2 trillion dollars (Alzheimer's Association, 2015). It is well recognized that health care associated costs are higher for individuals with dementia (Arling et al., 2013; Martin, Ricci, Kotzan, Lang, & Menzin, 2000). In fact, it costs approximately three times as much to treat a medical condition in a patient with an existing dementia diagnosis as it does to treat an aged-match peer without dementia who has the same medical condition (Alzheimer's Association, 2015; Hurd et al., 2013). The cost of treating a patient with dementia increases as the severity of the dementia increases and with increased numbers of comorbidities (Oremus & Aguilar, 2011).

Hospitalizations are a significant portion of dementia-associated health care costs (Arling et al., 2013; Callahan et al., 2012; Callahan et al., 2015). Older adults diagnosed with dementia (a) have hospitalization rates three times greater than their age-matched peers, (b) are more likely to have multiple hospitalizations, (c) have longer hospital stays, (d) are more likely to be discharged to a skilled nursing facility, and (e) have a greater risk of mortality (Fillenbaum, Heyman, Peterson, Pieper, & Weiman, 2001; Rudolph et al., 2010; Zekry et al., 2009). Hospitalizations are burdensome and have detrimental effects on the overall health and functional status of older adults diagnosed with dementia (Fick, Agostini, & Inouye, 2002; Mitchell et al., 2009; Pedone et al., 2005; Travers, Byrne, Pachana, Klein, & Gray, 2014). Individuals with dementia have a higher risk of experiencing functional decline during hospitalization (Inouye et al., 1993; McCusker, Kakuma, & Abrahamowicz, 2002; Mukadam & Sampson, 2011) and are less likely to recover and regain the function that was lost (Sands et al., 2003).

Dementia mortality. Pneumonia has been identified as the leading cause of infection and death for individuals diagnosed with dementia, accounting for at least half of all dementia-related deaths (Brunnström & Englund, 2009; Centers for Disease Control and Prevention, 2013; Foley, Affoo, & Martin, 2014; Magaki, Yong, Khanlou, Tung, & Vinters, 2014). Patients with dementia are twice as likely to contract pneumonia and to experience a pneumonia-related death as compared with age-related norms (Foley et al., 2014; Schmidt-Ioanas & Lode, 2006). It is estimated that between 40% to 65% of all individuals with dementia will develop pneumonia (Chen et al., 2006; D'Agata & Mitchell, 2008; Givens, Jones, Shaffer, Kiely, & Mitchell, 2010; Mitchell et al., 2009). Patients with dementia are believed to be at an increased risk of developing pneumonia due to (a) ineffective airway clearance, (b) impaired swallowing, (c) frailty, and (d) decreased immune function (Brunnström & Englund, 2009; Chamandy & Wolfson, 2005; Fu et al., 2004). The risk of being hospitalized due to pneumonia has been reported to be 1.5 (Zhao, Kuo, Weir, Kramer, & Ash, 2008) to 1.88 times greater for patients with dementia (Phelan, Borson, Grothaus, Balch, & Larson, 2012). It has also been estimated that 14% to 28% of individuals with dementia who develop pneumonia will be hospitalized (Chen et al., 2006; Mehr et al., 2003; van der Steen et al., 2004).

Gap in the current research. As was previously stated, all-cause pneumonia readmission data are in the early stages of analysis (Dharmarajan et al., 2013; C. Hebert et al., 2014; Hines et al., 2014; Lee et al., 2014). Hospital readmission rates and predictive factors for all individuals diagnosed with pneumonia have been examined in current research et al., 2011a; Suter et al., 2014). Development of programs to decrease all-cause pneumonia readmissions and their associated costs depends on having a

thorough understanding of factors influencing readmissions. Expanding current research to analyze data for high-risk subgroups of the population could provide additional information about factors influencing readmission rates. The fact that individuals with dementia (a) have increased susceptibility to, (b) poorer recovery from, and (c) increased mortality with pneumonia makes these individuals a high-risk subgroup (Rudolph et al., 2010). Additionally, predictive factors for all-cause pneumonia hospital readmissions include neurological comorbidities, and as a neurological condition, dementia has the potential to influence readmission rates (Hebert et al., 2014; Jasti, Mortensen, Obrosky, Kapoor, & Fine, 2008; Tang et al., 2014).

Currently, there is lack of research specifically addressing all-cause pneumonia readmission rates and predictive factors for older adults diagnosed with dementia. This study contributed to the current literature on pneumonia readmission rates and predictive factors for this patient population. Information gained from this study included the following:

1. Insight into the relationship between dementia and all-cause pneumonia readmissions.
2. Identification of factors that play a significant role in all-cause pneumonia readmissions.
3. Identification of potentially modifiable factors.

Dementia and pneumonia are two separate diagnoses that individually have a significant impact on the lives of older adults, both in regard to quality of life and in financial impact. Further investigation into the relationship of these two variables is warranted and may influence efforts to maximize quality of care for older adults diagnosed with

dementia. The purpose of this quantitative, correlational, cross-sectional, retrospective study of publicly available secondary data was to investigate the risk of readmission and associated risk factors for older adults with dementia after an index admission with a primary diagnosis of pneumonia.

Relevance

Current standards of care for individuals with dementia include (a) patient-centered care, (b) comprehensive assessment, and (c) preventative care planning (Alzheimer's Association, 2009). A primary goal of these standards is to prevent secondary complications, such as (a) weight loss, (b) malnutrition, (c) pressure ulcers, (d) infection, and (e) poor healing (Alzheimer's Association, 2009). Individuals diagnosed with dementia are cared for in a multitude of settings, including (a) in their own homes, (b) at assisted living facilities, (c) in memory care units, (d) in skilled nursing facilities, or (e) in hospitals. Transitions between these settings can be burdensome and problematic for individuals with dementia due to their (a) increased vulnerability to poor quality care, (b) fragmentation of care, and (c) poor communication between settings (Coleman, 2003). These transitions represent a substantial portion of health care costs and are believed to be somewhat preventable and, therefore, have become an important target for efforts to improve quality and efficiency of health care (Arling et al., 2013; Callahan et al., 2015; Coleman, 2003).

Individuals with dementia are at a heightened risk of preventable transitions due to their (a) cognitive impairments, (b) increased number of comorbidities, and (c) large number of transitions (Callahan et al., 2015; Gozalo et al., 2011; Teno et al., 2013). Each transition, therefore, presents a new risk for “miscommunication, duplication of services,

medical errors, and provision of care in conflict with the individual's and family's goals of care" (Callahan et al., 2012, p. 818). Health care systems treating older adults with dementia need to pay close attention to the process of managing care across the continuum of settings (Callahan et al., 2012). Gaining additional information on all-cause readmissions specific to patients with dementia has the potential to affect care transitions and inform care pathways that are aimed at decreasing preventable transitions. Studying all-cause pneumonia readmission rates and predictive factors for individuals with dementia could assist in doing the following:

1. Determine if dementia warrants more targeted efforts regarding readmission risks.
2. Assess dementia as a predictive factor in all-cause pneumonia readmissions.
3. Improve preventative strategies for readmissions.
4. Expand existing knowledge about the course of pneumonia in patients with dementia.

Thus, this study is both timely and relevant to the evolution of the current health care system and contributes to the understanding of all-cause pneumonia readmission rates.

Research Questions

This study examined the following questions:

1. What is the all-cause pneumonia readmission rate for older adults diagnosed with dementia and for older adults with no known diagnosis of dementia?
2. Is there a significant difference in the all-cause pneumonia readmission rate for older adults with dementia as compared with the all-cause pneumonia readmission rate for older adults without dementia?

3. Is there a significant difference between patient factors of older adults with dementia who were readmitted and patient factors of older adults without dementia who were readmitted?
4. Is there a significant difference between patient factors of older adults with dementia who were readmitted and patient factors of older adults with dementia who were not readmitted?
5. Does the diagnosis of dementia affect the predictive factors for all-cause pneumonia readmissions?

Definitions

The following definitions were used for the following words and phrases in this study.

1. All-cause readmissions. Readmission to a hospital after discharge from an index admission for any reason.
2. All-cause pneumonia readmission (all-cause PNA-RA). Readmission to a hospital within 30 days of discharge from an index admission with a principle diagnosis of pneumonia in which the readmission occurs for any reason.
3. Clinical syndrome. A recognizable constellation of signs and symptoms (Breitner, 2006, p. 130).
4. Dementia. A global term describing memory loss and cognitive deficits that significantly impact daily activities due to a variety of neurodegenerative diseases including Alzheimer's disease (U.S. National Library of Medicine, 2015).

5. Hospital readmissions reduction program. Federal program established as part of the Affordable Care Act in 2009 that requires CMS to reduce payment to hospitals with excessive readmission rates for specified conditions (CMS, 2016).
6. Hospitalization. Admission to a hospital.
7. Index admission. An original admission to a hospital in which the primary diagnosis is the target diagnosis, the patient is discharged alive, is not discharged against medical advice, and is not transferred out to another hospital.
8. Older adults. Individuals aged 65 years or older (Committee on the Future Health Care Workforce, 2008).
9. Pneumonia (PNA). An acute respiratory infection that is caused by viral, bacterial, and fungal infections (CDC, 2013).
10. Principle diagnosis. The primary diagnosis for which a patient was admitted to a hospital.
11. Quality of care. The degree to which the process of care conforms to the accepted standards (Ashton & Wray, 1996).
12. Revisits. Multiple health care encounters for a particular patient that are not limited solely to inpatient stays.
13. Readmission (RA). Subsequent hospital admission for any cause (to the same hospital or another hospital) within 30 days of discharge from a hospital index admission (CMS, 2016; Hines et al., 2014).

14. Readmission rate. Number of readmissions divided by the total number of index admissions between January and November.

Summary

Dementia and pneumonia are two separate diagnoses that individually have a significant impact on the lives of older adults, both in regards to quality of life and in financial impact. Further investigation into how these two diagnoses interact was warranted and may be beneficial to maximizing quality of care for older adults diagnosed with dementia. This quantitative, cross-sectional analysis of publicly accessible secondary data addressed the current lack of literature addressing readmissions for individuals with dementia. More specifically, the risk of all-cause pneumonia readmission and associated predictive factors for older adults with dementia was investigated in this study. In the next chapter, the theory and literature related to all-cause pneumonia readmissions will be further explored and potential contributions to health care research are discussed.

Chapter 2: Literature Review

Hospital readmissions have been a topic of interest in the United States for many years (Achté & Apo, 1967; Benbassat & Taragin, 2000; Burgess & Hockenberry, 2014; Kahn et al., 1990; Mayes, 2007; Pearl, 1921). Sample populations utilized when examining all-cause pneumonia readmissions have been broad and included the general population of patients (Dharmarajan et al., 2013; Hebert et al., 2014; Tang et al., 2014). However, the subgroup of patients with pneumonia who have a known diagnosis of dementia has not been addressed by similar research. The understanding of dementia and the care for individuals with dementia has changed significantly over the years through research and clinical experience.

This chapter addresses the following:

1. Historical content about both hospital readmissions and dementia care.
2. An understanding of the conceptual framework for this study.
3. Current literature regarding hospital readmissions for individuals with dementia and potential intervention strategies.
4. The potential contributions of this study.

Historical Overview

Readmissions. The concept of tracking hospital readmissions has been discussed as far back as 1921 when Raymond Pearl proposed a punch card system for tracking hospital administrative data, which included a criterion for identifying readmissions (Pearl, 1921). Research about hospital readmissions continued throughout the years for various patient populations and for various purposes (Achté & Apo, 1967; Jenkins, Bemiss, & Lorr, 1953; Strauss, Sirotkin, & Grisell, 1974; Wing, Denham, & Munro,

1959). It was not until the 1970s when health services research began to evolve that hospital readmissions caught the attention of policy makers (Burgess & Hockenberry, 2014). At the time, most research about hospital readmissions was focused on individuals with mental health conditions (Burgess & Hockenberry, 2014).

In the 1980s, older adults' quality of care became the focus of health services research (Burgess & Hockenberry, 2014). CMS, formerly known as the Health Care Financing Administration, commissioned retrospective studies examining the impact of the Medicare prospective payment system (PPS) on the quality of care (Kahn et al., 1990; Rogers et al., 1990). It was theorized that incentives embedded in PPS were resulting in high readmission rates due to patients being discharged early and with lesser degrees of medical stability (Anderson & Steinberg, 1985; Burgess & Hockenberry, 2014). At the time, readmissions were measured as overall readmission rates for an entire hospital, and it was believed that most were caused by deterioration of the original admitting diagnosis (Anderson & Steinberg, 1985). Diagnosis-related-groups (DRGs) were also introduced to the hospital payment system at this time (Mayes, 2007). With the implementation of DRGs came greater interest in the association between financial impact and hospital readmissions (Mayes, 2007). DRGs were found to incentivize hospitals to increase admissions, resulting in inappropriate increases of hospital readmissions and their associated costs (Anderson & Steinberg, 1984, 1985; Cutler, 1995).

In 2000, Benbassat and Taragin conducted a 10-year comprehensive review of literature regarding hospital readmissions. The most common findings of the studies reviewed were that most hospital readmissions were caused by frailty and disease progression and that there was a wide range (9%-48%) of estimates as to how many

readmissions were preventable. There was not a national tracking system for measuring hospital readmissions, so most findings were from smaller studies that had been extrapolated to provide a national estimate. Benbassat and Taragin's (2000) review led the way for more contemporary research regarding hospital readmissions.

Section 501(b) of the Medicare Prescription Drug, Improvement, and Modernization Act of 2003 established the Hospital Inpatient Quality Reporting Program. This program mandates reporting of quality information by hospitals on identified core measures, including overall hospital readmission rates. Reported quality measures were made available to the public via CMS's Hospital Compare Web site. With public disclosure of the data came shaming efforts, but there were no true incentives for hospitals to dedicate time and resources to reducing readmission rates. In 2007, MedPAC issued the Payment Policy for Inpatient Readmissions, which shifted the focus from overall hospital readmission rates to diagnosis-specific readmission rates.

The most recent and most impactful piece of legislation regarding hospital readmissions was the ACA in 2010. Under the ACA, the HRRP was established, and for the first time, CMS was granted authority to collect readmission data and withhold reimbursements to hospitals based on the collected data (CMS, 2016). The first three diagnoses tracked for excessive hospital readmissions were (a) congestive heart failure, (b) myocardial infarct, and (c) pneumonia. These diagnoses were chosen due to their (a) high incidence rates, (b) costs, and (c) the fact that they were considered to be preventable. By 2011, CMS had (a) defined 30-days as the period for tracking hospital readmissions, (b) developed a policy for calculating excess diagnosis specific hospital readmission rates, and (c) defined methods for tracking hospital readmissions that were

consistent with standards set by the National Quality Forum and MedPAC (Burgess & Hockenberry, 2014).

Hospitals were now expected to shoulder a significant portion of the efforts to decrease hospital readmissions. Penalties for excessive readmission rates began at 1% in 2013, increased to 2% in 2014, and were capped at 3% in 2015 (CMS, 2016). In 2013, 2,213 hospitals were penalized for excessive readmission rates with an aggregate loss of approximately 280 million dollars (Boccuti & Casillas, 2015, p. 3). In 2014, 2,225 hospitals lost approximately 227 million dollars, followed by 2,610 hospitals losing approximately 480 million dollars in 2015 (Boccuti & Casillas, 2015, p. 3). It is estimated that 2,665 hospitals will lose around 420 million dollars in 2016 due to penalties incurred under HRRP (Boccuti & Casillas, 2015, p. 3). Additional diagnoses were also added. In 2015, (a) exacerbations of chronic obstructive pulmonary disease, (b) total hip arthroplasty, and (c) total knee arthroplasty were added. In 2017, coronary artery bypass graft will be added to the list of diagnoses being tracked (CMS, 2013).

Dementia care. The term "senile" was once used to describe changes that were believed to be the normal loss of cognitive processes with aging (Boller & Forbes, 1998; McKenzie, 2004). In 1851, the diagnosis of dementia was recognized as a pathological condition, but it was not until 1912 that the premature nature of Alzheimer's disease was recognized (McKenzie, 2004). Research into the relationship between anatomical changes in the brain and the condition of dementia did not begin until the 1950s (McKenzie, 2004). Throughout much of history, individuals with dementia were (a) institutionalized in state hospitals or sanatoriums, (b) kept out of sight of the public, (c) hidden at home, or (d) turned out and left homeless (McKenzie, 2004). Medical care

consisted of (a) antipsychotic interventions, (b) physical or pharmacological restraints, and (c) infantilization of these individuals (Boller & Forbes, 1998). Minimal consideration was given to quality of life or general health status. A shift toward keeping individuals out of state hospitals and sanatoriums began in the 1960s, but changes in care did not arise until the 1980s (McKenzie, 2004).

Today the medical community recognizes dementia as a condition resulting from a pathological process (Alzheimer's Association, 2015). As the understanding of dementia has improved so has the approach to caring for individuals diagnosed with dementia. Current standards of care for individuals with dementia include (a) patient-centered care, (b) comprehensive assessment, and (c) preventative care planning (Alzheimer's Association, 2009). A primary goal in treating patients with dementia is prevention of secondary complications, such as (a) weight loss, (b) malnutrition, (c) pressure ulcers, (d) infection, and (e) poor healing (Alzheimer's Association, 2009).

Pneumonia is one of the primary infections that affect individuals with dementia (Foley et al., 2014). Standard treatment for individuals diagnosed with pneumonia consists of antibiotic therapy and hospitalization in severe cases (Mandell et al., 2007). This has been the standard of care for pneumonia for more than 20 years (Mandell et al., 2007). However, individuals diagnosed with dementia who develop pneumonia receive a lower level of care or no care at all, despite being twice as likely to die from pneumonia (Foley et al., 2014; van der Steen, Ooms, Ader, Ribbe, & van der Wal, 2002). Substandard care for individuals diagnosed with dementia and pneumonia has been documented as far back as 1979 (Brown & Thompson, 1979). Substandard care in this

patient population is attributable to delays in both diagnosis and treatment of comorbid conditions (Fox et al., 2014; Kovach, Logan, Simpson, & Reynolds, 2010).

Individuals with dementia are at a high risk of delays in timely diagnosis due to (a) atypical symptom presentation, (b) poor ability to communicate symptoms, (c) increased attention directed at management of dementia versus comorbidities, (d) difficulty in distinguishing behavioral changes due to acute illness from behaviors associated with dementia, and (e) inadequacy of caregivers and health professionals to identify illness symptoms in these individuals (El Solh, 2009; Kovach et al., 2010; Thorpe et al., 2012). Potential reasons for delays in treatment or decreased levels of care for patients with dementia include (a) diminished decision-making capacity of the patient, (b) perceived altered benefits and burdens, (c) the patient's decreased ability to adhere to a regimen and report adverse effects, (d) a lack of availability of caregivers, and (e) poor mechanisms to compensate for communication and other deficits (Brauner, Muir, & Sachs, 2000). Delayed diagnosis and treatment of individuals with dementia and pneumonia can result in (a) increased severity of disease, (b) decreased patient comfort and quality of life, and (c) increased hospitalizations (Barry et al., 2002; Intrator, Zinn, & Mor, 2004).

A complete lack of treatment for pneumonia in this patient population may be due to a failure to identify the acute illness (Barry et al., 2002; Fox et al., 2014; Kovach et al., 2010) or could be the result of a purposeful decision not to treat (Mitchell et al., 2009). There is an ethical debate surrounding the use of antibiotics in the treatment of patients with dementia, specifically those in the later stages of dementia. Pneumonia-related mortality rates increase significantly as the severity of dementia increases (Brunnström &

Englund, 2009; Fabiszewski, Volicer, & Volicer, 1990). It has also been suggested that high pneumonia mortality rates are an indicator of the terminal stages of dementia (Brunnström & Englund, 2009; Mitchell et al., 2009). Based on these concepts, it has been questioned whether the benefits of treatment outweigh the risk of harm (Mitchell et al., 2009; Morrison & Siu, 2000). Givens et al. (2010) found that antibiotics (a) decreased mortality rates for individuals with dementia and pneumonia; (b) did not improve the patients' comfort levels; and (c) aggressive interventions, such as intravenous antibiotics and hospitalization, have the potential to decrease a patient's comfort level. In contrast, van der Steen, Pasman, Ribbe, van der Wal, and Onwuteaka-Philipsen (2009) found that there was a significant increase in patient comfort levels when antibiotics were administered but agreed that aggressive strategies may not be beneficial in the final stages of dementia. There is no agreement on the best course of care. Therefore, while some individuals may unknowingly go untreated, others may have treatment withheld purposefully. However, it should be noted that of those patients who have dementia and pneumonia, between 85% to 91% receive some form of antibiotics, so purposefully foregoing treatment does not appear to be the usual course of action (Chen et al., 2006; Givens et al., 2010; Mehr et al., 2003).

Conceptual Framework

Two conceptual frameworks informed this study: the Quality Health Outcomes Model (QHOM; (Mitchell, Ferketich, & Jennings, 1998) and the determinants of hospital readmissions (Kangovi & Grande, 2011). These conceptual frameworks have been selected because they (a) address the multifaceted aspects of hospital readmissions, (b) are consistent with current thought regarding hospital readmissions, and (c) account for

factors specific to the care of individuals with dementia. Using these two frameworks concurrently allows for a comprehensive analysis of all factors and interactions amongst these factors that affect hospital readmissions.

The QHOM was developed in 1998 by Mitchell et al. (1998) as a revision to the structure-process-outcome model developed by Donabedian in 1996 (Mitchell et al., 1998). The QHOM encompasses multiple complex factors that affect quality of care in a nonlinear, reciprocal manner. There are four components of the QHOM: client, system, interventions, and outcomes. The client encompasses the individual, family, or community and addresses demographics, health status, and disease factors. The system includes organizational level descriptive factors, processes, and functionality. The interventions include both direct and indirect interventions and activities related to the administration of the interventions. Outcomes refer to outcomes of interventions and assessments and encompass care models and quality of life. The QHOM (see Figure 1) includes bidirectional arrows to indicate the influence that all factors have on each other. There is not a direct link between interventions and outcomes because the outcomes are a result of the interaction between the client and the system as proposed by the model. Thus, it is believed that interventions do not have an independent direct impact on outcomes (Mitchell et al., 1998).

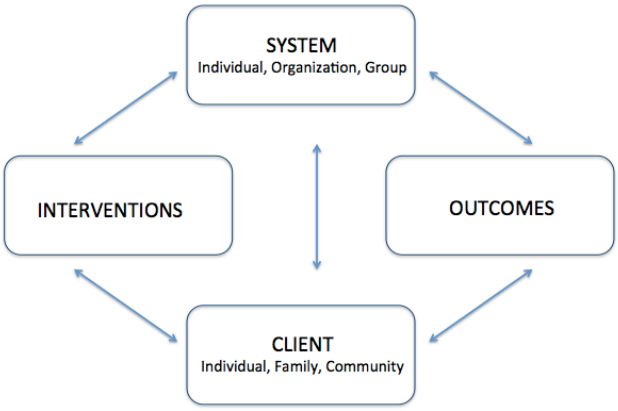

Figure 1. Quality health outcomes model. Adapted from "Health Policy. Quality Health Outcomes Model," by P. H. Mitchell, S. Ferketich, and B. M. Jennings, 1998, *Journal of Nursing Scholarship, 30*(1), p. 44. Copyright 1998 by John Wiley & Sons.

Historically, the conceptual framework regarding hospital readmissions stipulated that poor inpatient quality of care led to incomplete evaluation and management of the patient, which resulted in readmission to the hospital (Ashton & Wray, 1996). More recently, Kangovi and Grande (2011) proposed a conceptual framework for hospital readmissions, determinants of hospital readmissions, which proposed that health policy is the environment in which the patient and the health care services exist as is depicted in Figure 2. In this model, health services encompass both inpatient and outpatient services and addresses access to care and quality of care. Access to care refers to the ease in which an individual can enter a health system, whereas quality of care refers to how a patient is cared for once he or she has entered the system. The patient variable addresses the patient's health status and socioeconomic resources.

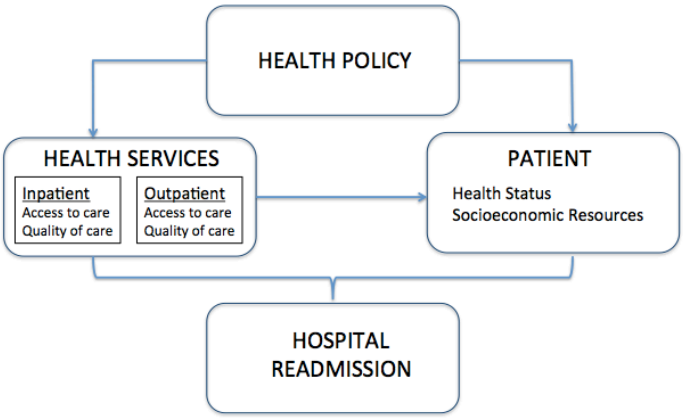

Figure 2. Determinants of hospital readmission. Adapted from "Hospital Readmissions—Not Just a Measure of Quality," by S. Kangovi and D. Grande, 2011, *Journal of the American Medical Association, 306*(16), p. 1797. Copyright 2011 by American Medical Association.

As was previously discussed in this chapter, patients with dementia often receive substandard care when treated for diagnoses, such as pneumonia (Foley et al., 2014; van der Steen et al., 2002). Edvardsson, Fetherstonhaugh, and Nay (2009) found that the diagnosis of dementia influences the way in which society and health care providers view and interact with individuals with dementia. Therefore, having a dementia diagnosis affects the care provided to these individuals. It is this concept in which the diagnosis of dementia changes the way the patient and health care system interact that is incorporated as a key element in the conceptual framework of this study. This concept is consistent with the client component of the QHOM (Mitchell et al., 1998) and with the patient component of Kangovi and Grande's (2011) framework for hospital readmissions.

Known and Unknown

Dementia and hospital readmissions. There is a paucity of research regarding hospital readmission rates and predictive factors for individuals with dementia and even more so specifically for individuals with dementia who contract pneumonia. However,

some general information about the population of individuals with dementia who experience a readmission exists (Daiello, Gardner, Epstein-Lubow, Butterfield, & Gravenstein, 2014). Daiello et al. (2014) found that older adults with dementia who experience a hospital readmission (a) are more often female, (b) have three or more comorbidities, and (c) experience longer length of stays during the index admission. Daiello et al. (2014) also found that the most common primary diagnoses upon readmission for these patients were (a) urinary tract infections, (b) congestive heart failure exacerbation, and (c) pneumonia. In studying care transitions in older adults with dementia, Callahan et al. (2015) identified that the greater the degree of severity of dementia, the higher the likelihood that the individual will experience a hospital readmission.

Hospital readmission rates for older adults with dementia have been examined in recent studies. Daiello et al. (2014) conducted a retrospective cohort study of 2009 administrative data from Rhode Island hospitals to determine if dementia was an independent predictor of 30-day readmissions. The study sample consisted of 25,839 hospitalizations for 16,244 Medicare beneficiaries. Daiello et al. (2014) examined 30-day all-cause readmissions for any index admission diagnosis and found that hospital readmissions rates were higher (17.8%) for patients with dementia as compared with 14.5% for those who did not have dementia. Similarly, in a prospective, longitudinal study of 4,197 community dwelling older adults, Callahan et al. (2012) found that the 30-day readmission rate for older adults with dementia was 23%. Callahan et al. did not include a comparative hospital readmission rate for individuals without dementia, making it difficult to determine the significance of this finding. Ahmedani et al. (2015) conducted

a study of data from the HMO Research Network Virtual Data Warehouse of 11 health systems from 2009 to 2011. The purpose of this study was to examine the impact of psychiatric conditions on all-cause hospital readmissions for index hospitalizations for (a) heart failure, (b) pneumonia, and (c) myocardial infarct. Ahmedani et al. (2015) found that the all-cause hospital readmission rate for individuals with psychiatric conditions (including dementia) was 21.7%, which is 5% higher than the readmission rate for individuals without psychiatric conditions. More specifically, Ahmedani et al. (2015) found that individuals with dementia who are admitted for an index hospitalization for pneumonia have a 25% readmission rate as compared with 16% for individuals without dementia. The issues related to dementia and hospital readmission have begun to be explored but have several limitations. These limitations include (a) inconsistencies with current CMS methodology; (b) limited, unique patient populations that may not be generalizable to the entire population of individuals with dementia; and (c) limited attempts to address potential predictive factors.

Studies have identified a link between hospital readmissions for older adults with dementia and the discharge disposition of the patient (Callahan et al., 2012; Daiello et al., 2014; Nazir et al., 2013). Skilled nursing facilities have been identified as the most common discharge disposition of older adults with dementia (Daiello et al., 2014). It has been suggested that the likelihood of a patient with dementia experiencing a hospital readmission increases when the discharge disposition of the index admission is to a skilled nursing facility (Callahan et al., 2012; Nazir et al., 2013). In addition to discharge disposition, Daiello et al. (2014) also identified (a) being female, (b) taking antipsychotic medications, (c) having longer length of stays for index admission, and (d) having a

history of previous hospital admissions as potential predictive factors in hospital readmissions of older adults with dementia.

Interventions strategies. The AHRQ suggested that health care organizations implement the following strategies to decrease hospital readmissions due to pneumonia: (a) develop a portfolio of strategies, (b) improve transitional care processes, (c) collaborate with cross-setting partners, and (d) enhance services for high-risk patients (Agency for Healthcare Research and Quality, 2014a). Vest et al. (2010) recommended that organizations implementing strategies to decrease readmissions conduct organization-specific research before implementing strategies due to current gaps in the literature. Programs to decrease hospital readmissions are being implemented across the nation (Askren-Gonzalez & Frater, 2012; Enguidanos, Gibbs, & Jamison, 2012; Morello et al., 2015; Ornstein, Smith, Foer, Lopez-Cantor, & Soriano, 2011). Decreases in hospital readmission rates have been indicated in initial results with some programs (Jack et al., 2009; Voss et al., 2011). Unfortunately, interventions for patients with dementia were not specifically targeted by any of these programs, and in fact, individuals with dementia are often purposefully excluded from programs.

Contribution to the Field

This study established baseline knowledge about hospital readmissions for patients with dementia who have an index admission for pneumonia. Development of programs to decrease all-cause pneumonia readmissions and the associated costs is dependent on having a thorough understanding of factors influencing readmissions. Expanding current research to analyze data for high-risk subgroups of the population could provide additional information about factors influencing readmission rates. This

study provides insight into the factors that influence the risk of hospital readmissions for patients with dementia who have an index admission for pneumonia. Knowledge gained from this study provides baseline data for developing and tracking the effectiveness of future interventions aimed at decreasing hospital readmissions in this patient population. This study contributes to existing literature regarding pneumonia readmissions.

Summary

Significant time and attention is being devoted to identifying factors that influence hospital readmission rates for individuals diagnosed with pneumonia. Research specific to hospital readmissions is still in its infancy, and multiple facets have yet to be explored. Examining hospital readmission rates for potentially high-risk subgroups within the population of patients with pneumonia is supported by existing literature. This study examined the subgroup of patients with pneumonia who have a known diagnosis of dementia and expanded on the current understanding of the factors affecting hospital readmissions. The following chapter outlines the methodology for this study.

Chapter 3: Methodology

The introduction and literature review have justified the need and value of this study of all-cause pneumonia readmission rates of older adults with a known diagnosis of dementia as compared to older adults without dementia. This chapter provides a detailed description of the methods used for this study. Research methods to be discussed include (a) study design, (b) published methodology, (c) database selection, (d) data collection, (e) variables, and (f) data analysis. Additionally, resource requirements, reliability and validity, and timeline are addressed.

Study Design

The type of research questions being posed determines study design. This study identified the incident rate of all-cause pneumonia readmissions occurring in older adults with a known diagnosis of dementia and determined the impact of a dementia diagnosis on factors predictive of all cause pneumonia readmission. Second, the incident rate and predictive factors of older adults with pneumonia and a known diagnosis of dementia were compared to older adults with pneumonia who do not have a known diagnosis of dementia in this study. Non-experimental research does not attempt to manipulate the independent variable and is used to investigate new areas of inquiry or to identify existing factors and their associated relationships (Christensen et al., 2014). Utilization of a non-experimental research method was appropriate and consistent with the research questions posed in this study.

Correlational research is a type of non-experimental research that measures two or more variables in a natural state and seeks to determine the size and direction of the relationship (Christensen et al., 2014). Correlational research is limited by an inability to

determine cause and the potential influence of extraneous variables (Christensen et al., 2014). Correlational studies can be cross-sectional or longitudinal. Longitudinal studies are designed to collect data multiple times over a long period of time. Cross-sectional research is designed to examine data that were collected during a single, relatively short period of time (Christensen et al., 2014). When used to explore new areas of inquiry, the purpose of cross-sectional research is to identify representative samples that differ on a given variable and then measure outcomes during a set period of time (Christensen et al., 2014).

Analytical techniques used in correlational research include (a) descriptive statistics, (b) correlation, and (c) regression. Benefits of non-experimental research include (a) minimizing the practical challenges and logistics of experimental studies, (b) providing a natural understanding of the situation, and (c) having a strong ability to measure co-variance. Disadvantages of non-experimental research include (a) decreased control over the study as compared to experimental research, (b) the inability to establish causal relationships, and (c) difficulty in ruling out the influence of extraneous variables (Rose, Spinks, & Canhoto, 2015).

Data sources for correlational research may be primary or secondary and can be collected through (a) questionnaires, (b) direct observation, or (c) from organizational datasets (Rose et al., 2015). Datasets are considered secondary when they are being used for purposes other than the purpose for which they were originally gathered (Boslaugh, 2007). The advantages of secondary datasets include the following:

1. Decreased resources devoted to data collection.

2. Minimized cost for data collection as compared to the cost of collecting new data.
3. Decreased time spent on data collection.
4. Availability of a large breadth of data (Boslaugh, 2007; Christensen et al., 2014).

The primary disadvantage of secondary data is the limited or complete lack of control the researcher has over the dataset. Additional disadvantages of secondary data include the following:

1. The risk that not all of the variables of interest are available in the dataset.
2. The challenge of having the variables defined in a manner that is not consistent with the desired definitions.
3. The withholding of certain information that was gathered but not released to secondary researchers.
4. Uncertainty in the process of data collection (Boslaugh, 2007).

For this study, the benefits of (a) decreased time devoted to data collection, (b) minimized costs, (c) extraction of a large sample, and (d) facilitation of data collection and analyses in a timely manner outweighed the disadvantages of using a secondary dataset. This study utilized a quantitative, correlational, cross-sectional, retrospective study design to analyze publicly available secondary data.

Published Methodology

Several methodologies have been proposed for defining, identifying, and studying readmissions (Barrett, Raetzman, & Andrews, 2012). The most commonly used measures include the following:

1. Agency for Healthcare Research and Quality HCUP 30-day readmission measure.
2. Centers for Medicare and Medicaid Services readmission measure.
3. National Committee on Quality Assurance (NCQA) plan-level readmission measure.
4. United Health Group (UHG) all-cause readmission measure.
5. 3M potentially preventable readmission measure (Barrett et al., 2012).

While there are similarities across these measures, there are also differences that are important to consider when selecting a measure. Most of these measures focus on hospital-level readmission rates with the exception of the HCUP measure and the NCQA measure. The HCUP focuses on estimates of nationwide readmission rates and the NCQA focuses on insurance plan readmission rates (Barrett et al., 2012). Because the purpose of this study was to look at nationwide readmission rates, the HCUP 30-day readmission measure was the foundation for the methods utilized in this study.

The HCUP measure addresses 30-day, all-cause readmissions for patients aged 1 year and older, admitted within one calendar year, and who were discharged alive with a condition of interest (Barrett et al., 2012). Exclusion criteria include (a) individuals discharged in December, (b) individuals who died in the hospital, and (c) individuals younger than a year old. Additionally, records with (a) missing patient identifiers, (b) missing length of stay, or (c) 20 or more records were excluded (Barrett et al., 2012).

Index admissions are defined by HCUP as every hospital record in which the patient has the condition of interest on discharge (Barrett et al., 2012). The HCUP measure does not require the patient to have a clean period prior to the first index

admission nor does the HCUP measure require a patient to be with a payer source for a set amount of time prior to counting an index admission. The index admission must occur between January 1 and November 30. This time frame is imposed because individuals cannot be tracked from year to year in HCUP databases, so individuals discharged in December cannot be tracked for 30 days.

The HCUP measure defines a qualifying readmission as the first all-cause hospital readmission within 30 days of the index admission (Barrett et al., 2012). The HCUP measure counts readmissions to any hospital. The HCUP measure allows a record to be both an index admission and a readmission, which is not consistent with the CMS measure that states that a discharge record cannot be both an index admission and a readmission (Barrett et al., 2012). These differences in technique can lead to discrepancies in reported readmission rates (Dharmarajan et al., 2013; Hemenway & Naretta, 2015; Hines et al., 2014; Mather et al., 2014; Navarro et al., 2012; Shorr et al., 2013; Suter et al., 2014). HCUP does not count transfer records as readmissions and combines transfers that occur on the same day as the index admission with the index admission into one record (Barrett et al., 2012). The criteria of the HCUP 30-day measure was modified to meet the inclusion and exclusion criteria of this study and to allow comparison of the results of this study to existing literature.

Database Selection

A wide variety of secondary datasets are available for public access. Factors that should be considered when selecting a database include (a) dataset complexity, (b) available data elements, (c) cost, (d) time to acquire the database, and (d) the reputation of the rigor of the agency providing the database (Smith et al., 2011). The Healthcare

Utilization Project established by the AHRQ is a set of health care databases and tools developed through a state and federal collaboration that are available for purchase publically (AHRQ, 2015c). HCUP contains the largest collection of hospital data in the United States, representing 97% of all hospital discharges (AHRQ, 2015c). Forty-seven states contribute data to HCUP (2015c). Discharge-level data contained in HCUP databases include (a) inpatient, (b) ambulatory surgery, and (c) emergency department records (AHRQ, 2015c). HCUP databases are structured to do the following:

1. Create consistency among sources while maximizing the amount of information retained from original sources.
2. Transform data into a uniform format that allows multistate comparisons and tracking of patients from admission to admission.
3. Provide structure that allows data to be efficiently stored, edited, manipulated, and analyzed. (AHRQ, 2015c)

HCUP databases are available as nationwide databases or as individual state databases. Nationwide databases include the (a) Nationwide Inpatient Sample, (b) Kids Inpatient Database, (c) Nationwide Emergency Department Sample, and (d) Nationwide Readmissions Database (NRD). The state level databases include the (a) State Inpatient Databases (SID), (b) State Ambulatory Surgery and Services Databases, and (c) State Emergency Department Databases (AHRQ, 2015c).

The method of data coding that HCUP utilizes results in a useable database that retains as much of the original data as possible. This method also provides uniformity across states and protects patient confidentiality (AHRQ, 2008). Table 1 illustrates the HCUP principles of data coding.

Table 1
Coding Conventions

Examples of data elements	Action taken on values
Diagnosis and procedure codes	Retained in the form provided by the data source
Physician identifiers, person identifiers	Encrypted into synthetic values
Sex, race, expected primary pay source	Recoded into uniform coding schemes
Age, length of stay, day of procedure	Calculated (when possible)
Diagnosis-related groups (DRGS), clinical classification software	Assigned using external algorithms

Note: Adapted from "HCUP Coding Practices" by Agency on Healthcare Quality and Research, 2008, (www.hcup-us.ahrq.gov/db/coding.jsp). Copyright 2008 by U.S. Department of Health and Human Services.

HCUP revisit variables allow researchers to analyze hospital visits for an individual over time and across hospital settings (AHRQ, 2014b). Revisit data is available within the SIDs from select states and within the NRD. The NRD is a database compiled from information in the SIDs, specifically for the purpose of studying readmissions. It contains discharge data from 21 geographically dispersed states and accounts for approximately 49% of all hospitalizations in the United States (AHRQ, 2015f). Records are included for individuals of all ages and for all payer sources.

The 2013 NRD was the most current version of the NRD available at the time of this study, and the cost for students was $150.00. The 2013 NRD contains data from approximately 14 million discharges, which when weighted represents approximately 36 million discharges. The NRD includes both clinical and nonclinical variables that allow for detailed assessment of hospital readmissions. The NRD variables include (a) patient linkage numbers, (b) time between admissions, (c) length of stay, (d) admission source, (e) weighting variable for national estimates, (f) International Classification of Disease (ICD-9) diagnosis and procedure codes, (g) patient demographics, (h) payment source, (i) discharge disposition, and (j) total charges and hospital cost (AHRQ, 2015f). The 2013 NRD was selected as the database for this study.

Participant Characteristics

Inclusion. The target sample for this study was individuals aged 65 and older with a primary discharge diagnosis of pneumonia. This target sample was separated into two groups: those who have a known diagnosis of dementia and those that do not. The primary diagnosis of pneumonia and the diagnosis of dementia were identified by ICD-9 clinical modification (CM) diagnosis codes recorded in the patient's record (see Appendix A and Appendix B).

Exclusion criteria. Each of the exclusion criteria and the associated rationale for the exclusion criteria are identified on Table 2. There are exclusion criteria that apply to the entire study and separate exclusion criteria that apply to index admissions and to readmissions. Exclusion criteria are consistent with previously established readmission measures (Barrett et al., 2012).

Table 2
Exclusion Criteria

	Criteria	Rationale
Entire study	64 years or younger	The target population for this proposed study is older adults aged 65 and older.
	No index admission for PNA	If the patient has no recorded admission for PNA the record is not relevant to this study.
	Missing visitLink identifier	This variable is needed to track patients from admission to admission. If a record does not have a visitLink identifier the patient cannot be tracked for readmissions.
	Missing Days to event	This variable is needed for the calculation required to identify readmissions that occur within 30 days of the index admission. If this variable is missing the time from discharge to readmission cannot be calculated.
	Missing length of stay	This variable is needed for the calculation required to identify readmissions that occur within 30 days of the index admission. If this variable is missing the time from discharge to readmission cannot be calculated.
Index admission	Died in the hospital	Individuals who die in the hospital are excluded because this study is interested in tracking readmission. Death in the hospital makes it impossible for the patient to be readmitted.
	Discharged AMA*	Individuals who discharge themselves against medical advice are considered outliers and are generally excluded from readmission studies.
	December admission date	Individuals admitted in December cannot be tracked for 30 days for readmission due to the nature of the Healthcare Utilization Project databases being for one calendar year only.
Readmissions	Scheduled readmissions	Scheduled readmissions are removed from readmissions because they are considered to be a different type of event than a readmission.

Note: AMA = against medical advice. Adapted from *Overview of Key Readmission Measures* (HCUP Methods Series Report No. 2012-04), by M. Barrett, S. Raetzman, and R. Andrews, 2012, Rockville, MD: Agency on Healthcare Quality and Research. Copyright 2012 by U.S. Department of Health and Human Services.

Variables

All variables in this study were extracted or created from the data available in the NRD. The primary outcome measure for this study was occurrence of all-cause pneumonia readmission rates (OCRA). The presence of a diagnosis of dementia was used as an interactive variable in order to assess the impact of dementia on predictive factors for all cause pneumonia readmissions. Predictive factors that were examined include

patient level and hospital level factors. Variable details including (a) operational definitions, (b) level of coding, and (c) association with research questions are described in Tables 3 through 6.

Table 3
Calculation Variables

Variable	Operational definition	Level of coding	Use
Primary diagnosis (DX1)	The diagnosis identified at discharge as the reason for the admission.	Character ICD-9 CM codes	Data structuring
Diagnoses (DXn)	Comorbidities as identified by ICD-9 codes	String	Data structuring
Pneumonia diagnosis* (PNADX)	Indicates the presence of a primary diagnosis of pneumonia based on ICD-9 codes for pneumonia present in DX1	Categorical, 0: absent 1: present	Data structuring
Patient identifier (visitLink)	An encrypted patient linkage variable that allows a patient to be tracked from admission to admission.	String	Data structuring
Index admission* (IA)	An admission with a primary diagnosis of PNA that meets all inclusion criteria.	Categorical, 0: absent 1:present, 2:non-qualifying	Data structuring
Days to event (DToE)	The time between a random, encrypted start date and the admission date. This timing variable, in combination with visitLink and LOS, was used to calculate time between discharge and readmission.	Continuous 0-365	Data structuring
Length of stay (LOS)	The time between the patient's admission and discharge	Continuous 0-365	Data structuring
Time to revisit* (TtoRV)	The amount of time between a discharge and a new admission to a hospital for a patient. Calculated by subtracting DToE and LOS of the first admission from DToE of the second admission.	Continuous 0-365	Data structuring
Readmission* (RA)	This variable identifies if a record qualifies as a readmission.	Categorical, 0: absent 1: present 2:non-qualifying	Data structuring
Discharge weights (DISCWT)	Weight to discharges in the universe	----------	Weighting

Note: Variables with an * are variables that were created based on the existing data in the NRD.

Table 4
Criterion and Interaction Variables

Variable	Operational definition	Level of coding	Research questions
Criterion variable			
Occurrence of readmission	This variable indicates whether or not a qualifying index admission was followed by a qualifying readmission.	Categorical 0: absent 1: present	1,2,3,4,5
Interaction variable			
Dementia diagnosis* (DEMDX)	Indicates if an ICD-9 code for a dementia diagnosis is present in DX2-24	Categorical 0: absent 1: present	1,2,3,4,5

Note: Variables with an * are variables that were created based on the existing data in the NRD.

Table 5
Patient Predictor Variables

Variable	Operational definition	Level of coding	Research questions
Age	Age in years calculated from birth date to admission date	0-90	3,4,5
Sex (Female)	The sex of the patient	0: male 1: female	3,4,5
Number of visits	Total hospital admissions in 2013	0-19	3,4,5
Number chronic condition (N_Chronic)	The count of unique chronic conditions reported at discharge	0-30	3,4,5
Number of diagnoses (NDX)	Total number of diagnoses coded at discharge.	0-30	3,4,5
Single-level diagnoses (CCS)	Single-level diagnosis classification scheme aggregating illnesses and conditions into mutually exclusive, homogeneous categories. See Appendix C for full list of all single-level diagnoses.	0: absent 1: present	5
Multilevel diagnoses (MCCCS)	Hierarchical system of ICD-9 codes and Single-level CCS diagnoses to creating categories of conditions. See Appendix D for full list of multilevel diagnoses.	0: present 1: absent	5
Loss of function (APRDRG_Severity)	A variable developed by 3M Health Information Systems to indicate the extent of physiological decompensation or loss of function.	1: Minor 2: Moderate 3: Major 4: Extreme	3,4,5
Risk of mortality (APRDRG_Mortality)	A variable developed by 3M Health Information Systems to indicate the likelihood of death	1: Minor 2: Moderate 3: Major 4: Extreme	3,4,5
Payer source (Pay1)	Indicates the expected payer	1:Medicare 2:Medicaid 3:Private 4:Self pay 5:No charge 6:Other	3,4
Patient location (PL_NCHS)	County location of the patient based on county characteristics from the Department of Agriculture and the Census Bureau	1: Central-metro 2: Fringe-metro 3:Counties small 4:Counties large 5:Micropolitan 6:Non metro/micro	3,4,5
Total charges (TOTCHG)	Total charges for an admission rounded to the nearest dollar.	Continuous	3,4,5
Median household income (ZIPNC_QRTL)	Quartile classification of the estimated median income for residents in the patient's zip code.	1: First (low) 2: Second 3: Third 4: Fourth (highest)	3,4,5
Discharge disposition (DISPUniform)	Indicates the discharge disposition of the patient.	1: Routine 2: Short term hospital 5: Skilled Nursing 6: Home health care	3,4,5

Note: Variables with an * are variables that were created based on the existing data in the NRD.

Table 6
Hospital Predictor Variables

Variable	Operational definition	Level of coding	Research questions
Hospital bed size (Hosp Bedsize)	Category identifying small, medium or lager hospital size.	Categorical 1: small 2:medium 3: large	5
Hospital location (HOSP-URCAT4)	Indicates the urban-rural designation of the hospital location	Categorical 1: Large metro 2:Small metro 3:Micro 4:Non metro/micro	5
Teaching hospital (HOSP-UR-Teach)	Indicates the teaching status of the hospital	Categorical 1: Metro-non 2: Metro- yes 3:Non metro	5

Note: Variables with an * are variables that were created based on the existing data in the NRD.

Data Collection and Structuring

The 2013 NRD was delivered in the form of zipped files on a DVD. Instructions for use and analysis of the NRD database were obtained from HCUP and reviewed prior to data collection. HCUP provides the NRD data in an ASCII file format. SPSS load programs were downloaded from the HCUP Web site. Using the SPSS load programs, the unzipped ASCII file was loaded into SPSS. Once loaded into SPSS, database statistics were compared against 2013 NRD statistics published by HCUP to ensure that the file had loaded properly. Data collection began upon receipt of the institutional review board (IRB) protocol number and final approval from the IRB. Data collection was a multistep process that included (a) restructuring of data, (b) creation of new variables, and (c) application of inclusion and exclusion criteria to arrive at an appropriate sample.

Restructuring of data. The NRD included several variables that were not relevant to this study; those variables were removed from the dataset. The data in the

NRD arrived formatted with each discharge record on a separate row. In order to apply the inclusion and exclusion criteria and to analyze the data, the database needed to be restructured so that each row represented one individual, which was accomplished using the visitLink variable. Once all inclusion and exclusion criteria had been applied and new variables had been created, the data were transformed back so that each row represented one discharge record.

Creation of new variables. In order to perform the data analysis for this study, some existing variables within the database were restructured, and others variables needed to be created based on the available data. For this study, DX1, a string variable containing ICD-9 codes, was recoded into a dichotomous, categorical variable called PNA. This is the variable that was used to determine if a discharge record had a primary diagnosis of pneumonia. The specific ICD-9 CM codes (see Appendix A) used to determine the presence of pneumonia were consistent with the codes included in the CMS pneumonia readmissions measure (Kim et al., 2013).

Similarly, the remaining diagnosis variables, DX2 through variable DX25, were recoded into dichotomous, categorical variables, DementiaDx2 through DementiaDx25. These recoded variables were the basis of creating a new variable, DEMDX, to indicate if any of the 24 diagnoses contained a dementia diagnosis. The ICD 9 codes used to identify the presence of dementia in a record are listed in Appendix B. This DEMDX variable was used throughout the data analysis to compare and contrast older adults with and without dementia.

Each discharge record was classified as (a) an index admission, (b) a readmission, or (c) a non-qualifying record. In order to do this classification, an index admission

variable (IA) and a readmission variable (RA) were created. These new variables were created based on the inclusion and exclusion criteria for index admissions and readmissions outlined in Table 2.

For the readmission variable, a few extra steps had to be taken to determine if the record met the criteria for a readmission. Revisit variables contain an encrypted patient identifier (visit Link) that allows individuals to be tracked over time without violating patient privacy laws (Agency for Healthcare Research and Quality, 2014b). HCUP also assigns each individual a unique start date that allows time between visits to be calculated without revealing protected health information. The days to event variable indicates the amount of time between the unique start date assigned to the patient and the admission date (AHRQ, 2015e). The length of stay variable (LOS) indicates the amount of time between the admission and discharge of a record. The time between one discharge and the next hospital admission (time to revisit variable) can be determined by subtracting the value of the days to event variable and length of stay variable for the first admission from the value of the days to event variable for the second admission. A categorical readmission variable (RA) was then created to separate records with time to revisit less than or equal to 30 from those records with time to revisit greater than 30. Coding of the readmission variable (RA) indicates if the readmission met inclusion criteria and counts as a readmission. In order to identify if an index admission was followed by a readmission, a new dichotomous, categorical variable, occurrence of readmission (OCRA) was created.

And lastly, a new variable was created for each of the single-level CCS diagnoses and the multilevel CCS diagnoses using the ICD 9-CM codes present in DX2-DX25. The

CCS for ICD-9 CM is a diagnosis categorization scheme developed by HCUP to condense the roughly 14,000 ICD-9-CM codes into smaller, clinically meaningful categories that can be used for analysis (HCUP, 2016b). There are 285 mutually exclusive, aggregate categories referred to as single-level diagnoses (HCUP, 2016a). These single-level diagnoses are composed of clinically homogeneous ICD-9 CM codes. Single-level CCS diagnoses codes are then grouped together to create 18 multilevel CCS diagnoses categories (HCUP, 2016a). The multilevel CCS diagnoses represent 17 body systems. Categorical variables were created for each of the single-level and multilevel CCS codes used in this study. A full list of the single-level and multilevel CCS codes used in this study can be found in Appendix C and D, respectively.

Application of inclusion and exclusion criteria. Two of the exclusion criteria for this study were address by HCUP prior to the release of the 2013 NRD. First, HCUP removed all records from the NRD that had 20 or more visits, which is consistent with the methodology of the AHRQ HCUP 30-day readmission measure (Barrett et al., 2012). The AHRQ HCUP 30-day readmission measure does not allow discharge records that transferred out to another acute care hospital to be counted as an index admission. However, in the 2013 NRD, HCUP has collapsed pairs of records in which a discharge record with a transfer out disposition occurs on the same day as a discharge record with a transfer in admission status into one record (AHRQ, 2015d). Information from both admissions have been combined and the new record is labeled a same day event and is eligible to be considered as a potential index admission or a potential readmission (AHRQ, 2015d). All other inclusion and exclusion criteria were applied to the sample as

outlined in the above section. Outcomes of the application of the inclusion and exclusion criteria are described below.

Sample size. The size of the sample utilized in this study was determined once the database had been structured to remove patient records that meet the exclusion criteria. Approximately 40% of the 14 million discharge records included in the 2013 NRD are over the age of 65 (Agency for Healthcare Research and Quality, 2015f). Given the size of the 2013 NRD and the percentage of records of older adults contained within the NRD, it was reasonable to expect that the records meeting inclusion criteria would be of adequate number to provide an appropriately sized sample. The NRD contains 14,325,172 unweighted discharge records. Application of inclusion and exclusion criteria resulted in an unweighted sample of 163,642 discharge records, representing 155,861 patients. Weighted, this sample represents 389,198 records and 370,003 patients. The steps taken to arrive at this sample are depicted in Figure 3.

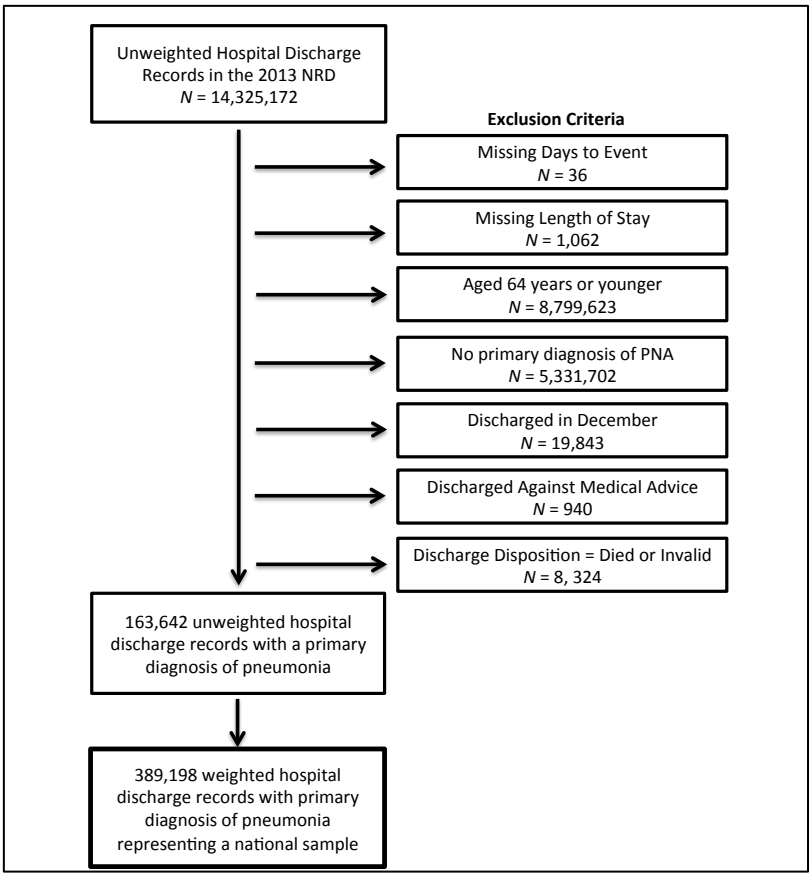

Figure 3. Extraction of sample from the 2013 NRD.

Study sample characteristics. The discharge records included in the sample represented individuals ranging in age from 65 to 90 years of age with a mean age of 79. Fifty-four percent of the discharge records were for women. Individuals averaged two hospital discharges each during 2013, had an average of approximately 13 diagnoses, and had approximately six chronic conditions. The average length of stay was 5 to 6 days, was paid for by Medicare (91%), and cost approximately $37,500. The majority of discharge records indicated a moderate (43%) to major (43%) loss of function and moderate (46%) to major (35%) risk for mortality. Discharge records were almost equally distributed across the four quartiles for median household income by the patients' zip codes. Most discharge records were from hospitals with large bed capacities (56%) that

were located in large metropolitan areas (47%) and that were classified as non-teaching hospitals (48%). Table 7 (Patient Characteristics) and Table 8 (Hospital Characteristics) provide full details of the descriptive statistics for the weighted sample used in this study.

Table 7.
Demographics of the Sample: Patient Characteristics

Variable	Total
Discharge records (n = 163,642^{uw})	389,198^{w}
Patients, 155, 861^{uw}	370, 003^{w}
Age	79.10 (7.87)
Sex (female)	54%
Number of visits	2.12 (1.77)
Number of diagnoses	12.79 (5.196)
Number of chronic conditions	6.49 (3.031)
Length of stay	5.44 (5.57)
Payer	
Medicare	91%
Medicaid	1.5%
Private insurance	5.2%
Self-pay	0
No Charge	0
Other	1.2%
Discharge Disposition	
Routine	48.7%
Short-term hospital	1.0%
Skilled-nursing facility	28.6%
Home health care	21.7%
Alive, unknown	<1%
Total charges[a] (n = 160, 640^{uw})	37,478 (55,965)
Loss of function	
Minor loss of function	6.5%
Moderate loss of function	42.9%
Major loss of function	43%
Extreme loss of function	7.6%
Risk of mortality	
Minor likelihood of dying	11.1%
Moderate likelihood of dying	45.6%
Major likelihood of dying	35%
Extreme likelihood of dying	8.3%
Median household income by zip code	
First: 1-37,999 (poorest)	27.1%
Second: 38,000-47,999	27.5%
Third: 48,000-63,999	24.2%
Fourth: 64,000 & above (richest)	19.6%
Patient location: Urban/rural code	
Central (metro ≥ 1 million)	24.7%
Fringe (metro ≥ 1 million)	21.6%
Metro (250,000-999,999)	20.3%
Metro (50,000-249,999)	11%
Micropolitan counties	11.8%
Not metropolitan or micropolitan	10.5%

Note: a. Missing values with sample size provided. Weighted = *w*. Unweighted = *uw*.

Table 8.
Demographics of the Sample: Hospital Characteristics

Variable	Total
Discharge records (n = 163,642[uw])	389,198[w]
Patients, 155,861[uw]	370,003[w]
Hospital location:	
Large metropolitan	46.9%
Small metropolitan	34.5%
Micropolitan	11.3%
Not metropolitan or micropolitan	7.3%
Hospital bed size	
Small (1-249)	17%
Medium (250-449)	26.8%
Large (450+)	56.2%
Teaching status	
Metropolitan/non-teaching	47.6%
Metropolitan/teaching	33.8%
Non-metropolitan	18.6%

Note: Weighted = *w*. Unweighted = *uw*.

Data Analysis

Statistical analyses were conducted utilizing SPSS 21 (IBM Corp, 2011) and Stata 14.1 (StataCorp., 2015). The statistical analyses for this study included descriptive and inferential analyses. Descriptive statistics were utilized to describe the demographics of the sample population. Differences between groups were analyzed using chi-square, *t* test, or non-parametric statistics as appropriate. A generalized linear model was utilized to examine predictive factors for all-cause pneumonia readmissions. All statistical analyses were performed with a weighted sample, using the weights provided by HCUP.

Weights. Discharge weight variables (DISCWT) contained in the NRD were used during data analysis. These discharge weights allow the sample contained within the 2013 NRD to be extrapolated to a national estimate. The following paragraphs describe the process used by HCUP to create these discharge weight variables.

Target universe refers to the entire group of individuals or entities to which investigators wish to generalize the results of a study (Christensen et al., 2014). The target universe for the NRD is "inpatient discharges treated at community hospitals in the United States that were not rehabilitation or LTAC facilities" (AHRQ, 2015d, p. 13). HCUP gathered information on the target universe from the American Hospital Association's (AHA) annual survey of hospitals (AHRQ, 2015d). It is not normally possible for researchers to include all individuals or entities in the target universe in a study for a variety of reasons. Thus, those individuals or entities within a target universe that are accessible to the researcher are referred to as the sampling frame (Christensen et al., 2014). The sampling frame for the NRD was "limited to discharges for patients treated at community hospitals in the NRD States that were not rehabilitation or LTAC facilities" (AHRQ, 2015d, p. 13). The NRD is a sample of convenience as all records included in the sampling frame were included in the NRD (AHRQ, 2015d).

HCUP created discharge weights for national estimates for the NRD using the target universe as the standard (Agency for Healthcare Research and Quality, 2015d). In order to ensure that the sampling frame appropriately represented the target universe, post-stratification (after sampling) techniques were used. As documented by previous research, inpatient outcomes were influenced by the following hospital characteristics: (a) census region, (b) urban/rural location, (c) hospital teaching status, (d) size of the hospital defined by number of beds, and (e) hospital control (AHRQ, 2002; 2015d). For this reason, HCUP used a post-stratification technique to ensure that the sampling frame did not include over- or under- representation of types of hospitals or types of discharges in relation to the target universe as defined by the AHA's annual hospital survey data. Post-

stratification techniques were also employed for patient characteristics, such as age (divided into five age groups) and sex (AHRQ, 2015d).

Next, discharge counts were determined for both the target universe and the sampling frame (AHRQ, 2015d). Target universe discharge counts were based on all discharges contained in all 2013 SIDs and augmented with the AHA data. Discharge counts for the sampling frame were based on all discharges contained in the NRD, which includes 21 of the SID. To create discharge weights, the number of discharges for the target universe and sampling frame were summarized by strata as defined by hospital and patient characteristics. To ensure that each stratum had an adequate number of hospitals and discharges in each stratum, strata were collapsed based on the following characteristics and in the following order: (a) hospital control/ownership, (b) hospital location, and (c) bed size. Strata were not collapsed based on hospital region or teaching status. The formula for the discharge weights (DISCWTij) in which (i = sex) and (*j* = age) group is as follows: $DISCWT_{ij} = Ns(universe)_{ij} + Ns(sample)_{ij.}$ Thus, the discharge weight indicates the number of inpatient discharge records that it represents in the stratum for 2013. These discharge weights were used to create a national estimate of pneumonia readmission rates based on the sample collected from the NRD (AHRQ, 2015d).

Research Question 1. What is the all-cause pneumonia readmission rate for older adults diagnosed with dementia and for older adults with no known diagnosis of dementia? The variable used to determine the all-cause pneumonia readmission rate was occurrence of readmission. A frequency rate was calculated to the hundredth degree using SPSS 21(IBM Corp, 2011) to determine the all-cause pneumonia readmission rate

for (a) the entire sample, (b) older adults without dementia, and (c) older adults with dementia.

Research Question 2. Is there a significant difference in the all-cause pneumonia readmission rate for older adults with dementia as compared with the all-cause pneumonia readmission rate for older adults without dementia? A bivariate analysis, using a Rao-Scott chi-square test, was calculated in Stata 14.1 (StataCorp., 2015) to determine if a significant difference existed between the all-cause pneumonia readmission rates for older adults with and without dementia. Parameter estimates with odds ratios were used to identify differences in the odds of all cause pneumonia readmission between older adults with dementia and older adults without dementia.

Research Question 3. Is there a significant difference between patient factors of older adults with dementia who were readmitted and patient factors of older adults without dementia who were readmitted? A statistical analysis comparing predictor variables for older adults with dementia who were readmitted to older adults without dementia who were readmitted was performed using SPSS 21 (IBM Corp, 2011). Chi-square tests with Cramer's V were calculated for categorical variables and independent *t* tests with Cohen's *d* were calculated for continuous variables.

Research Question 4. Is there a significant difference between patient factors of older adults with dementia who were readmitted and patient factors of older adults with dementia who were not readmitted? Statistical analyses comparing predictor variables for older adults with dementia who were and were not readmitted was performed using SPSS 21(IBM Corp, 2011). Chi-square tests with Cramer's V were calculated for categorical

variables and independent *t* tests with Cohen's *d* were calculated for continuous variables.

Research Question 5. Does the diagnosis of dementia affect the predictive factors for all-cause pneumonia readmissions? To address this research question, several steps were taken. A bivariate analysis of all variables was calculated followed by a generalized linear model with weighted estimates. Calculation of the generalized linear model included parameter estimates with odds ratios and pairwise comparisons of significant findings. Subanalyses included analysis of specific comorbid diagnoses and one of the factors that was found to significantly interact with dementia. These methods were performed in Stata 14.1 (StataCorp., 2015).

Reliability and Validity

Using large datasets for secondary analysis poses unique threats to validity and reliability. When using secondary data, especially administrative data, it is important that the primary data collection and the secondary data analysis are conceptually congruent (Magee, Lee, Giuliano, & Munro, 2006). Risk of errors will be decreased and validity will be increased if the secondary analysis aligns with the original framework that guided primary data collection. Additionally, it is crucial that consideration be given to the selection of variables that will be analyzed in order to minimize the threats to validity (Magee et al., 2006).

Quality assurance checks. Quality assurance checks are used to determine reliability and validity of data. Quality assurance checks are of particular importance in administrative databases because the data was originally collected for purposes other than

research (Motheral et al., 2003). HCUP takes several steps to ensure the quality of the data contained in all databases available from HCUP.

HCUP assess each discharge record for (a) validity of values, (b) internal consistency, and (c) consistency with established norms (AHRQ, 2015b). To validate the values contained in the databases, HCUP checks the values against the values and ranges permitted by the data source and against accepted normative value ranges (AHRQ, 2015). To assess the internal consistency, HCUP compares the values of related data variables for congruence. HCUP specifically checks the following variables for validity and consistency:

1. Age and date of birth.
2. Admission date, discharge date, length of stay.
3. Procedure day.
4. Total charges.
5. ICD-9-CM diagnosis and procedure codes.
6. External cause of injury codes.
7. CPT/HCPCS procedures (AHRQ, 2015b).

HCUP has specific descriptions of each check and courses of action to be taken if any record should fail to pass any check. These strategies serve to verify the validity and consistency of the available data while minimizing the amount of data removed and maximizing the usability of the database.

Internal validity. Internal validity refers to the accuracy and quality of a study (AHRQ, 2015b). In correlation studies, internal validity is often low due to an inability to control for confounding variables. Threats to internal validity in correlational studies

include (a) subject characteristics, (b) mortality, (c) instrument decay, (d) location, (e) testing, (f) history, (g) data collector variables, and (h) data collector bias (Christensen et al., 2014). For correlational studies involving large datasets, the threat of history is of particular interest. History refers to an external event that occurs during the course of data collection that can alter the validity of the data. In secondary data analysis, changes in data reporting and coding over time can lead to erroneous data and compromise internal validity. HCUP maintains consistency in coding procedures for a given year in order to minimize error (AHRQ, 2015). However, changes in coding practices at the hospital and state level cannot be accounted for or controlled. Selecting a database that provides detailed information about (a) which data were collected, (b) data collection procedures, and (c) coding procedures can minimize threats to internal validity (Christensen et al., 2014) . The HCUP NRD meets these criteria.

External validity. External validity refers to the ability to generalize the findings of a study to people outside of the study (Christensen et al., 2014). In studies utilizing large databases, external validity is often high while internal validity is low (Magee et al., 2006). Threats to external validity compromise the generalizability of the findings. The selection of secondary datasets poses a threat to external validity. When choosing a secondary dataset, it is important to consider the similarities between the target population and the sample included in the database. External validity is also influenced by researcher decisions about sampling (Magee et al., 2006). Complex sampling can make the results more generalizable and increase external validity. It is also important to be careful of artificial inflation of the significance of results. It is important to distinguish between statistical significance and clinical significance when interpreting the findings of

secondary data analysis. Steps should be taken to minimize Type I errors (Motheral et al., 2003).

Ethical Considerations/Confidentiality

The required IRB form was completed and submitted to the IRB of the College of Health Care Sciences at Nova Southeastern University. After receiving approval from the IRB at Nova Southeastern University, a secondary IRB was submitted to the Spaulding Rehabilitation Hospital IRB. The data collection and data analysis began after receiving IRB approval from both institutions.

All datasets released by HCUP must follow the Health Insurance Portability and Accountability Act of 1996 (HIPAA) rules and regulations (AHRQ, 2015a). AHRQ removes direct identifiers from all collected data stored in HCUP databases consistent with HIPAA prior to releasing any of the data to the public (AHRQ, 2015d). This study adhered to all HIPAA and AHRQ data user agreement requirements in order to protect the confidentiality and privacy of participants. The risk of a breach of confidentiality of privacy in this study was minimal. Tabulated data with 10 or less values increases the risk of a breach of confidentiality and privacy. In order to minimize the risk of a breach of confidentiality or privacy, information in which the number of observations in any given cell of tabulated data were less than or equal to 10 was not reported. HCUP releases the NRD data in the form of a DVD. This DVD is stored in a locked file cabinet. All electronic data extracted from the DVD is stored on an encrypted, password-protected computer that only the researcher can access. All data collected from the database will be destroyed 3 years after the end of this study.

Resource Requirement

The resources that were required for this study included (a) the NRD, (b) the financial resources needed to secure the database, (c) a statistical processing program, and (d) human resources. The cost of the NRD was $150.00 and was funded through a grant awarded by the HPD Research Committee at Nova Southeastern University in Ft. Lauderdale, Florida. IBM SPSS Statistical Package, Version 21.0 was used for (a) data cleaning, (b) data structuring, and (c) data analysis. Stata 14.1 (StataCorp., 2015) was used for statistical analyses for the generalized linear model. The human resources that were utilized in this study included (a) the time of the principle investigator, (b) support from a statistician, and (c) utilization of a copy editor. Funding for the statistician also came from the HPD Grant. There were no facility resources required for this study.

Timeline

The NRD database was ordered in time to begin data analysis upon receipt of IRB approval. The IRB proposal was submitted to the Nova Southeastern University IRB. Upon receipt of IRB approval from the Nova Southeastern University IRB, an IRB proposal was submitted to the Spaulding Rehabilitation Hospital IRB. Data collection and analysis began upon receipt of approval from both institutions. Data collection and analysis were completed within the proposed one-year time line for the project.

Summary

The researcher used a quantitative, correlational, cross-sectional, retrospective study to analyze the publicly available NRD. The purpose of this study was to identify the incident rate of pneumonia-related readmissions rates and predictive factors of older adults with a known diagnosis of dementia. The data were analyzed with descriptive and

inferential analysis techniques, and results are presented in narrative and tabular format. The results of this study and the meaning of those results are discussed in the following chapters.

Chapter 4: Results

The purpose of this study was to examine the impact of a dementia diagnosis on pneumonia-related readmissions. The previous chapters have justified the need for this study and have described the specific methods used to answer the posed research questions. This chapter provides a description of (a) the results of the data extraction, (b) descriptive statistics of the sample population and subgroups, and (c) the results of the statistical analysis for each research question.

Dementia versus Non-Dementia

Descriptive and comparative statistics are provided in Tables 9 and 10 for the weighted subgroups of older adults with dementia and older adults without dementia. Using SPSS 21(IBM Corp, 2011), Chi-square tests with Cramer's V were calculated for categorical variables and independent *t* tests with Cohen's *d* were calculated for continuous variables. Statistically significant interactions were found for all variables. Of particular interest was that older adults with dementia (a) were found to be 5 years older, (b) were more likely to be female (5%), (c) had one more diagnosis, (d) had one more chronic condition, (e) incurred approximately $2,000 more in total charges, and (f) had higher rates of major and extreme risks of mortality than older adults without dementia. While statistically significant differences were found for hospital characteristics, there was not clinical significance in the difference. Hospital characteristics will not be further discussed in this study.

Table 9
Demographics of the Sample: Patient Characteristics for Dementia versus Non-Dementia

Variable	Total	Non-dementia	Dementia	*p*/effect size
Discharge records, (*n*= 163,642[uw])	389,198[w]	303,210[w]	85,988[w]	
Patients, 155, 861[uw]	370,003[w]	----------	----------	
Age, $\bar{x}$ (*SD)*	79.10 (7.87)	77.9 (7.76)	83.34 (6.576)	.000/1.026 *
Sex (female)	54%	53%	58.5%	.000/.045 **
Number of visits, $\bar{x}$ *(SD)*	2.12 (1.77)	2.03 (1.650)	2.43 (1.848)	.000/.324 *
Number of diagnoses, $\bar{x}$ *(SD)*	12.79 (5.196)	12.51 (5.201)	13.71 (5.054)	.000/.325 *
Number of chronic conditions, $\bar{x}$ *(SD)*	6.49 (3.031)	6.34 (3.034)	7.02 (2.983)	.000/.310 *
Length of stay, $\bar{x}$ *(SD)*	5.44 (5.57)	5.27 (5.144)	5.96 (7.833)	.000/.147 *
Payer				
Medicare	91%	91.6%	94.7%	.000/.053 **
Medicaid	1.5%	1.2%	1.1%	
Private insurance	5.2%	5.6%	2.8%	
Self-Pay	0	0.2%	0.2%	
No Charge	0	0	0	
Other	1.2%	1.2%	1.1	
Discharge Disposition				
Routine	48.7%	56.1%	23%	.000/.325 **
Short-term hospital	1.0%	0.9%	1.1%	
Skilled nursing facility	28.6%	21.2%	54.2%	
Home health care	21.7%	21.8%	21.5%	
Alive, Unknown	<1%	<1%	0.2%	
Total charges[a], (*n*=160, 640[uw]), $\bar{x}$ *(SD)*	37, 478 (55,965)	37,002 (57,266)	39,074 (51,189)	.000/.051 *
Loss of function				
Minor loss of function	6.5%	6.8%	5.4%	.000/.043 **
Moderate loss of function	42.9%	44%	41.5%	
Major loss of function	43%	42.1%	44.7%	
Extreme loss of function	7.6%	7.1%	8.3%	
Risk of mortality				
Minor likelihood of dying	11.1%	13.8%	1.6%	.000/.165 **
Moderate likelihood of dying	45.6%	45.3%	48.7%	
Major likelihood of dying	35%	33%	40.8%	
Extreme likelihood of dying	8.3%	7.9%	8.8%	
Median household income by zip code				
First: 1-37,999 (poorest)	27.1%	27.8%	29.5%	.000/.019 **
Second: 38,000-47,999	27.5%	29.1%	27.6%	
Third: 48,000- 63,999	24.2%	23.6%	22.9%	
Fourth: 64,000 & above (richest)	19.6%	17.9%	18.6%	
Patient location: Urban/rural code				
Central (metro ≥ 1 million)	24.7%	18.8%	22.1%	.000/.041 **
Fringe (metro ≥ 1 million)	21.6%	22.7%	22.6%	
Metro (250,000-999,999)	20.3%	19.1%	19%	
Metro (50,000-249,999)	11%	10.6%	9.8%	
Micropolitan counties	11.8%	14.9%	13.8%	
Not metropolitan or micropolitan	10.5%	13.8%	12.5%	

Note: *Cohen's *d* effect size **Cramer's V effect size

Table 10
Demographics of the Sample: Hospital Characteristics for Dementia versus Non-Dementia

Variable	Total	Non-dementia	Dementia	*p*/effect size
Discharge records (n = 163,642[uw])	389,198[w]	303,210[w]	85,988[w]	
Patients, 155, 861[uw]	370,003[w]	----------	----------	
Hospital location				
Large metropolitan	46.9%	42.2%	45.2%	
Small metropolitan	34.5%	33.1%	30.9%	.000
Micropolitan	11.3%	14.9%	14.1%	
Not metropolitan or micropolitan	7.3%	9.8%	9.8%	
Hospital bed size				
Small (1-249)	17%	19.9%	19.6%	.000
Medium (250-449)	26.8%	24.8%	25.6%	
Large (450+)	56.2%	55.3%	54.8%	
Teaching status				
Metropolitan/non-teaching	47.6%	40.9%	42.8%	.000
Metropolitan/teaching	33.8%	34.3%	33.3%	
Non-metropolitan	18.6%	24.7%	23.9%	

Note: Weighted = *w*. Unweighted = *uw*.

Research Question 1

What is the all-cause pneumonia readmission rate for older adults diagnosed with dementia and for older adults with no known diagnosis of dementia? The pneumonia readmission rate for the entire sample was 19.2%, the rate for older adults without dementia was 17.97%, and the rate for older adults with dementia was 23.52%. Table 11 presents the readmission rates for the entire sample as well as for older adults with and without dementia.

Table 11
Readmission Rates

	Total sample	Older adults without dementia	Older adults with dementia
Readmission rate	19.2%	17.97%	23.52%

Research Question 2

Is there a difference in the all-cause pneumonia readmission rate for older adults with dementia as compared with the all-cause pneumonia readmission rate for older

adults without dementia? A Rao-Scott chi-square test comparing the frequency of all-cause pneumonia readmissions in older adults with and without dementia showed a significant interaction effect (F [1,160931] = 489.11, $p < .001$). Older adults with dementia were more likely (24%) to experience an all-cause pneumonia readmission than older adults without dementia (18%). Table 12 presents the findings from the bivariate analysis. Controlling for all other factors, parameter estimates with odds ratios showed that older adults with dementia were 2.9 times more likely to experience a pneumonia-related readmission than older adults without dementia. Table 13 presents the findings from the parameter estimates.

Table 12
Bivariate Analysis: Dementia

Readmission	No dementia	Dementia	Total
No readmit	63.9%	16.9%	80.8%
Readmit	14.0%	5.2%	19.2%
Total	77.9%	22.1%	100.0%

Note: Designed-based $F(1.00, 160931) = 489.11$, $p < .001$.

Table 13
Parameter Estimates with Odds Ratios for Dementia

Readmission	Odds ratio	Std. Err.	$P > z$	Lower 95% CI	Upper 95% CI
Dementia	2.91	0.61	0.00	1.93	4.40

Research Question 3

Is there a significant difference between patient factors of older adults with dementia who were readmitted and patient factors of older adults without dementia who were readmitted? Full results of the chi-square tests for categorical variables and independent *t* tests for continuous variables are reported in Table 14. Statistically significant interactions ($p < .001$) were found for all variables except total charges.

Consistent with comparisons of all older adults with and without dementia, older adults with dementia who experienced a readmission were (a) 5 years older, (b) more likely to be female (5%), and (c) have higher rates of major mortality risk than older adults without dementia who were readmitted. Additionally, older adults with dementia who were readmitted had almost double the percentage of individuals discharged to skilled nursing facilities (59.2%) as compared with older adults without dementia who were readmitted (29.7%). Fewer older adults with dementia who were readmitted were discharged routinely (18.6%), and fewer were discharged to home health care (20.9%) as compared with older adults without dementia who were readmitted (routine 43%, home health care 26.1%). Also, while found to be statistically different, the comparison of older adults with dementia who were readmitted to older adults without dementia who were readmitted showed little to no clinical difference in (a) number of diagnoses, (b) number of chronic conditions, (c) total charges, and (d) extreme risk of mortality.

Table 14
Readmissions Only Comparisons

Variable	Total	Non-Dementia	Dementia	*p*/effect
Discharge records, (n^W)	74,891[w]	54,482[w]	20,409[w]	------
Patients	73,167	53218	19949	------
Age, $\bar{x}$ *(SD)*	79	77.60	82.70	.000/.8656 *
Sex (female)	52.9%	51.5%	56.6%	.000/.047 **
Number of visits, $\bar{x}$ *(SD)*	3.46	3.41	3.55	.000/.089 *
Number of diagnoses, $\bar{x}$ *(SD)*	14.09	13.93	14.39	.000/.110 *
Number of chronic conditions, $\bar{x}$ *(SD)*	7.23	7.17	7.38	.000/.880 *
Length of stay, $\bar{x}$ *(SD)*	6.27	6.15	6.40	.000/.050 *
Payer				
Medicare	93%	92.3%	94.7%	
Medicaid	1.2%	1.2%	1.2%	
Private insurance	4.4%	5.0%	2.7%	.000/.048 **
Self-pay	0.2%	0.2%	0.1%	
No charge	0%	0%	0%	
Other	1.2%	1.2%	1.3%	
Discharge disposition				
Routine	36.3%	43%	18.6%	
Short-term hospital	1.3%	1.2%	1.1%	
Skilled nursing facility	37.7%	29.7%	59.2%	.000/.280 **
Home health care	24.7%	26.1%	20.9%	
Alive, unknown	<0.2%	<0.2%	<0.2%	
Total charges[a], (n= 74,187[w]), $\bar{x}$ *(SD)*	40,105 (57,495)	40,162 (59,318)	39,954 (52,334)	.644 *
Loss of function				
Minor loss of function	3.3%	3.1%	3.5%	
Moderate loss of function	35.1%	34.9%	35.7%	.000/.014 **
Major loss of function	50.7%	51.2%	49.3%	
Extreme loss of function	11.0%	10.8%	11.6%	
Risk of mortality				
Minor likelihood of dying	5.8%	7.4%	1.5%	
Moderate likelihood of dying	41.5%	41.0%	42.9%	.000/.112 **
Major likelihood of dying	42.0%	41.0%	44.5%	
Extreme likelihood of dying	10.7%	10.6%	11.1%	
Median household income by zip code				
First: 1-37,999 (poorest)	29.1%	28.3%	31.4%	
Second: 38,000-47,999	28.3%	28.7%	27.0%	.000/.029 **
Third: 48,000- 63,999	23.3%	23.7%	22.1%	
Fourth: 64,000 & above (richest)	17.7%	17.7%	17.9%	
Patient location: Urban/rural code				
Central (metro $\geq$ 1 million)	20.1%	19.0%	23.3%	
Fringe (metro $\geq$ 1 million)	23.6%	23.4%	23.9%	
Metro (250,000-999,999)	18.7%	19.0%	17.9%	.000/.056 **
Metro (50,000-249,999)	10.8%	11.1%	10.0%	
Micropolitan counties	14.1%	14.4%	13.3%	
Not metropolitan or micropolitan	12.5%	12.9%	11.5%	

Note: a. Missing values with sample size provided. *w.* Weighted = *w*. Unweighted = *uw*.
*Cohen's *d* effect size. **Cramer's V effect size.

Research Question 4

Is there a significant difference when comparing patient factors of older adults with dementia who were readmitted to the patient factors of older adults with dementia who were not readmitted? Full results of chi-square tests for categorical variables and independent *t* tests for continuous variables are reported in Table 15. Statistically significant interactions ($p = .000$) were found for all variables except for payer. Older adults with dementia who were readmitted had (a) 1.5 times more hospitalizations, (b) one more diagnosis, (c) one more chronic condition, (d) one day longer lengths of stay, (e) more discharges to skilled nursing facilities (59.2%) and less routine discharges (18.6%), (f) $6,000 more in costs, (g) greater percentages of major and extreme levels of functional loss, and (h) greater percentages of major and extreme risks of mortality than older adults with dementia who were not readmitted.

Table 15
Dementia: Readmissions versus No Readmission

Variable	Total	Not readmitted	Readmitted	*p*/effect
Discharge records, n^W	85,988[w]	65,578[w]	20,409[w]	------
Patients	81,047[w]	-----	-----	-----
Age, $\bar{x}$ *(SD)*	83.34 (6.576)	83.54 (6.464)	82.70 (6.882)	.000/.170 *
Sex (female)	41.5%	59.1%	56.6%	.000/.021 **
Number of visits, $\bar{x}$ *(SD)*	2.43 (1.848)	2.08 (1.678)	3.55 (1.923)	.000/1.118 *
Number of diagnoses, $\bar{x}$ *(SD)*	13.71 (5.054)	13.50 (5.013)	14.39 (5.125)	.000/.239 *
Number of chronic conditions, $\bar{x}$ *(SD)*	7.02 (2.983)	6.90 (2.943)	7.38 (3.080)	.000/.217 *
Length of stay, $\bar{x}$ *(SD)*	5.96 (7.833)	5.82 (8.329)	6.40 (5.945)	.000/.101 *
Payer				
Medicare	94.7%	94.7%	94.7%	
Medicaid	1.1%	1.1%	1.2%	
Private insurance	2.8%	2.9%	2.7%	0.00/.012 **
Self-pay	0.2%	0.2%	0.1%	
No charge	0.0%	0.0%	0.0%	
Other	1.1%	1.1%	1.3%	
Discharge Disposition				
Routine	22.6%	23.8%	18.6%	
Short-term hospital	1.1%	1.1%	1.1%	
Skilled nursing facility	55.5%	54.4%	59.2%	.000/.055 **
Home health care	20.6%	20.5%	20.9%	
Alive, unknown	<0.2%	<0.2%	<0.2%	
Total charges[a], *(n*= 85,192[w]), $\bar{x}$ *(SD)*	34,886 (45,638)	33,304 (43,215)	39,954 (52,234)	.000/.190 *
Loss of Function				
Minor loss of function	5.4%	6.0%	3.5%	
Moderate loss of function	41.5%	43.4%	35.7%	.000/.101 **
Major loss of function	44.7%	43.3%	49.3%	
Extreme loss of function	8.3%	7.3%	11.6%	
Risk of mortality				
Minor likelihood of dying	1.6%	1.7%	1.5%	
Moderate likelihood of dying	48.7%	50.5%	42.9%	.000/.071 **
Major likelihood of dying	40.8%	39.7%	44.5%	
Extreme likelihood of dying	8.8%	8.1%	11.1%	
Median household income by zip code				
First: 1-37,999 (poorest)	29.5%	28.9%	31.4%	
Second: 38,000-47,999	27.6%	27.7%	27.0%	.000/.025 **
Third: 48,000- 63,999	22.9%	23.1%	22.1%	
Fourth: 64,000 & above (richest)	18.6%	18.9%	17.9%	
Patient location: Urban/rural code				
Central (metro ≥ 1 million)	22.1%	21.7%	23.3%	
Fringe (metro ≥ 1 million)	22.6%	22.3%	23.9%	
Metro (250,000-999,999)	19.0%	19.4%	17.9%	.000/.032 **
Metro (50,000-249,999)	9.8%	9.8%	10.0%	
Micropolitan counties	13.8%	14.0%	13.3%	
Not metropolitan or micropolitan	12.5%	12.8%	11.5%	

Note: a. Missing values with sample size provided. Weighted = *w*. Unweighted = *uw*.
*Cohen's *d* effect size. **Cramer's V effect size.

Research Question 5

Does the diagnosis of dementia affect the predictive factors for all-cause pneumonia readmissions? A bivariate analysis was calculated for each predictor variable and the outcome variable (readmission) for the entire sample. After reviewing the bivariate analysis, a generalized linear model was formed using the appropriate survey weights (provided by AHRQ) with robust standard errors. Pairwise comparisons were calculated for significant model effects. A sub-group analysis was run for the single-level diagnosis and multilevel diagnoses variables using a loglinear model. A generalized linear model (with clustered, robust standard errors) was used to calculate the effect of age and number of chronic conditions with dementia on the probability of readmission. A generalized linear model (with clustered, robust standard errors) was calculated to determine the effect of number of chronic conditions and dementia on discharge disposition.

Bivariate analysis. A bivariate analysis was calculated for each predictor variable and the outcome variable (readmission) for the entire sample. Bivariate analysis included Rao-Scott chi-square analysis for categorical predictors and Welch *t* tests for continuous predictors. All predictors were found to have a significant effect on the occurrence of readmission. The results of the bivariate analyses of categorical and continuous variables are presented in Table 16 and Table 17, respectively.

Table 16
Bivariate Analysis: Categorical Variables

Gender							
OCRA	Male	Female	Total				
No Readmit	0.37	0.44	0.81				
Readmit	0.09	0.10	0.19				
Total	0.46	0.54	1.00				
Design-based F (1.00, 160931) = 23.99, $p < .001$							
Patient home location (PL_NCHS)							
OCRA	Central	Fringe	Counties Medium	Counties Large	Micro Counties	Non-Metro	Total
No Readmit	0.16	0.18	0.16	0.08	0.12	0.11	0.81
Readmit	0.04	0.05	0.04	0.02	0.03	0.02	0.19
Total	0.20	0.23	0.19	0.10	0.15	0.13	1.00
Design-based F (1.98, 3.2e + 05) = 31.31, $p <.001$							
Median household income (ZIPINC_QRTL)							
OCRA	25th	50th	75th	100th	Total		
No Readmit	0.23	0.24	0.19	0.15	0.81		
Readmit	0.06	0.06	0.05	0.03	0.19		
Total	0.29	0.29	0.24	0.18	1.00		
Design-based F (3.00, 4.8e + 05) = 5.40, $p <.001$							
Discharge disposition (DISPUNIFORM)							
OCRA	Routine	Short Term	SNF	Home Health Care	Alive, Unknown	Total	
No Readmit	0.42	0.01	0.22	0.16	0.00	0.81	
Readmit	0.07	0.00	0.07	0.05	0.00	0.19	
Total	0.49	0.01	0.29	0.21	0.00	1.00	
Design-based F (3.91, 6.3e + 05) = 546.59, $p < .001$							
Loss of Function (APRDRG_Severity)							
OCRA	Minor	Moderate	Major	Extreme	Total		
No Readmit	0.06	0.37	0.33	0.05	0.81		
Readmit	0.01	0.07	0.10	0.02	0.19		
Total	0.06	0.43	0.43	0.07	1.00		
Design-based F (3.00, 4.8e + 05) = 691.29, $p < .001$							
Risk of mortality (APRDRG_Risk_Mortality)							
OCRA	Minor	Moderate	Major	Extreme	Total		
No Readmit	0.10	0.38	0.27	0.06	0.81		
Readmit	0.01	0.08	0.08	0.02	0.19		
Total	0.11	0.46	0.35	0.08	1.00		
Design-based F (3.00, 4.8e + 05) = 566.63, $p < .001$							
Hospital size (HOSP_BEDSIZE)							
OCRA	Small	Medium	Large	Total			
No Readmit	0.16	0.20	0.44	0.81			
Readmit	0.03	0.05	0.11	0.19			
Total	0.20	0.25	0.55	1.00			
Design-based F (1.98, 3.2e + 05) = 31.31, $p < .001$							
Hospital location (HOSP_URCAT4)							
OCRA	Large Metro	Small Metro	Micro	Not Metro	Total		
No Readmit	0.34	0.26	0.12	0.08	0.81		
Readmit	0.09	0.06	0.03	0.02	0.19		
Total	0.43	0.33	0.15	0.10	1.00		
Design-based F (1.98, 3.2e + 05) = 31.31, $p < .001$							

Table 17
Bivariate Analysis: Continuous Variables

Age (AGE)				Lower	Upper
Group	*N*	*M*	Std. Dev.	95% CI	95% CI
No readmit	129962.00	79.14	7.87	79.10	79.18
Readmit	30970.00	79.02	7.85	78.93	79.10
Difference		0.13		0.03	0.22
t (46929) = 2.53, p =.011					
Length of stay (LOS)				Lower	Upper
Group	*N*	*M*	Std. Dev.	95% CI	95% CI
No readmit	129962.00	5.24	5.33	5.21	5.27
Readmit	30970.00	6.28	6.02	6.21	6.35
Difference		-1.04		-1.11	-0.97
t (43259) = -27.95, p < .000					
Number of diagnoses (NDX)				Lower	Upper
Group	*N*	*M*	Std. Dev.	95% CI	95% CI
No readmit	129,962	12.49	0.01	12.46	12.52
Readmit	30,970	14.09	0.03	14.03	14.15
Difference		-1.60		-1.54	
t (46135) = -48.45, p < .000					
Number of chronic conditions (*N*-chronic)				Lower	Upper
Group	*N*	*M*	Std. Dev.	95% CI	95% CI
No readmit	129,962	6.32	0.01	6.30	6.33
Readmit	30,970	7.23	0.02	7.20	7.27
Difference		-0.92		-0.95	-0.88
t (46135) = -47.34, p < .000					
Single-level diagnosis codes (CCS)				Lower	Upper
Group	*N*	*M*	Std. Dev.	95% CI	95% CI
No readmit	129,962	0.12	0.10	0.12	0.12
Readmit	30,970	0.15	0.11	0.15	0.15
Difference		-0.03		-0.03	-0.03
t (46135) = -44.25, p < .000					
Multilevel diagnosis codes (MCCS)				Lower	Upper
Group	*N*	*M*	Std. Dev.	95% CI	95% CI
No readmit	129,962	0.37	0.13	0.37	0.37
Readmit	30,970	0.40	0.13	0.40	0.40
Difference		-0.03		-0.03	-0.03
t (46135) = -34.82, p < .000					

Generalized linear model. After reviewing the bivariate analysis, a generalized linear model was formed using the appropriate survey weights (provided by AHRQ) with robust standard errors. The variable dementia was included in the model as an interactive effect to determine its effect on the occurrence of readmission. The equation for the model is presented in Figure 4.

$$f(\text{ocra}) = b_0 + b1_{\text{dementia}} + b2_{\text{aprdrg\_severity}} + b3_{\text{dementia * aprdrg\_severity}} + b4_{\text{age}} + b5_{\text{dementia * age}} + b6_{\text{female}} + b7_{\text{dementia * female}} + b8_{\text{dispuniform}} + b9_{\text{dementia * dispuniform}} + b10_{\text{hosp\_bedsize}} + b11_{\text{dementia * hosp bedsize}} + b12_{\text{hosp\_urcat4}} + b13_{\text{dementia * hosp\_urcat4}} + b14_{\text{los}} + b15_{\text{dementia * los}} + b16_{\text{pl\_nchs}} + b17_{\text{dementia * pl\_nchs}} + b18_{\text{zipinc\_qrtl}} + b19_{\text{dementia * zipinc\_qrtl}} + b20_{\text{ndx}} + b21_{\text{dementia * ndx}} + b22_{\text{nchronic}} + b23_{\text{dementia * nchronic}} + b24_{\text{ccs}} + b25_{\text{dementia * ccs}} + b26_{\text{ccs}} + b27_{\text{dementia * ccs}} + b28_{\text{mccs}} + b29_{\text{dementia * mccs}}$$

Figure 4. Generalized linear model.

Parameter estimates with odds ratios were calculated for all predictor variables and are presented in Appendix E. Pairwise comparisons were calculated for significant model effects and are displayed in Appendix F.

Age. For each one-year increase in age, the estimated odds of a pneumonia-related readmission decrease by .98 ($p < .001$. 95% CI [.98, .98]) when controlling for all other factors. Thus, as age increases, there is a decrease in the odds of a pneumonia-related readmission occurring.

Sex. Older adult women are 0.90 ($p < .001$, 95% CI [0.88, 0.93]) times less likely to experience an all-cause pneumonia-related readmission than older adult males when controlling for all other factors. Conversely, this means that older adults men are 1.11 times more likely to experience a pneumonia-related readmission than older adult women.

Length of stay. For each additional day on the length of stay, the estimated odds of a pneumonia-related readmission increases by 1.01 when controlling for all other factors ($p < .001$, 95% CI [1.00, 1.01]).

Number of chronic conditions. For each additional chronic condition, the estimated odds of a pneumonia-related readmission increase by 1.04 when controlling for all other factors ($p < .001$, 95% CI [1.04, 1.05]).

Number of diagnoses. There was no change in the risk of readmission with changes in the number of diagnoses.

Discharge disposition. Individuals discharged to short-term hospitals (OR 1.36, 95% CI [1.12, 1.66]), skilled nursing facilities (OR 1.52, 95% CI [1.44, 1.61]), and home health care (OR 1.34, 95% CI [1.26, 1.43]) are more likely to be readmitted than those older adults who have routine discharges. Older adults discharged to skilled nursing facilities are 1.02 times more likely to be readmitted than older adults discharged to home health care.

Loss of function. Older adults with moderate (OR 1.24, 95% CI [1.12, 1.38]), major (OR 1.55, 95% CI [1.38, 1.75]), and extreme (OR 1.88, 95% CI [1.63, 1.88]) loss of function are more likely to experience a pneumonia-related readmission than older adults with a minor loss of function. Older adults with major (OR 1.25, 95% CI [1.18, 1.32]) and extreme (OR 1.51, 95% CI [1.37, 1.68]) loss of function were more likely to experience a pneumonia-related readmission than older adults with moderate loss of function. Older adults with extreme (OR 1.21, 95% CI [1.12, 1.32]) loss of function are more likely to be readmitted than older adults with major loss of function. As the severity of loss increases, the risk of pneumonia-related readmissions increases.

Risk of mortality. Older adults with moderate (OR 1.19, 95% CI [1.03, 1.38]) and major (OR 1.19, 95% CI [1.02, 1.39]) risks for mortality have an increased risk of pneumonia-related readmission as compared with older adults with minor risks of mortality. There is a decrease in the risk of readmission for older adults with extreme risk of mortality as compared with moderate risk of mortality (OR 0.88, 95% CI [0.8, 0.97]) and major risk of mortality (OR 0.88, 95% CI [0.81, 0.96]). Thus, when controlling for all other factors, the odds of a pneumonia-related readmission initially increase as the severity of risk of mortality increases but then plateaus and decreases in higher severity levels.

Patient location. There was not a significant difference in the odds of readmission for the majority of the patient location categories. The only significant finding was a slight increase in the odds of readmission for large counties (OR 1.08, 95% CI [1.00, 1.18]) as compared with medium counties.

Median household income. Older adults in the 50th (OR 0.94, 95% CI [0.89, 0.99]), 75th (OR 0.90, 95% CI [0.85, 0.95]) and 100th (OR 0.88, 95% CI [0.83, 0.93]) quartiles are less likely to be readmitted than older adults in the 25th quartile. Older adults in the 100th quartile are 0.93 times less likely to be readmitted than older adults in the 50th quartile (95% CI [0.88, 0.88]). In other words, older adults in the 25th quartile for median household income (the lowest income level) have increased odds of pneumonia-related readmissions as compared with older adults in the 50th (1.06), 75th (1.11), and 100th (1.14) quartiles. Older adults in the 50th quartile are 1.08 times more likely to be readmitted than older adults in the 100th quartile.

Significant interactions. Four variables were found to significantly interact with dementia: (a) risk of mortality, (b) discharge disposition, (c) mean income by zip code, and (d) number of chronic conditions. Pairwise comparisons were calculated for significant model effects and are presented in Appendix G through Appendix I.

Risk of mortality and dementia. Older adults with dementia and a minor risk of mortality are 2.35 times more likely to be readmitted than older adults without dementia who also have a minor risk of mortality ($p < .001$, 95% CI [1.2, 4.61]). There is not an increase in odds for readmission for older adults with dementia and higher levels of risk of mortality as compared with older adults without dementia and higher levels of risk of mortality. There also is not an increase in odds of a pneumonia-related readmission when comparing older adults with dementia at different levels of risk for mortality. These findings are depicted in a dot plot in Figure 5.

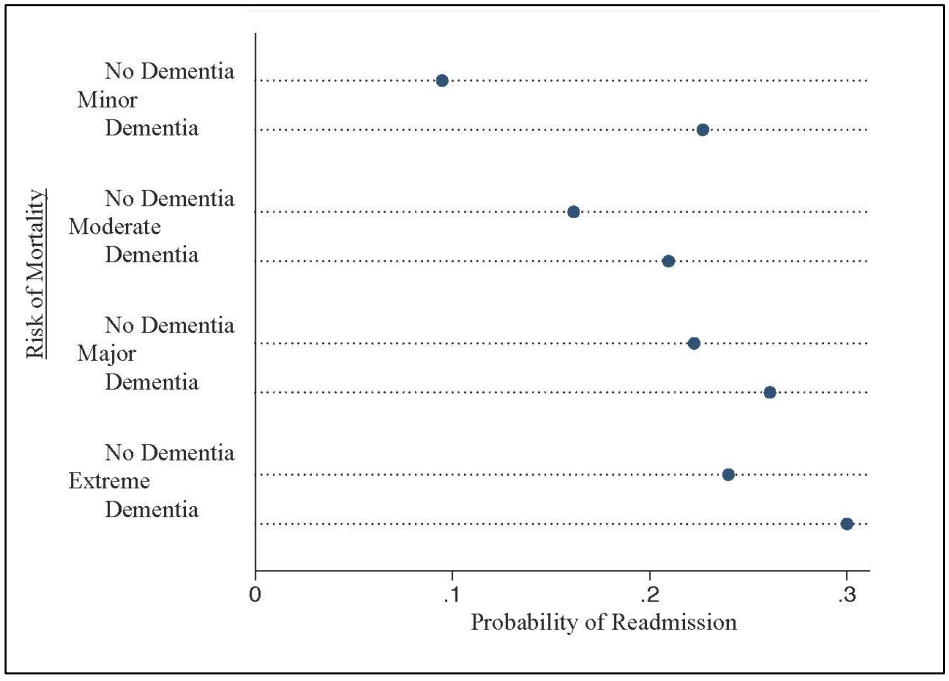

Figure 5. Risk of mortality, dementia, and probability of readmission.

Discharge disposition and dementia. When controlling for all other factors, older adults with dementia who were discharged to short-term hospitals (OR 1.20, 95% CI [1.16, 1.44]) and skilled nursing facilities (OR 1.19, 95% CI [1.05, 1.35]) had increased odds of pneumonia-related readmission as compared with older adults with dementia who had routine discharges. Older adults with dementia who were discharged to home health care did not have increased odds of readmission as compared with older adults with dementia who had routine discharges. This finding is different from the findings in the comparisons of the overall model that found increased odds of readmission with discharge to home health as compared to routine discharge. These findings are depicted in a dot plot in Figure 6.

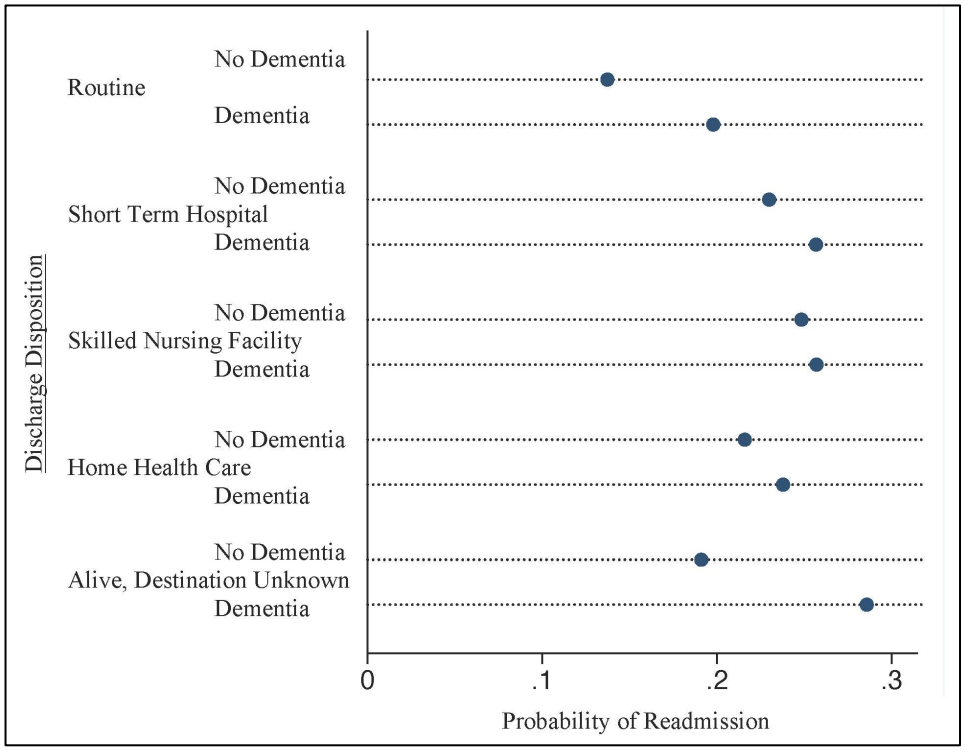

Figure 6. Median household income, dementia, and probability of readmission.

Median household income and dementia. Older adults with dementia who are in the 75th quartile (OR 0.85, 95% CI [0.76, 0.95]) and those in the 100th quartile (OR 0.83,

95% CI [0.73, 0.94]) are less likely to be readmitted than older adults with dementia in the 25th quartile when all other factors are controlled for. Stated in reverse, older adults with dementia who are in the 25th quartile for median household income (the lowest income level) had increased odds of readmission as compared with older adults with dementia who were in the 75th (1.2) and 100th (1.18) quartiles when controlling for all other factors. There was not an increased odds of readmission for older adults in the 25th quartile as compared with older adults with dementia in the 50th quartile. This finding is different from the finding in the overall model that showed increased odds of readmission for older adults in the 25th quartile as compared to older adults in the 50th quartile. Additionally, the increase in odds for older adults with dementia appears to be slightly greater than the increased odds for older adults in general. These findings are depicted in a dot plot in Figure 7.

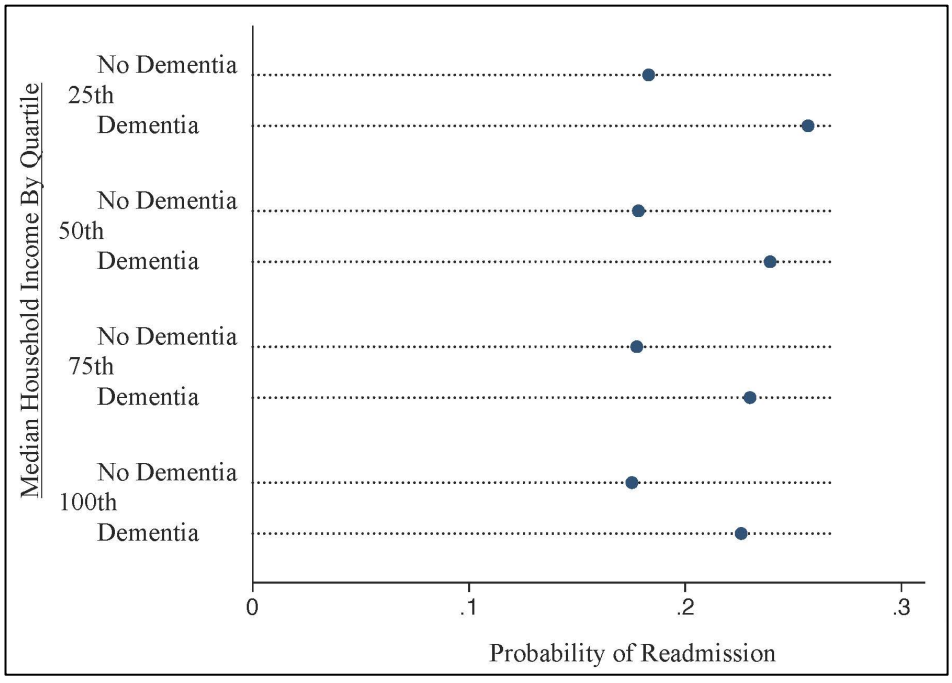

Figure 7. Discharge disposition, dementia, and probability of readmission.

Number of chronic conditions and dementia. For each additional chronic condition, the estimated odds of a pneumonia-related readmission for older adults with dementia decreased by .97 (95% CI [0.95, 0.98]) when controlling for all other factors. These findings are different from the findings in the general model that found that there was an increase in the odds of readmission with each additional chronic condition (OR 1.04, 95% CI [1.04, 1.05]). These findings are depicted in a line graph in Figure 8.

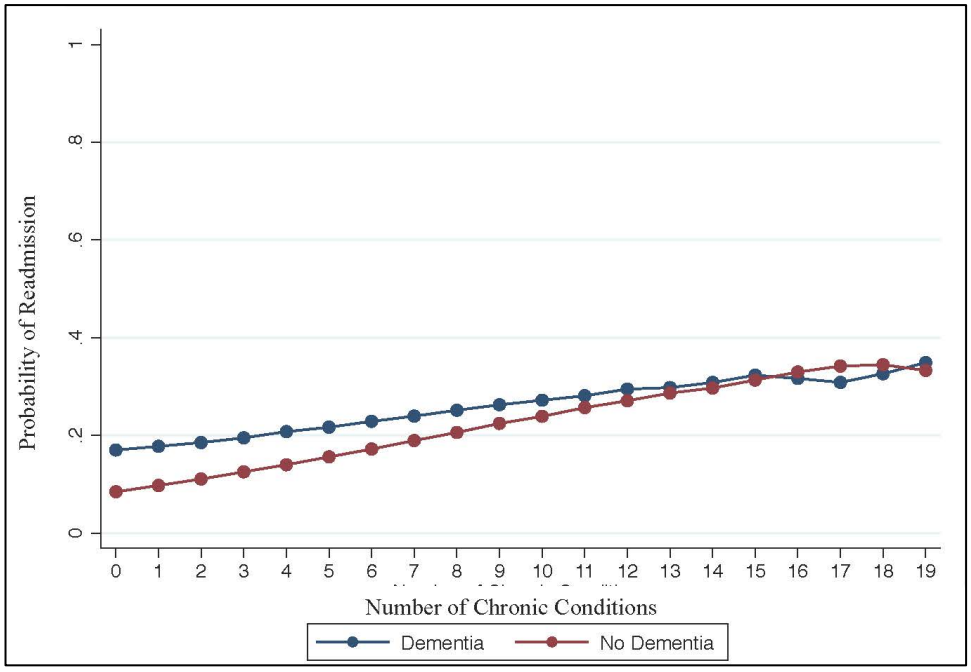

Figure 8. Number of chronic conditions, dementia, probability of readmission.

Subanalysis 1. A sub-group analysis was run for the single-level diagnosis and multilevel diagnoses variables using a loglinear model. All single and multilevel diagnoses were found to have a significant effect on the occurrence of readmission. There were six single-level diagnoses and 11 multilevel diagnoses that had (a) 5% or greater difference between older adults with and without dementia, (b) had the diagnosis present, and (c) were readmitted. The six single-level diagnoses included (a) anxiety disorder, (b) chronic obstructive pulmonary disorder, (c) esophageal dysfunction, (d) hip

fracture, (e) nutritional deficits, and (f) urinary tract infections. The 95% confidence intervals for the comparisons did not overlap with the exception of hip fracture that overlapped by a value of 2. The 11 multilevel diagnoses were (a) diseases of the circulatory system, (b) diseases of the digestive system, (c) diseases of the blood, (d) diseases of the genitourinary system, (e) injury and poisoning, (f) infectious diseases, (g) mental illness, (h) diseases of the musculoskeletal system, (i) diseases of the neurological system, (j) diseases of the respiratory system, and (k) diseases of the skin. There was no overlap of confidence intervals for these comparisons. The results of the subgroup analysis are presented in Table 18 and Table 19.

Table 18
Subanalysis 1: Loglinear Model: Single-Level Diagnoses

	No readmission				Readmission			
	Not present		Present		Not present		Present	
	No dementia	Dementia	No dementia	Dementia	No dementia	Dementia	No dementia	Dementia
Anxiety disorder								
Proportion	0.82	0.77	0.79	0.74	0.18	0.23	0.21	0.26
Lower 95% CI	0.82	0.76	0.78	0.73	0.17	0.23	0.21	0.24
Upper 95% CI	0.83	0.77	0.79	0.76	0.18	0.24	0.22	0.27
Congestive heart failure								
Proportion	0.84	0.78	0.76	0.72	0.16	0.22	0.24	0.28
Lower 95% CI	0.84	0.78	0.76	0.71	0.15	0.21	0.23	0.27
Upper 95% CI	0.85	0.79	0.77	0.73	0.16	0.22	0.24	0.29
Chronic obstructive pulmonary disease								
Proportion	0.84	0.78	0.79	0.73	0.16	0.22	0.21	0.27
Lower 95% CI	0.84	0.77	0.79	0.72	0.16	0.21	0.20	0.26
Upper 95% CI	0.84	0.79	0.80	0.74	0.16	0.23	0.21	0.28
Chronic skin ulcers								
Proportion	0.82	0.77	0.70	0.67	0.18	0.23	0.30	0.33
Lower 95% CI	0.82	0.77	0.68	0.65	0.17	0.22	0.29	0.31
Upper 95% CI	0.83	0.78	0.71	0.69	0.18	0.23	0.32	0.35
Delirium								
Proportion	0.82	0.76	0.80	0.77	0.18	0.24	0.20	0.23
Lower 95% CI	0.82	0.76	0.77	0.74	0.18	0.23	0.17	0.20
Upper 95% CI	0.82	0.77	0.83	0.80	0.18	0.24	0.23	0.26
Esophageal dysfunction								
Proportion	0.82	0.77	0.81	0.75	0.18	0.23	0.19	0.25
Lower 95% CI	0.82	0.76	0.80	0.74	0.17	0.23	0.19	0.24
Upper 95% CI	0.83	0.77	0.81	0.76	0.18	0.24	0.20	0.26
Hip fracture								
Proportion	0.82	0.76	0.69	0.51	0.18	0.24	0.31	0.49
Lower 95% CI	0.82	0.76	0.60	0.41	0.18	0.23	0.24	0.38
Upper 95% CI	0.82	0.77	0.76	0.62	0.18	0.24	0.40	0.59
Myocardial infarct								
Proportion	0.82	0.76	0.76	0.73	0.18	0.24	0.24	0.27
Lower 95% CI	0.82	0.76	0.74	0.68	0.18	0.23	0.22	0.24
Upper 95% CI	0.82	0.77	0.78	0.76	0.18	0.24	0.26	0.32
Nutritional deficits								
Proportion	0.82	0.77	0.79	0.74	0.18	0.23	0.21	0.26
Lower 95% CI	0.82	0.76	0.78	0.73	0.17	0.23	0.20	0.25
Upper 95% CI	0.83	0.77	0.80	0.75	0.18	0.24	0.22	0.27
Urinary tract infection								
Proportion	0.82	0.77	0.79	0.74	0.18	0.23	0.21	0.26
Lower 95% CI	0.82	0.76	0.78	0.73	0.17	0.23	0.20	0.25
Upper 95% CI	0.83	0.77	0.80	0.75	0.18	0.24	0.22	0.27

Table 19
Subanalysis 1: Loglinear Model: Multilevel Diagnoses

	No readmission				Readmission			
	Not present		Present		Not present		Present	
	No dementia	Dementia	No dementia	Dementia	No dementia	Dementia	No dementia	Dementia
Diseases of the circulatory system								
Proportion	0.85	0.78	0.82	0.76	0.15	0.22	0.18	0.24
Lower 95% CI	0.84	0.77	0.81	0.75	0.15	0.20	0.18	0.23
Upper 95% CI	0.85	0.80	0.82	0.77	0.16	0.23	0.19	0.25
Diseases of the digestive system								
Proportion	0.83	0.78	0.80	0.74	0.17	0.22	0.20	0.26
Lower 95% CI	0.83	0.77	0.80	0.74	0.16	0.22	0.19	0.25
Upper 95% CI	0.84	0.78	0.81	0.75	0.17	0.23	0.20	0.26
Diseases of the blood								
Proportion	0.84	0.78	0.78	0.73	0.16	0.22	0.22	0.27
Lower 95% CI	0.84	0.77	0.78	0.72	0.16	0.21	0.21	0.26
Upper 95% CI	0.84	0.79	0.79	0.74	0.16	0.23	0.22	0.28
Diseases of the genitourinary system								
Proportion	0.83	0.78	0.80	0.75	0.17	0.22	0.20	0.25
Lower 95% CI	0.83	0.77	0.80	0.74	0.16	0.22	0.20	0.25
Upper 95% CI	0.84	0.78	0.80	0.75	0.17	0.23	0.20	0.26
Injury & poisoning								
Proportion	0.82	0.76	0.82	0.76	0.18	0.24	0.18	0.24
Lower 95% CI	0.82	0.76	0.81	0.75	0.18	0.23	0.18	0.23
Upper 95% CI	0.82	0.77	0.82	0.77	0.18	0.24	0.19	0.25
Infectious diseases								
Proportion	0.82	0.77	0.80	0.74	0.18	0.23	0.20	0.26
Lower 95% CI	0.82	0.76	0.80	0.73	0.17	0.23	0.19	0.25
Upper 95% CI	0.83	0.77	0.81	0.75	0.18	0.24	0.20	0.27
Mental illness								
Proportion	0.82	0.76	0.82	0.76	0.18	0.24	0.18	0.24
Lower 95% CI	0.82	0.76	0.81	0.76	0.17	0.23	0.18	0.23
Upper 95% CI	0.83	0.77	0.82	0.77	0.18	0.24	0.19	0.24
Diseases of the musculoskeletal system								
Proportion	0.82	0.76	0.82	0.77	0.18	0.24	0.18	0.23
Lower 95% CI	0.82	0.75	0.81	0.76	0.18	0.23	0.18	0.22
Upper 95% CI	0.82	0.77	0.82	0.78	0.18	0.25	0.19	0.24
Neoplasms								
Proportion	0.83	0.77	0.79	0.75	0.17	0.23	0.21	0.25
Lower 95% CI	0.83	0.76	0.78	0.74	0.16	0.23	0.21	0.24
Upper 95% CI	0.84	0.77	0.79	0.76	0.17	0.24	0.22	0.26
Diseases of the neurological system								
Proportion	0.83	0.77	0.81	0.76	0.17	0.23	0.19	0.24
Lower 95% CI	0.82	0.76	0.80	0.75	0.17	0.23	0.19	0.23
Upper 95% CI	0.83	0.77	0.81	0.77	0.18	0.24	0.20	0.25
Diseases of the respiratory system								
Proportion	0.85	0.79	0.81	0.74	0.15	0.21	0.19	0.26
Lower 95% CI	0.85	0.78	0.80	0.74	0.15	0.21	0.19	0.25
Upper 95% CI	0.85	0.79	0.81	0.75	0.15	0.22	0.20	0.26
Diseases of the skin/subcutaneous								
Proportion	0.82	0.76	0.79	0.74	0.18	0.24	0.21	0.26
Lower 95% CI	0.82	0.76	0.77	0.71	0.18	0.23	0.20	0.24
Upper 95% CI	0.82	0.77	0.80	0.76	0.18	0.24	0.23	0.29

Subanalysis 2. A generalized linear model (with clustered, robust standard errors) was calculated to determine the effect of the number of chronic conditions and dementia on discharge disposition. The model shows that dementia has a significant effect on discharge disposition ($C^2(10) = 3842.73$, $p < 0.001$). Table 20 displays the results of this analysis and Figure 9 provides a graphic representation of the results.

Table 20
Subanalysis 2: Number of Chronic Conditions, Discharge Disposition, and Dementia

	No dementia					Dementia				
Conditions	A	B	C	D	E	A	B	C	D	E
0	0.72	0.01	0.14	0.14	0.00	0.38	0.01	0.45	0.16	0.00
1	0.70	0.01	0.15	0.15	0.00	0.35	0.01	0.47	0.17	0.00
2	0.67	0.01	0.16	0.16	0.00	0.33	0.01	0.48	0.18	0.00
3	0.65	0.01	0.17	0.17	0.00	0.30	0.01	0.50	0.18	0.00
4	0.62	0.01	0.19	0.18	0.00	0.28	0.01	0.52	0.19	0.00
5	0.60	0.01	0.20	0.19	0.00	0.26	0.01	0.53	0.20	0.00
6	0.57	0.01	0.21	0.21	0.00	0.24	0.01	0.55	0.20	0.00
7	0.54	0.01	0.23	0.22	0.00	0.22	0.01	0.56	0.21	0.00
8	0.52	0.01	0.24	0.23	0.00	0.20	0.01	0.57	0.21	0.00
9	0.49	0.01	0.25	0.25	0.00	0.19	0.01	0.58	0.22	0.00
10	0.46	0.01	0.26	0.26	0.00	0.17	0.01	0.59	0.22	0.00
11	0.44	0.01	0.28	0.28	0.00	0.16	0.01	0.60	0.23	0.00
12	0.41	0.01	0.29	0.29	0.00	0.14	0.01	0.61	0.23	0.00
13	0.38	0.01	0.30	0.30	0.00	0.13	0.01	0.62	0.23	0.00
14	0.36	0.01	0.31	0.32	0.00	0.12	0.01	0.63	0.24	0.00
15	0.33	0.01	0.33	0.33	0.00	0.11	0.01	0.64	0.24	0.00
16	0.31	0.01	0.34	0.34	0.00	0.10	0.01	0.64	0.25	0.00
17	0.29	0.01	0.35	0.35	0.00	0.09	0.01	0.65	0.25	0.00
18	0.27	0.01	0.36	0.36	0.00	0.08	0.01	0.66	0.25	0.00
19	0.24	0.01	0.37	0.37	0.00	0.07	0.01	0.66	0.25	0.00

Note: A = Routine. B = Short-term hospital. C = SNF. D = Home health care. E = Unknown

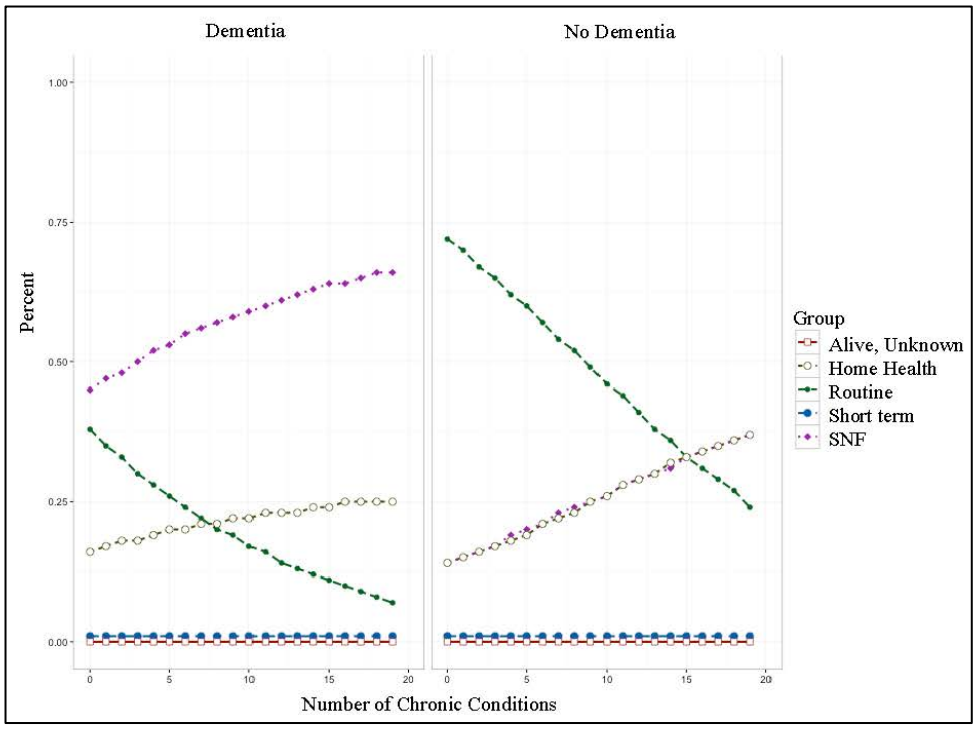

Figure 9. Effect of number of chronic conditions on discharge disposition.

Chapter 5: Discussion

The previous chapters have described the purpose, methods, and results of this quantitative, correlational, retrospective study, examining the impact of dementia on all-cause pneumonia readmission rates and predictive factors for older adults. The meaning of the results in the context of current literature and in relation to the limitations of this study are discussed in this chapter. Implications of these findings and recommendations for future research are addressed. This chapter concludes with an overall summary of this study.

Sample

Size. Of the approximately 14 million records contained in the 2013 NRD, 163, 642 discharge records (155,861 patients) met the inclusion criteria and were extracted. When weighted, this sample represented 389,198 records (370, 003 patients). Both the weighted and unweighted samples were of adequate size to allow statistical inferences to be made. The method that HCUP utilized to create the discharge weights was based on the AHA annual hospital survey data and makes it appropriate to view this sample as a nationally representative sample of older adults discharged from community hospitals with a primary diagnosis of pneumonia in 2013. This study was the first to examine the impact of dementia on pneumonia readmissions with a nationally representative sample.

Sample characteristics. The number of older adults in the United States has risen from 36.2 million in 2004 to 46.2 million in 2014 and is expected to double in size to 98 million by 2060 (Administration on Aging, 2015). Older adults are less than 13% of the population in the United States but account for 40% of hospitalizations (Mattison, 2016). Of approximately 14 million unweighted discharge records contained in the NRD, 40%

were older adults. Thus, the percentage of older adults represented in the NRD is consistent with the percentage of hospitalizations usually accounted for by older adults. Fifty-five percent of older adults in America are women (Administration on Aging, 2015). Similarly, women accounted for 54% of the sample used in this study. Medicare is the primary health insurance provider for 93% of the older adult population in the United States (Administration on Aging, 2015). Likewise, Medicare was the primary health insurance provider for 91% of this study sample. The similarities in the demographics of the sample and the entire population of older adults in the United States further supports the appropriateness of using the NRD for this study and the generalizability of the findings.

Hospitalizations. Older adults are known to have higher rates of hospitalization than younger adults (18-64 years old). Eleven percent of older adults experience one hospitalization, 3% have two hospitalizations, and 2% have three or more hospitalizations (Administration on Aging, 2015). These rates are almost double the rates of younger adults (Administration on Aging, 2015). The mean number of hospital visits for the sample in this study was 2.12. The most logical explanation of this higher rate is that published rates include older adults who have never been hospitalized, thus including a zero value and decreasing the average number of visits. This study only included individuals who had been hospitalized with at least one hospitalization. Thus, it makes sense that the average number of hospitalizations would be higher in this study than the rates published by the Administration on Aging (2015). Another explanation may be that hospitalization rates increase with age (Weiss & Elixhauser, 2014). The mean age in this study was 79, thus the higher average number of visits may be due to a higher mean age.

Length of stay. In addition to having higher rates of hospitalization, older adults also stay in the hospital longer. The average length of stay in the hospital for older adults is 5.5 days, which is longer than the 5.0 days length of stay for adults aged 45 to 65 (Administration on Aging, 2015). The CDC has reported that the average length of stay for older adults with a primary diagnosis of pneumonia is 5.4 days (Centers for Disease Control and Prevention, 2010). The mean length of stay for the sample in this study was 5.44 days. Thus, the average length of stay for (a) the older adult population in the United States, (b) older adults with the diagnosis of pneumonia, and (c) the length of stay for index admissions within this study were consistent.

Costs. Older adults have the highest cost per hospitalization of all age groups, with an average cost of $13,000 (Moore, Levit, & Elixhauser, 2014). More specifically, the average cost of a hospitalization for an older adult diagnosed with dementia in 2010 was $9,300 (Pfuntner et al., 2013). Sato, Gomez-Re, Nelson, and Pinsky (2013) found a much broader range of charges for hospitalization of older adults with pneumonia with a mean charge of $27,661 and a range of $11,148 to $51,219. The median cost of a hospitalization in this study was $37,478. This amount is more consistent with the findings from Sato et al. (2013). The difference in average cost most likely has to do with differences in methodology for determining the costs.

Chronic conditions. Most older adults have one chronic condition and many have two or more chronic conditions (Administration on Aging, 2015). Ward, Schiller, and Goodman found that (a) 25% of older adults had one chronic condition, (b) 27.6% had two chronic conditions, and (c) 33.2% had three or more chronic conditions (2014). The CMS (2012) found that (a) 32% of older adults had zero to one chronic conditions, (b)

32% had two to three chronic conditions, (c) 23% had four to five chronic conditions, and (d) 14% had six or more chronic conditions. The samples in both of these studies included community dwelling older adults and older adults living in institutions. The mean number of chronic conditions for older adults in this study was 6.49. Therefore, the average number of chronic conditions in this study was at the high end of the number of chronic conditions that most older adults have. However, both Ward et al. and the CMS examined all older adults, whereas this study only examined older adults who were hospitalized for pneumonia. The CMS (2012) found that as the number of chronic conditions increases so do the number of hospitalizations. Roughly 20% Medicare beneficiaries are admitted to the hospital within a year, but for Medicare beneficiaries with six or more chronic conditions, the percentage increases to 60% (Centers for Medicare and Medicaid Services, 2012). It is likely that older adults who are hospitalized are in poorer health and have more chronic conditions than older adults that are not hospitalized. Given that more individuals are hospitalized when there are greater numbers of chronic conditions, it is logical to expect that a sample of hospitalized individuals, such as in this study, would have a mean number of chronic conditions at the middle to high end of the range.

Discharge disposition. The majority of hospitalized older adults (72%) have a routine discharge to their homes (Mattison, 2016). However, older adults over the age of 85 are discharged to a skilled nursing facility (SNF) 40% of the time. It has been speculated that with increased age comes an increased severity of disease that results in an increased need for assistance post discharge, and thus results in placement in a SNF. In this study, (a) 48.7% were discharged routinely, (b) 28.6% were discharged to a SNF,

and (c) 21.7% were discharged to home health care. The sample in this study had a much smaller percentage of individuals discharged routinely than previously published rates, which could be related to the fact that this sample was limited to index admissions for pneumonia, whereas hospitalizations for all causes has been included in previous research. A pneumonia diagnosis may affect the discharge disposition differently than other diagnoses do. The need to further explore the relationship between pneumonia hospitalizations and discharge disposition was indicated by these findings.

Loss of function. Disease severity was measured in this study through the use of the APR-DRG severity measure that reflects the patients' functional status. There are no known published statistics regarding mean APR-DRG severity measures for older adults. However, 41% of older adults do report having a functional limitation (Federal Interagency Forum on Aging-Related Statistics, 2012). More specifically, 12% have difficulties with instrumental activities of daily living (IADL) and 25% have difficulty with activities of daily living (ADL; Federal Interagency Forum on Aging-Related Statistics, 2012). In this study, the majority of records were classified as either moderate loss of function (42.9%) or major loss of function (43%). Both of these categories would most likely correlate with deficits in IADL and ADL performance. Approximately 8% of the records in this study were classified as extreme loss of function. With this type of categorization, it would be expected that the patient has experienced significant deficits in ADLs and IADLs and requires significant assistance. In general, older adults in this study who had an index admission for pneumonia had decreased function and would likely require assistance with ADLs and IADLs. This increased need for assistance may

affect the ability to perform self-care tasks and manage post discharge instructions and, therefore, affect the risk of readmission.

Median household income. The median household income for older adults in 2014 was $54,838 and can be broken down into quartiles (Administration on Aging, 2015). In this study, income was reported by quartiles of median household income by the zip code in which the patient lived (developed by HCUP). The quartiles utilized in this study were not identical to the quartiles reported by the Administration on Aging (2015) but can be compared. Table 19 provides a side-by-side comparison. The primary difference is that fewer records in this study fell into the highest income bracket as compared with the numbers reported by the Administration on Aging (2015). This difference could be due to the fact that the income levels used in this study are an estimate based on the median income from the patient's zip code and not an individualized amount. However, the fact that more individuals in this study fell into lower income brackets than population studies estimate is important to consider. Individuals with lower incomes will have fewer resources, which may influence risk of readmission.

Table 21
Comparison of Median Household Income Quartiles

Administration on aging		Quartiles used in this study	
<34,999	28%	<37,999	27.1%
35,000-49,999	29%	38,000-47,999	27.5%
50,000-74,999	19%	48,000-63,999	24.2%
75,000 +	35%	64+	19.6%

Dementia versus non-dementia subgroups. Based on the Aging, Demographics, and Memory Study (ADAMS), a nationally representative sample of older adults, approximately 14% of older adults over the age of 71, and 37.4% of older adults over the

age of 90 have some form of dementia (Plassman et al., 2007). Alzheimer's disease is the most prevalent form of dementia, accounting for 60% to 80% of all cases of dementia (Alzheimer's Association, 2016). The Alzheimer's Association (2016) reported that 11% of older adults aged 65 and older and 32% of older adults aged 85 years and older have Alzheimer's disease. Thus, the percentage of older adults with dementia increased with age, ranging from 11% to 14% at the low end (65 years) and increasing to 32% to 37% in the later years in life (85+). In this study, older adults with dementia comprised 22% of the sample. This percentage falls in the middle of the previously reported ranges and was not unrealistic given the mean age for this study sample was 79. This proportion of older adults with dementia was also similar to findings from Daiello et al. (2014) who studied hospital readmissions for older adults. Daiello et al. (2014) found that of all older adults discharged from Rhode Island hospitals in 2009, approximately 18%, had a dementia diagnosis.

Age. Older adults with dementia have been found to be older than older adults without dementia in previous studies (Husaini et al., 2015; Lin, Scanlan, Liao, & Nguyen, 2015; Zhu et al., 2015). A study of 154,945 Tennessee Hospital discharge records in 2008 found a mean age of 82.5 for older adults with dementia (Husaini et al., 2015). A prospective cohort of Medicare beneficiaries' aged 65 and over found older adults with dementia to have a mean age of 84 as compared with a mean age of 77 years for older adults without dementia (Zhu et al., 2015). The mean age of older adults with dementia in this study was 83.34 as compared to a mean age of 77.9 for older adults without dementia and was consistent with the findings by Zhu et al. (2015). An independent *t* test found that the five-year age difference between older adults with dementia and older adults

without dementia was statistically significant ($p < .001$) and had a large effect size (1.026). Over 80% of older adults with dementia are 75 years or older (Administration on Aging, 2015), so it makes sense that the mean age for this group would be higher than the mean age for older adults without dementia. When studying hospital admissions for older adults with and without dementia, Daiello et al. (2014) found older adults with dementia to be older (81) than older adults without dementia (72.4). Thus, the differences in age of older adults with and without dementia in this sample aligned with prior research.

Sex. Population studies by the Administration on Aging (2015) indicated that two thirds of older adults with dementia are female. Of individuals aged 71 and over, 16% of women have dementia and 11% of men have dementia (Administration on Aging, 2015). Lin et al. (2015) and Zhu et al. (2015) compared hospitalizations of older adults with dementia with hospitalizations of older adults without out dementia and found greater proportions of women than men in the dementia groups. The results of this study are consistent with the findings of Lin et al. (2015) and Zhu et al. (2015) and indicate that women account for a greater proportion of older adults with dementia (58.5%) as compared with older adults without dementia (53%). This difference was smaller than the difference found by Daiello et al. (2014) who found women to represent 62% when studying discharge records of older adults in Rhode Island. The leading theory about why more women than men have dementia is that women live longer, and increasing age is the greatest risk factor for dementia (Administration on Aging, 2012). However, genetics, biological factors, and life experiences may increase the risk of dementia for women as suggested by new but limited evidence (Administration on Aging, 2015; Chêne et al., 2015).

Hospitalizations. Older adults with dementia have a higher risk for hospitalization (Zhu et al., 2015) and have been found to have twice as many all-cause hospitalizations as older adults without dementia (Administration on Aging, 2015). The hospitalization rate for pneumonia was 1.5 to 1.88 times greater for older adults with dementia than for older adults without dementia (Phelan et al., 2012; Zhao et al., 2008). In this study, there was a significant difference ($p < .001$, small effect .324) in the number of hospital admissions older adults with dementia had (2.43, *SD* 1.848) as compared with older adults without dementia (2.03, *SD* 1.650). Older adults with dementia had 1.2 times more hospitalizations for pneumonia than older adults without dementia. This was near but less than the rates published in prior research.

Length of stay. Older adults with dementia are known to have longer index admission length of stays (Husaini et al., 2015; Lin et al., 2015; Zhu et al., 2015). Husaini et al. (2015) found that older adults with dementia had index admission lengths of stay approximately 7 days longer than older adults without dementia. When studying all-cause hospitalizations, Lin et al. (2015) found a significant increase of only 1 day in length of stay for older adults with dementia versus older adults without dementia. Daiello et al. (2014) found a statistically significant increase in length of stay of less than a day for older adults with dementia as compared with older adults without dementia. In this study, there was a significant difference ($p < .001$, small effect .147) of less than 1 day when comparing index admission lengths of stay of older adults with dementia (5.96 days, *SD* 7.833) and without dementia (5.27 days, *SD* 5.144). While this difference is small, it is similar to differences found by Lin et al. (2015) and Daeillo et al. (2014), suggesting that

older adults with dementia often have a longer length of stay. The small difference, however, may make it difficult to apply this finding to clinical situations.

Costs. Older adults with dementia have been reported to have a 14% (Husaini et al., 2015) to 18% (Zhu et al., 2015) increase in hospitalization costs as compared with older adults without dementia. A significant increase ($p < .001$, small effect .051) in hospitalization costs for older adults with dementia of approximately $2,000 was found in this study. This difference was equivalent to a 5% increase in costs and is much smaller than increases in cost reported by Husaini et al. (2015) and Zhu et al. (2015). Previous increases in costs have in part been attributed to longer lengths of stay for older adults with dementia. While significant, the difference in lengths of stay for this study was small and may contribute to a smaller difference in hospitalization costs.

Chronic conditions. Older adults with dementia have more chronic conditions than older adults without dementia (Administration on Aging, 2015; Husaini et al., 2015). The Alzheimer's Association (2015) reported that 12%of older adults with dementia have five or more chronic conditions as compared with 2.5% of older adults without dementia who have five or more chronic conditions. Husaini et al. (2015) found older adults with dementia had at least one more chronic condition than older adults without dementia. In this study, there was a significant difference ($p < .001$, small effect .310) between the number of chronic conditions of older adults with dementia (7.02, *SD* 2.983) and older adults without dementia (6.34, *SD* 3.034). The difference was less than one chronic condition. The finding that older adults with dementia were likely to have more chronic conditions than older adults without dementia was consistent with previous research but may not be clinically meaningful given the small difference.

Number of diagnoses. Similar to the significant difference found with chronic conditions, a significant difference ($p < .001$, moderate effect .325) was found when comparing the number of diagnoses for older adults with dementia (13.71, *SD* 5.504) and older adults without dementia (12.51, *SD* 5.201). Chronic conditions have been evaluated in previous literature but have not been specifically considered for the differences in the number of diagnoses on discharge records, especially when differentiating between older adults with and without dementia. However, it is generally accepted that the more diagnoses a patient has, the poorer the patient's health. Taking the number of diagnoses into consideration means that older adults with dementia in this study may have been in poorer health than those without dementia.

Discharge disposition. A link between hospital readmissions for older adults with dementia and the discharge disposition of the patient has been identified in previous studies (Callahan et al., 2012; Daiello et al., 2014; Nazir et al., 2013). Lin et al. (2015) studied hospitalizations for older adults utilizing a nationwide sample over 12 years and found that the presence of a dementia diagnosis significantly decreased an individual's likelihood of being discharged home. Skilled nursing facilities have been identified as the most common discharge disposition of older adults with dementia (Daiello et al., 2014). It has been suggested that the likelihood of a patient with dementia experiencing a hospital readmission increases when the discharge disposition of the index admission is to a skilled nursing facility (Callahan et al., 2012; Nazir et al., 2013). However, Daiello et al. (2014) found that the greatest risk of readmission for older adults with dementia occurred when the discharge disposition was to home health. Thus, previous research indicated that discharge disposition is an important consideration.

Comparisons of older adults with and without dementia in this study showed significant differences ($p < .001$, medium effect .325) in discharge dispositions. Older adults with dementia had half as many routine discharges to home (23%) as older adults without dementia (56%). In reverse, older adults with dementia had twice as many discharges to skilled nursing facilities (54.2%) as older adults without dementia (21.2%). These findings are consistent with previous literature in which skilled nursing facilities were identified as the primary discharge disposition for older adults with dementia. The impact of these discharge dispositions on risk of readmission are further explored later in this chapter.

Risk of mortality. The risk of mortality is another variable of importance to consider when comparing older adults with and without dementia within this study. As reported in previous studies, older adults with dementia who are hospitalized have higher rates of mortality than older adults without dementia (Morrison & Siu, 2000; Sampson, Blanchard, Jones, Tookman, & King, 2009; Shen, Lu, & Li, 2012; Sherzai, Sherzai, Sahak, & Ani, 2016). In this study, the APR-DRG risk of mortality measure was used. The APR-DRG risk of mortality variable has four levels: (a) minor, (b) moderate, (c) major, and (d) extreme. A significant difference ($p < .001$, small effect .165) was found when comparing the mortality risk of older adults with and without dementia in this study. Older adults with dementia had greater proportions in the moderate (48.7%) and major (40.8%) categories and fewer in the minor category (1.6%) than older adults without dementia. Older adults without dementia had approximately (a) 12% more individuals in the minor category, (b) 8% less in the major category, and (c) 3% less in the moderate category. The findings in this study were consistent with previous research

in which older adults with dementia have been found to have an increased risk of mortality.

Summary. While statistically significant differences ($p < .001$) were found when comparing (a) payer, (b) loss of function, (c) median household income, and (d) patient location, all had small effects (<.10) and showed no clinically relevant differences. Overall, the majority of the differences between the dementia and non-dementia subgroups are supported by previous research. These identified differences reflect the need to consider older adults with dementia as a separate and characteristically different subgroup of individuals when addressing all-cause pneumonia readmissions.

Research Question 1

What is the all cause pneumonia readmission rate for older adults diagnosed with dementia and for older adults with no known diagnosis of dementia? The all-cause pneumonia readmission rate for the entire sample in this study was 19.2%. This readmission rate was similar to prior research in which the all-cause pneumonia readmission rate was roughly 18% (Allaudeen et al., 2011; Dharmarajan et al., 2013; Epstein et al., 2011; Hemenway & Naretta, 2015; Lindenauer et al., 2011; Suter et al., 2014).

The all-cause pneumonia readmission rate for older adults without dementia in this nationally representative sample was 17.97%. The all-cause pneumonia readmission rates for older adults without dementia separate from older adults with dementia have been reported in only two previous studies. Ahmedani et al. (2015) found an all-cause pneumonia readmission rate for older adults without dementia to be 16% while Daeillo et al. (2014) found a rate of 14.5%. Thus, the all-cause pneumonia readmission rate for

older adults without dementia was slightly higher in this study than previously reported rates.

The all-cause pneumonia readmission rate for older adults with dementia in this nationally representative sample was 23.52%. This finding was consistent with previous studies in which the all-cause pneumonia readmission rates for older adults with dementia ranged from 23 to 25% (Ahmedani et al., 2015; Callahan et al., 2012). Ahmedani et al. (2015) investigated the influence of psychiatric conditions, including dementia, on 30-day, all-cause readmissions for heart failure, myocardial infarct, and pneumonia by conducting a retrospective review of 160,169 records from 11 health systems over 2 years. Callahan et al. (2012) conducted a prospective review of 4,197 older adults in a single health system over 1 year to investigate care transitions for older adults with dementia. Both of these studies included calculations of all-cause pneumonia readmission rates for older adults with and without dementia. The methodologies used in both studies were similar to the methods used in this study (Ahmedani et al., 2015; Callahan et al., 2012). Ahmedani et al. (2015) based their methods on the CMS's methodology and was, therefore, the most similar in methods to this study. Callahan et al. (2012) used slightly different methods of sampling given that the study was prospective but did use the same criteria for identification of index admissions and readmissions.

Daeillo et al. (2014) published a lower all-cause pneumonia readmission rate for older adults with dementia of 18% but also found a lower than usual readmission rate for older adults without dementia (14.5%). Daeillo et al. (2014) examined records from one state's Medicare claims data to determine the influence of dementia on hospital readmissions. As was described earlier in the paper, methods used to determine the rate

of readmission can have a significant effect on the outcomes (Dharmarajan et al., 2013; Hemenway & Naretta, 2015; Hines et al., 2014; Mather et al., 2014; Navarro et al., 2012; Shorr et al., 2013; Suter et al., 2014). It is not clear which inclusion and exclusion criteria Daeillo et al. (2014) used to arrive at their final sample. Variations in methodology may explain the lower all-cause pneumonia readmission rates as reported by Daeillo et al. (2014) as compared with this study and the studies by Ahmedani et al. (2015) and Callahan et al. (2012).

The studies by Ahmedani et al. (2015) and Callahan et al. (2012) used samples from health systems. Daeillo et al. (2014) used the Medicare claims data from one state. However, this study is the first to use a nationally representative sample to determine the all-cause pneumonia readmission rate for older adults with dementia.

Research Question 2

Is there a difference in the all-cause pneumonia readmission rate for older adults with dementia as compared with the all-cause pneumonia readmission rate for older adults without dementia? The all-cause pneumonia readmission rate for older adults with dementia (23.52%) was found to be 5% greater than the all-cause pneumonia readmission rate for older adults without dementia (17.5%). This finding was consistent with the findings of previous research. Ahmedani et al. (2015) found a difference of 9% between the all-cause pneumonia readmission rate for older adults with dementia (25%) as compared with the rate for older adults without dementia (16%). Daeillo et al. (2014) found a 4% difference in the all-cause pneumonia readmission rates for older adults with dementia (18%) and older adults without dementia (14%). Thus, the findings from this

study were consistent with previously published differences in all-cause pneumonia readmission rates between older adults with dementia and older adults without dementia.

A bivariate analysis was calculated for this study and indicated that older adults with dementia were almost three times more likely to experience an all-cause pneumonia-related readmission than older adults without dementia when controlling for all other factors. Justification for categorizing older adults with dementia as a high-risk population for all-cause pneumonia readmissions were provided by these findings. It has been suggested that to decrease readmissions, strategies should be focused on high-risk populations (Agency for Healthcare Research and Quality, 2014a). There was a difference in the all-cause pneumonia readmission rate of older adults with and without dementia as indicated by the results of this study. Support for the development of strategies to decrease all-cause pneumonia readmissions in the high-risk subgroup of older adults with dementia was also demonstrated by the results of this study.

Research Question 3

Is there a significant difference when comparing patient factors of older adults with dementia who were readmitted and older adults without dementia who were readmitted? Part of understanding how a diagnosis of dementia affected all-cause pneumonia readmissions is to understand the differences in characteristics between older adults with and without dementia who were readmitted. The significant differences between these two groups in light of published research and in the context of the entire sample used for this study are discussed in the following paragraphs.

Dementia. Older adults with dementia constituted 37.48% of the individuals who experienced an all-cause pneumonia readmission. Thus, older adults with dementia

account for a greater proportion of the readmissions than the proportion they represented in the entire sample, which was 22%. The proportion of older adults in the United States with dementia ranges from 11% to 37% with the highest rates occurring in the oldest segments of the population (Alzheimer's Association, 2016; Plassman et al., 2007), which means that the percentage of older adults with dementia who were readmitted in this study was much larger than the percentage of older adults with dementia in the general population. The percentage of older adults with dementia who were readmitted was much larger than the 18% published by Daiello et al. (2014). The finding that older adults with dementia make up a greater proportion of individuals who were readmitted was consistent with the results from Research Questions 1 and 2, which found that older adults with dementia had almost three times greater risk of readmission than older adults without dementia.

Age. Older adults with dementia who were readmitted were on average 5 years older than older adults without dementia who were readmitted. This finding was statistically significant ($p < .001$) and had a large effect size (.8656). The average age for older adults with dementia who were readmitted (82.70) and the average age of older adults without dementia who were readmitted (77.60) were consistent with the age differences found for the entire sample (dementia 83.4, non-dementia 77.9). It was also consistent with previous research in which older adults with dementia were found to be older with a mean age of approximately 84 years (Husaini et al., 2015; Lin et al., 2015; Zhu et al., 2015).

Sex. Older adults with dementia who were readmitted were more often women (56.6%) than older adults without dementia who were readmitted (51.5%). This finding

was similar to the proportions of older adults with dementia who were female (58.5%) and older adults without dementia who were female (53%) in the entire sample. These findings were also in line with population studies in which a greater percentages of women with dementia than men were found (Administration on Aging, 2015). Results of other studies have also demonstrated greater proportions of women than me in older adults with dementia who have been hospitalized (Lin et al., 2015; Zhu et al., 2015). However, these findings were in opposition to pneumonia-readmission research in which men were found to be at a greater risk of readmission than women (Mather et al., 2014; Navarro et al., 2012; Neupane et al., 2010). The percentage of women readmitted was approximately 2% less for both older adults with and without dementia than the percentage of older adults with and without dementia in the entire sample for this study. This decrease in the percentage of women may be related to an increased risk of all-cause pneumonia readmissions for men as reported in prior research (Mather et al., 2014; Navarro et al., 2012; Neupane et al., 2010) and was supported in this study with men being 1.11 times more likely to be readmitted than women

Hospitalizations. There was a statistically significant difference ($p < .001$) in the number of hospitalizations for older adults with dementia who were readmitted (3.55 visits) and older adults without dementia who were readmitted (3.41 visits), but the effect size was small (.089). It has been found that older adults with dementia have 1.5 to 1.8 more hospitalizations than older adults without dementia (Phelan et al., 2012; Zhao et al., 2008). While the findings in the entire sample were consistent with other studies, comparison of older adults with and without dementia who were readmitted showed a much smaller difference in the number of hospitalizations. In fact, they were nearly the

same with only 1.04 more hospitalizations for older adults with dementia who were readmitted. However, the average number of hospitalizations for older adults who were readmitted was more than one visit greater than the average number of hospitalizations for both older adults with dementia and older adults without dementia in the entire sample, which suggests that all older adults who experience an all-cause pneumonia readmission were likely to have more hospitalizations than older adults who were not readmitted regardless of a dementia diagnosis.

Length of stay. The length of stay for older adults with dementia who were readmitted was 6.40 days as compared with a length of stay of 6.15 days for older adults without dementia who were readmitted. This finding was significant ($p < .001$) but had a small effect size (.050). This finding also had minimal clinical significance as the difference in lengths of stay represented mere hours. It is important to note that on average, both groups had lengths of stay 1 day longer than older adults with dementia (5.96 days) and older adults without dementia (5.27) in the entire sample.

In previous research, the length of stay for the index admission of individuals who were readmitted is on average 1 day longer than the index admission of individuals who were not readmitted (Navarro et al., 2012; Shams et al., 2015). Shams et al. (2015) more specifically found that the length of stay for the index admission of individuals who experienced an all-cause pneumonia readmission had a length of stay on average 1 day longer than those who did not experience an all-cause pneumonia readmission. While the difference in length of stay between those readmitted who did and did not have dementia was small, the change in lengths of stay between those who were and were not readmitted in this study was consistent with previous research. Regardless of dementia diagnosis,

older adults who were readmitted in this study spent 1 day longer in the hospital than older adults who were not readmitted.

Costs. While previous research has established that older adults with dementia have increased hospitalization costs as compared with older adults without dementia, prior studies have not looked at the difference in costs of older adults with dementia who were readmitted as compared with older adults without dementia who were readmitted (Husaini et al., 2015; Zhu et al., 2015). There was not a statistically significant difference (p = .644) in the cost incurred by older adults with dementia who were readmitted as compared with costs incurred by older adults without dementia who were readmitted.

There are two important points regarding this finding. The first is that older adults with dementia who were readmitted incurred less costs than older adults without dementia who were readmitted. The difference was approximately $200 as compared with total costs that were roughly $40,000. It has been suggested in prior research that older adults with dementia often receive subpar treatment (Foley et al., 2014; van der Steen et al., 2002) or forego curative care for palliative treatment (Mitchell et al., 2009; Morrison & Siu, 2000). It could be argued that for these reasons, older adults with dementia who were readmitted incur fewer costs during index admissions. However, it is highly unlikely that substantial changes such as these would result in a cost difference as little as $200.

It is also important to look at the difference in the costs for older adults who were readmitted versus the entire sample. The costs increased for all older adults who were readmitted as compared with the entire sample regardless of dementia diagnosis. The average cost spent for older adults with dementia within the entire sample was $39,007.

This amount increased by approximately $900 for older adults with dementia who were readmitted. The average cost spent for older adults without dementia for the entire sample was lower at $37,002. However, this amount increased substantially by roughly $3,000 to $40,162 for older adults without dementia who were readmitted. While both older adults with and without dementia who were readmitted had increased costs as compared with those who were not readmitted, older adults without dementia who were readmitted had a more substantial increase, which suggested that the cost of index admission hospitalization for older adults with dementia may not be well associated with a prediction of all-cause pneumonia readmissions.

Chronic conditions. Older adults with dementia who were readmitted had more chronic conditions (7.38) than older adults without dementia who were readmitted (7.17). This finding was statistically significant ($p < .001$) with a large effect size (.880). Both of these values represent roughly one additional chronic condition as compared with respective subgroups in the entire population (7.02 and 6.34). Differences in the number of chronic conditions for older adults with and without dementia who have been readmitted have not been studied in previous research. However, these findings were consistent with prior research in which older adults with dementia were found to have more chronic conditions than older adults without dementia (Administration on Aging, 2015; Husaini et al., 2015). The findings that individuals who were readmitted have more chronic conditions than individuals who were not readmitted matched the general understanding that with an increased number of chronic conditions come a decline in general health status.

Number of diagnoses. Similar to chronic conditions, there was a statistically significant ($p < .001$, small effect .110) increase in the number of diagnoses during index admissions for older adults with dementia who were readmitted (14.39) diagnoses as compared with older adults without dementia who were readmitted (13.93). These numbers represent an increase of approximately one diagnosis as compared with the respective subgroups in the entire sample (13.71, 12.51). There was no prior research to reference for comparison of these findings. However, it is generally accepted that greater numbers of diagnoses correlates to poorer health status. An increased number of diagnoses may be a factor leading to readmission for older adults who were readmitted.

Discharge disposition. As was stated previously in the paper, skilled nursing facilities are the most common discharge disposition for older adults with dementia (Daiello et al., 2014), which has held true in this study when comparing older adults with dementia who were readmitted with older adults without dementia who were readmitted. There was a significant difference ($p < .001$, medium effect .280) in discharge dispositions when comparing these two groups. Older adults with dementia who were readmitted most frequently had an index admission discharged to skilled nursing facilities (59.2%) followed by home health care (20.9%) and then routine discharges (18.6%). Older adults without dementia who were readmitted most frequently had an index admission discharged routinely (43%) followed by discharge to skilled nursing facilities (29.7%) and discharge to home health care (26.1%). Despite other characteristics being similar between the two groups (number of diagnoses, number of chronic conditions, and length of stay), discharge disposition was clearly different.

Likewise, there were differences in discharge disposition between these two groups and the respective groups in the entire sample. Fewer older adults both with and without dementia who were readmitted had been discharged routinely than older adults with and without dementia in the entire sample. More older adults both with and without dementia who were readmitted had been discharged to a skilled nursing facility as compared with older adults with and without dementia in the entire sample. Older adults without dementia who were readmitted were discharged to home health more than older adults without dementia in the entire sample. There was no change in the percentage of older adults with dementia who were readmitted who were discharged to home health as compared with the percentage of older adults within the entire sample who were discharged to home health. Therefore, regardless of dementia diagnosis, more older adults who were readmitted had an index admission discharge to a skilled nursing facility and fewer experienced a routine discharge. However, of those who were readmitted, older adults with dementia were more often discharged to skilled nursing facilities and home health than to routine discharges.

Risk of mortality. The overall sample for this study was consistent with previous research in which an increased risk of mortality was reported for older adults with dementia as compared with older adults without dementia (Sampson et al., 2009; Shen et al., 2012; Sherzai et al., 2016). There appears to be less of a difference between older adults with dementia who were readmitted as compared with older adults without dementia who were readmitted when considering mortality risk in this study. In general, the majority of older adults with dementia, and those without dementia who were readmitted fell into the moderate (42.9%, 41.0%) and major risk (44.5%, 41.0%) of

mortality categories. There were only slightly more older adults with dementia who were readmitted who were in the extreme category (11.1%) as compared with older adults without dementia who were readmitted (10.6%). There were fewer older adults with dementia who were readmitted in the minor category (1.5%) than older adults without dementia who were readmitted (7.4%).

When comparing these mortality rates to the rates of the respective groups in the entire sample, there were consistent changes across all categories. Regardless of dementia diagnosis, the percentage of older adults in the moderate category decreased and the percentages of older adults in the major and extreme categories increased. There was no change in the percentage of older adults with dementia who were readmitted in the minimum category, but there was a decrease in the number of older adults without dementia who were readmitted in the minimum category. Regardless of dementia diagnosis, older adults who are readmitted have increased risks of mortality during the index admission. For older adults with dementia who were readmitted, very few fell into the minimum category, and the percentages in the major and extreme categories were greater than the percentages for older adults without dementia who were readmitted. As suggested by the findings, there were greater similarities between older adults with dementia and older adults without dementia who were readmitted than there were similarities between older adults with and without dementia in the entire sample.

Summary. While statistically significant, differences were found when comparing (a) payer, (b) APR-DRG severity measure, (c) median household income, and (d) patient location, all had small effects (<.10) and showed no clinically relevant differences. Overall, older adults with dementia who were readmitted were (a) older, (b)

more often female, (c) had longer lengths of stay, (d) increased numbers of chronic conditions and diagnoses, (e) were more often discharged to skilled nursing facilities and home health care, and (f) had higher risks of mortality. Yet, regardless of dementia diagnosis, all older adults who were readmitted (a) had lower percentages of female patients, (b) more hospitalizations, (c) longer lengths of stay, (d) increased costs, (e) increased numbers of chronic conditions and diagnoses, (f) were more often discharged to skilled nursing facilities, and (g) had increased percentages with major and extreme risks of mortality. Thus, there a significant difference when comparing patient factors of older adults with dementia who were readmitted and older adults without dementia who were readmitted.

Research Question 4

Is there a significant difference when comparing patient factors of older adults with dementia who were readmitted to the patient factors of older adults with dementia who were not readmitted? In addition to comparing older adults with dementia to older adults without dementia, it is important to compare older adults with dementia who have experienced an all-cause pneumonia readmission with older adults with dementia who have not been readmitted.

Age. When comparing the age of older adults with dementia who experienced an all-cause pneumonia readmission with the age of older adults with dementia and pneumonia who were not readmitted, there was a statistically significant difference ($p <$ .001, small effect .170). However, the difference between 83.54 years for older adults with dementia who were not readmitted and 82.70 years for older adults with dementia who were readmitted was not clinically significant. For both groups, the average age was

approximately 83, which was consistent with the mean age of all older adults with dementia in this study and with previously published values (Husaini et al., 2015; Lin et al., 2015; Zhu et al., 2015).

Sex. In this study, the entire sample was 54% female, and 58.5% of older adults with dementia were female. Older adults with dementia who were readmitted consisted of 56.6% women, whereas older adults with dementia who were not readmitted consisted of 59.1% women. The difference between these two groups was found to be statistically significant ($p < .001$, small effect .021). While women make up a greater proportion of older adults in the United States and a greater proportion of older adults with dementia, men have been found to be at a greater risk of readmission than women (Mather et al., 2014; Navarro et al., 2012; Neupane et al., 2010). Additionally, older adult men were 1.11 times more likely to be readmitted than older adult women as demonstrated by the generalized linear model used in this study. The finding that men are at a greater risk for readmission could be a reason for the decreased percentage of older adults with dementia who were readmitted that were women.

Hospitalizations. Older adults with dementia who were not readmitted had an average of 2.08 hospitalizations as compared with 3.55 hospitalizations for older adults with dementia who did experience an all-cause pneumonia readmission. The difference between these values was statistically significant ($p < .001$) with a lager effect size (1.118). When compared in this manner, older adults with dementia who experience an all-cause pneumonia readmission have approximately 1.7 times more hospitalizations. Older adults with dementia who experienced an all-cause pneumonia readmission have the highest average number of hospitalizations of all groups assessed in this study,

including older adults without dementia who were readmitted (3.41 visits). For older adults with dementia who were not readmitted, the average number of hospitalizations (2.08) was most similar to the average number of hospitalizations for all patients without dementia (2.03), not the overall rate of hospitalizations for older adults with dementia (2.43), which suggested a significant difference in the characteristics of older adults with dementia who did and did not experience an all-cause pneumonia readmission. The number of hospitalizations is an important factor when identifying older adults with dementia at risk of pneumonia readmissions.

Length of stay. The average length of stay in a hospital for older adults is 5.50 days (Administration on Aging, 2015). In this study, the average length of stay of the entire sample was 5.44. The average index admission length of stay for older adults with dementia who were readmitted was 6.4 days as compared with 5.82 days for older adults with dementia who were not readmitted. There was a statistically significant ($p < .001$, small effect size .101) for these two groups, which means that older adults with dementia who were readmitted had longer lengths of stay for the index admission. When assessing older adults with dementia for risk of pneumonia readmission, length of stay for the index admission should be considered.

Costs. Older adults with dementia are known to have increased costs of hospitalization as compared with older adults without dementia (Husaini et al., 2015; Zhu et al., 2015). An average cost of $27,661 has been reported for pneumonia hospitalizations (Sato et al., 2013). The average cost in this study ranged from $37,002 for older adults without dementia to $39,074 for older adults with dementia. For older adults with dementia who were readmitted, the average cost increased to $39,953.

However, the average cost decreased to $33,304 for older adults with dementia who were not readmitted, which was a difference of approximately $6,000 or 15% between the two groups. A change of $6,000 or 15% in costs has significant implications for both patient and hospital resources. Older adults with dementia with higher costs during index admission may be at increased risk of readmission.

Chronic conditions. The differences between the number of chronic conditions present in older adults with dementia who did or did not experience an all-cause pneumonia readmission have not been compared in prior research. It is known is that 12% of older adults with dementia have five or more chronic conditions (Administration on Aging, 2015; Husaini et al., 2015). The average number of chronic conditions for older adults with dementia in this study was 7.02 (*SD* 2.983). For older adults with dementia who experienced an all-cause pneumonia readmission, the average number increased to 7.38 (*SD* 3.080). For older adults with dementia who did not experience an all-cause pneumonia readmission, the average number of chronic conditions decreased to 6.90 (*SD* 2.943). There was a statistically significant difference with a small effect ($p <$ .001, small effect .217) for the average number of chronic conditions for these two groups. Thus, older adults with dementia who did not experience an all-cause pneumonia readmission had an average number of chronic conditions lower than all older adults with dementia who were readmitted.

Number of diagnoses. The average number of diagnoses contained on the index admission was highest for older adults with dementia who were readmitted (14.39 diagnoses). Older adults with dementia who were not readmitted had an average number of diagnoses of 13.50. The difference between these two values was statistically

significant ($p < .001$, small effect .239), which suggested that older adults with dementia who experienced an all-cause pneumonia readmission likely had more diagnoses on the index admission. It was also suggested that older adults without dementia who experienced an all-cause pneumonia readmission had more diagnoses (13.93) on average than older adults with dementia who were not readmitted. These findings may reflect poorer health status of older adults with dementia who were readmitted as compared with older adults with dementia who were not readmitted.

Discharge disposition. The diagnosis of dementia has influences discharge disposition of a patient (Callahan et al., 2012; Daiello et al., 2014; Nazir et al., 2013). When comparing the discharge disposition of older adults with dementia who did and did not experienced an all-cause pneumonia readmission, there was a statistically significant difference ($p <.001$, small effect .055). The difference was much smaller than other comparisons of discharge disposition presented in this study. The two discharge dispositions in which there were differences were routine discharge and discharge to a skilled nursing facility. More older adults with dementia who were not readmitted were discharged routinely (23.8%) than older adults with dementia who were readmitted (18.6%). Conversely, more older adults with dementia who were readmitted were discharged to a skilled nursing facility (59.2%) than older adults with dementia who were not readmitted (54.4%), which is equal to a 5% change in discharge disposition distributions. Regardless of readmission status, the majority of older adults with dementia were discharged to a skilled nursing facility as suggested by the findings. Even though older adults with dementia who were not readmitted had a slightly greater percentage of routine discharges, the percentage was still much lower than the percentage of older

adults without dementia who were discharged routinely. The concept that the presence of a dementia diagnosis has a large impact on discharge disposition was further supported by the study.

Risk of mortality. The majority of older adults with dementia who were and who were not readmitted fell into the moderate (42.9%, 50.5%) and major (44.5%, 39.7%) risk of mortality categories. Even though the majority fell into these two categories, older adults with dementia who were not readmitted had greater numbers in the moderate category, indicating a lower risk. Older adults with dementia had greater numbers in the major category, indicating an increased risk of mortality. Older adults with dementia who were readmitted had a slightly greater proportion in the extreme category (11.1%) as compared with older adults with dementia who were not readmitted (8.1%). There were equal numbers of older adults with dementia who were and were not readmitted in the minor category (1.5%, 1.7%). Regardless of readmission status, very few older adults with dementia fell into the minimum category, suggesting that a dementia diagnosis may significantly affect an older adult's risk of mortality when hospitalized for pneumonia. This finding is consistent with previous research that indicates older adults with dementia are twice as likely to die from pneumonia and that pneumonia accounts for at least half of all dementia-related deaths (Brunnström & Englund, 2009; Centersfor Disease Control and Prevention, 2013; Foley et al., 2014; Magaki et al., 2014). Older adults with dementia who were readmitted had a greater percentage in the high risk for mortality categories. Older adults with dementia who were readmitted were characteristically different than older adults with dementia who were not readmitted given the differences in proportions across the categories of risk of mortality as indicated by the findings in this study.

Loss of function. The APR-DRG severity measure is a variable that has not had clinical significance in other comparisons in this paper but that is relevant to this comparison. APR-DRG severity measure is a measure of a patient's loss of function due to illness. Similar to the APR-DRG risk of mortality measure, there are four categories: (a) minor loss, (b) moderate loss, (c) major loss, and (d) extreme loss. There was a statistically significant difference ($p < .001$) with a small effect (.101) found for this comparison. The majority of older adults regardless of readmission status fell into the moderate and major loss categories. Older adults with dementia who were readmitted had greater proportions in the major (49.3%) and extreme (11.6%) categories than older adults with dementia who were not readmitted (43.3%, 7.3%). Older adults with dementia who were not readmitted had greater proportions in the minor (6.0%) and moderate (43.4%) categories than older adults with dementia who were readmitted (3.5%, 35.7%), which suggests that older adults with dementia who experience an all-cause pneumonia readmission had greater functional deficits due to illness than older adults with dementia who were not readmitted.

Summary. While statistically significant differences were found when comparing (a) payer, (b) median household income, and (c) patient location, all had small effects (<.10) and showed no clinically relevant differences. Overall, older adults with dementia who were readmitted (a) were more often female, (b) had more hospitalizations, (c) had longer lengths of stay, (d) increased costs, (e) increased numbers of chronic conditions and diagnoses, (f) had greater loss of function, and (g) had higher risks of mortality than older adults with dementia who were not readmitted. Older adults with dementia who were not readmitted had (a) fewer hospitalizations, (b) shorter lengths of stay, and (c)

fewer costs than older adults without dementia who were readmitted. It is suggested by the findings that there is a difference between older adults with dementia who were and were not readmitted. This new information regarding all-cause pneumonia readmissions may prove useful in identifying high-risk patients in clinical settings. These differences may be used to help identify patients at risk of all-cause pneumonia readmissions.

Research Question #5

Does the diagnosis of dementia affect the predictive factors for all-cause pneumonia readmissions? As was noted in the discussion of research Questions 1 through 4, there are significant differences in the characteristics of older adults with dementia who were readmitted as compared with both older adults with dementia who were not readmitted and older adults without dementia who were readmitted. The following discussion will address the results of the generalized linear model.

Variables in the model. The risk of an all-cause pneumonia readmission increased as the value of each of the following factors increased: (a) age, (b) number of chronic conditions, (c) length of stay, and (d) severity of illness. Risk of readmission increased when income level decreased. Risk of readmission was greater for men than women. Index admissions discharged to a skilled nursing facility had the greatest risk of readmission followed by home health and short-term hospitals. Risk of readmission initially increased with increased mortality rates and then decreased as mortality rates reach the extreme category.

Age. In a systematic review of 20 articles related to pneumonia readmissions, Calvillo-King et al. (2013) found that increasing age was the most consistent risk factor for readmissions. As part of a randomized, multicenter, control trial regarding the

implementation of practice guidelines, Jasti et al. (2008) found an increased risk of all-cause hospital readmission for older patients and identified an age difference of approximately 6 years between those who were and were not readmitted. Shams et al. (2015) conducted a retrospective review of inpatient records from the Veterans Health Affairs and found that increasing age increased the risk of pneumonia readmission. Findings from prior studies were consistent with the finding in this study that increasing age increased risk of readmission.

Sex. In general, men have a greater percentage of all-cause pneumonia readmissions than women (Jasti et al., 2008; Shams et al., 2015). Gender is often included as a factor in pneumonia readmission models (Calvillo-King et al., 2013). Mather et al. (2014) conducted a retrospective study of approximately 1,000 discharge records from a single tertiary care center over 3 months and found that older adult men were 1.5 times more likely to experience an all-cause pneumonia readmission than women. Neupane et al. (2010) conducted a prospective study of approximately 700 individuals who were admitted for pneumonia over a period of 2 years and found that men were 2.3 times more likely to be readmitted than women.

Similar to the findings of previous studies, results of this study indicated men were found to be 1.11 times more likely to experience an all-cause pneumonia readmission than women. This finding was a smaller increase in risk for men than previously published rates, but this study was the only one that assessed a nationally representative sample and had a much larger sample. The increased risk of all-cause pneumonia readmission for men also explained the decreased percentages of women in

the readmission groups discussed earlier in the paper. Thus, while women account for a greater proportion of the sample, men had greater odds of being readmitted.

Length of stay. There is conflicting evidence on the influence of the length of stay during the index admission on the risk of readmission (Jasti et al., 2008; Navarro et al., 2012; Scott et al., 2014; Shams et al., 2015). Navarro et al. (2012) and Jasti et al. (2008) both reported increased risks of pneumonia-readmissions with increased lengths of stay. Both have suggested that longer lengths of stay were indicative of increased severity of disease. However, Shams et al. (2015) found that shorter lengths of stay were linked to increased risk of readmission. Shams et al. (2015) hypothesized that the shorter lengths of stay were reflective of poor inpatient care that led to early discharge followed by readmission. Scott et al. (2014) found no correlation between length of stay of index admissions and the risk of readmission.

In this study, there was a small increase in the risk of readmission (1.01; 95% CI [1.00, 1.01]) for each additional day for the length of stay. This difference is minimal at best but prior research that found longer lengths of stay increased the risk of readmission was supported by the findings. Further research needs to be conducted to further investigate the relationship between length of stay and risk of readmission.

Number chronic conditions. An increased risk of pneumonia readmission with increased numbers of comorbid conditions has been identified in prior studies (Jasti et al., 2008; Navarro et al., 2012; Scott et al., 2014; Shams et al., 2015). Navarro et al. (2012) conducted a retrospective analysis of 1 year of records from a community-based medical center and found twice as many comorbidities for individuals who had a pneumonia

readmission as compared with those who did not. Jasti et al. (2008) found that individuals who had nine or more comorbidities were at increased risk for pneumonia readmissions.

Two variables that measured comorbidities were included in this study. The first was the number of diagnoses on the discharge record. This variable was not a significant factor in the generalized linear model. The second variable was the number of chronic conditions. This variable did show an increased risk of readmission as the number of chronic conditions increased, which suggests that it may be the number of chronic conditions, not just the total number of diagnoses, which influenced all-cause pneumonia readmissions. This study was the first to include risk of mortality within the model for all-cause pneumonia readmission risk.

Discharge disposition. The majority of hospitalized older adults (72%) had a routine discharge to their homes (Mattison, 2016). However, older adults over the age of 85 were discharged to a SNF 40% of the time. The link between discharge destination and risk of readmission is usually understood to be negative when a patient is discharged to a facility (Nazir et al., 2013). Hain, Tappen, Diaz, and Ouslander (2012) conducted a retrospective analysis of 6,809 discharge records from a community hospital and found that older adults discharged to skilled nursing facilities had the highest rate of readmission (15%) followed by home health (13%) and then by routine discharges (8%).

The results of this study were that discharge to a skilled nursing facility was 1. 5 times more likely to result in an all-cause pneumonia readmission than a routine discharge and that a discharge to home health care was 1.3 times more likely to result in an all-cause pneumonia readmission than a routine discharge. One potential reason for these increased risks of readmission was that individuals who were discharged to these

locations had increased severity of illness or increased medical complexity, resulting in an increased risk of readmission. Another possible contributing factor could be the quality of care received from the skilled nursing facility or the home health care agency was insufficient to prevent readmissions, which is an area that warrants further investigation.

Loss of function. The role of functional status as a predictor for hospital readmissions has not been well researched. A systematic review of readmission prediction models found that only two out of 30 studies included functional status as a variable (Kansagara et al., 2011). The effect of function on readmissions has begun to be explored in a few recent studies. In a retrospective study of approximately 4,000 patients between 2003-2011, Soley-Bori et al. (2015) found that baseline physical function was a predictor of hospital readmissions. Similarly, Conway, Byrne, O'Riordan, and Silke (2015) found that the severity of illness as measured by functional decline was a significant predictor of readmissions. Greysen Stijacic Cenzer, Auerbach, and Covinsky (2015) examined a nationally representative sample of approximately 23,000 admissions and found that as the severity of functional impairment increased, the risk of readmission increased, and they found this was especially true for pneumonia admissions.

In this study, the APR-DRG severity measure was used as a measure of functional loss. As the severity of loss increased, the risk of pneumonia readmissions increased. These findings were consistent with prior research, and the need to further explore the significance of functional status for the risk of all-cause pneumonia readmissions was supported. However, the measure used to quantify functional loss in this study and in

previous studies was not robust enough to give detailed information about the functional loss that could assist health care providers in identifying at risk individuals.

Risk of mortality. Measures of mortality risk are often reported as a measure of hospital outcomes (Krumholz et al., 2013; Wuerth, Bonnewell, Wiemken, & Arnold, 2016). Individuals with pneumonia who have increased risks of pneumonia are usually older and men (Calvillo-King et al., 2013). However, mortality risk has not been included in pneumonia readmission risk models (Calvillo-King et al., 2013).

In this study, risk of mortality was measured by the APR-DRG risk of mortality variable. Results showed an initial increase in risk of readmission with an increase in mortality risk was followed by a decrease in risk of readmission as risk of mortality reached extreme levels. It suggested that those older adults with moderate to major risks of mortality may have increased medical needs that necessitate their return to the hospital. Implementation of strategies targeted at these individuals may be warranted to decrease all-cause pneumonia readmission rates. Risk of readmission for older adults with extreme mortality risks may be lower due to death after discharge. This study did not follow individuals after discharge and thus cannot assess if death after discharge affected readmission rates for older adults with extreme mortality risks.

Median household income. Low income has been identified as a predictor of increased risk for all-cause pneumonia readmissions (Calvillo-King et al., 2013; Mather et al., 2014). In this study, the risk of readmission was greatest for older adults who lived in zip codes with the lowest median household incomes. The risk increased with comparison to higher median incomes. Individuals in low-income brackets were likely to have access to fewer resources, which may have increased the risk of readmission. When

planning for discharge, strategies may be able to be implemented to overcome this barrier and decrease risk of readmission.

Significant interactions with dementia. An important goal of this study was to understand how a diagnosis of dementia affects all-cause pneumonia readmissions. The following paragraphs discuss the four variables that were found to significantly interact with dementia: (a) risk of mortality, (b) discharge disposition, (c) mean income by zip code, and (d) number of chronic conditions.

Risk of mortality and dementia. When all other factors are controlled for and there is a minor risk of mortality, older adults with dementia are 2.35 times more likely to be readmitted than older adults without dementia. However, there is not an increased risk for all-cause pneumonia readmissions for older adults with dementia as compared with older adults without dementia at the higher levels of risk of mortality (moderate, major, and extreme). It was suggested that even at the lowest level of mortality risk, older adults with dementia are much more likely to experience an all-cause pneumonia readmission than older adults without dementia. From a clinical standpoint, it is important to understand that even if a patient with dementia has a low risk of mortality, it does not mean that there is a low risk of readmission. Another significant finding was that the risk of an all-cause pneumonia readmission did not increase for older adults with dementia as the mortality risk increased, which suggested that strategies to decrease all-cause pneumonia readmissions for older adults with dementia do not need to be tailored based on an individual's level of risk of mortality. As was mentioned previously, this was the first paper to include risk of mortality as a risk factor for readmission, thus there was no previous literature to compare with these findings.

Discharge disposition and dementia. There was conflicting evidence about discharge dispositions for older adults with dementia. It is generally accepted that older adults with dementia are most often discharged to skilled nursing facilities. Lin et al. (2015) found that the presence of dementia significantly influences discharge disposition and results in a negative likelihood of an older adult with dementia being discharged to home. In a retrospective review of hospital discharges from Rhode Island, Daiello et al. (2014) found that more older adults with dementia were discharged to skilled nursing facilities than older adults without dementia. However, in a nationally representative sample, Callahan et al. (2015) studied approximately 3,500 older adults with dementia and determined that 52% were discharged home without services, and 38% were discharged to a skilled nursing facility.

In this study, 54% were discharged to skilled nursing facilities, and 23% were discharged routinely. These findings were most consistent with Daiello et al. (2014), which suggested that discharge disposition may be significantly influenced by the presence of a dementia diagnosis.

In addition to understanding how dementia may influence decisions about discharge disposition, it is also important to understand how the discharge disposition may influence risk of readmission. Daiello et al. (2014) also found that older adults with dementia who were discharged to home health care were 1.28 times more likely to be readmitted than an older adult with dementia who was discharged routinely. Older adults with dementia who were discharged to skilled nursing facilities were 1.11 times more likely to be readmitted than older adults who were discharged routinely (Daiello et al., 2014).

In this study, when controlling for all other factors, older adults with dementia who were discharged to skilled nursing facilities were 1.19 times more likely to be readmitted than older adults with dementia who were discharged routinely. This finding was consistent with the findings by Daiello et al. (2014).

An unexpected finding in this study was that older adults with dementia who were discharged to home health services did not have an increased risk of readmission as compared with older adults with dementia who were discharged routinely. This finding contradicts the finding by Daiello et al. (2014) that the greatest risk of readmission was for older adults with dementia who were discharged to home health services. It also demonstrated the interaction that dementia has on discharge position because in the overall model, there was an increased risk of readmission with discharge to home health services as compared with routine discharge. Older adults with dementia do best in familiar settings (Alzheimer's Association, 2009; Son, Therrien, & Whall, 2002). It could be that by returning an older adult with dementia to his/her familiar settings, there was an increase in positive outcomes and a decrease in readmissions. Given the contradiction to previously published information, this area warrants further investigation.

Median household income and dementia. The risk of all-cause pneumonia readmissions increases as an individual's income decreases (Calvillo-King et al., 2013; Mather et al., 2014). It has not been studied whether or not a diagnosis of dementia exacerbates this relationship between risk of readmission and income level. In this study, older adults with dementia who were in the lowest income bracket were approximately 1.2 times more likely to be readmitted than older adults with dementia who were in the highest two income quartiles. However, there was not a difference in the odds of

readmission when comparing older adults with dementia in the lowest two quartiles. Older adults in the upper two income brackets may have greater availability of resources to prevent readmissions, such as (a) paid caregivers, (b) prescriptions, (c) home adaptations, or (d) necessary durable medical equipment. Older adults in the lower two income brackets may not have the funds available to access items or services to reduce the risk of readmission. Additionally, lower socioeconomic status has been linked to lower health literacy (American Psychological Association, 2016). Poor health literacy can affect medication adherence, adherence to discharge instructions, and nutritional status (Findley, 2015; Geboers et al., 2015). Thus, older adults with dementia in the lower two income quartiles may have lower health literacy, which could increase the risk of readmission.

Number of chronic conditions and dementia. Chronic conditions have been suggested to be the most important predictor of all-cause pneumonia readmissions (Neupane et al., 2010). The generalized linear model calculated in this study indicated that as the number of chronic conditions increased, the risk of all-cause pneumonia readmission increased. However, when dementia was used as an interaction term the findings reverse. For a patient with dementia, the odds of readmission decrease by .97 for each additional diagnosis. This reversal of odds of all-cause pneumonia readmission may be related to a shift in priorities of treatment. Older adults with dementia often shift to palliative care as their disease progresses. It is reasonable to expect that with more comorbidities, the overall health of an older adult declines. Another possibility was that with an increased number of chronic conditions comes an increased risk of mortality. Older adults with dementia who have an increased number of chronic conditions may

have greater mortality rates post discharge. If more are dying after discharge, there are fewer to be readmitted.

Subanalysis 1. The presence of multiple comorbid conditions has been suggested to be a predictive factor in multiple studies (Navarro et al., 2012; Neupane et al., 2010; Scott et al., 2014; Shams et al., 2015). Identifying comorbidities that increase the odds of readmission for older adults with dementia may be useful in early identification of high-risk individuals and facilitate implementation of strategies to decrease risk of all-cause pneumonia readmission for older adults with dementia.

A subgroup analysis was run to determine if any of the specified single-level and multilevel diagnoses had a significant interaction with the probability of readmission and dementia diagnosis. All were found to have a significant effect on the occurrence of readmission for both older adults with and without dementia, which supports the need to further investigate the role of comorbidities in predicting readmission risk for older adults with dementia. The role of comorbidities in predicting risk of all-cause pneumonia readmissions for both older adults with and without dementia has been explored in previous research but has included a variety of diagnoses (Ahmedani et al., 2015; Cabré et al., 2014; Lindenauer et al., 2011; Mather et al., 2014; Shams et al., 2015; Tang et al., 2014).

Of the single-level diagnoses, the only one not addressed in prior research regarding prediction of all-cause pneumonia readmissions was hip fractures. Dementia is associated with poor outcomes in the presence of hip fractures (Seitz et al., 2014). In this study, older adults with dementia had an 18% greater occurrence of hip fractures than older adults without dementia. The need for further investigation into the impact of hip

fractures on all-cause pneumonia readmissions is supported by these findings. Each of the following single-level diagnoses has been shown to affect the risk of all-cause pneumonia readmissions:

1. Anxiety (Ahmedani et al., 2015; Mather et al., 2014).
2. Chronic obstructive pulmonary disease (Lindenauer et al., 2011; Mather et al., 2014; Shams et al., 2015).
3. Esophageal dysfunction (Cabré et al., 2014).
4. Nutritional deficits (Mather et al., 2014).
5. Urinary tract infection (Lindenauer et al., 2011; Mather et al., 2014).

Five of the multilevel diagnoses were not addressed in prior research regarding predication of all-cause pneumonia readmission risk. These five multilevel diagnoses were (a) digestive system diseases, (b) genitourinary diseases, (c) infectious diseases, (d) musculoskeletal disease, and (e) skin diseases. Each of the following multilevel diagnoses were identified as increasing the risk of all-cause pneumonia readmission in prior research:

1. Circulatory system diseases (Mather et al., 2014; Shams et al., 2015; Tang et al., 2014).
2. Diseases of the blood (Mather et al., 2014).
3. Injury and poisoning (Mather et al., 2014).
4. Mental illness (Ahmedani et al., 2015; Mather et al., 2014; Shams et al., 2015).
5. Neurological system disease (Mather et al., 2014).
6. Respiratory dysfunction (Mather et al., 2014; Shams et al., 2015).

It is suggested by the findings that it is not just the number of comorbidities that a patient has that increases the risk of all-cause pneumonia readmission but also the specific diagnoses of the patient.

Mather et al. (2014) created a pneumonia readmission risk model and which included comorbidities. However, Mather et al. (2014) and other prior researchers have not analyzed how these comorbidities interacted with the risk of all-cause pneumonia readmission in the presence of dementia. Future studies should explore the impact of specific comorbidities on the risk of all-cause pneumonia readmissions for older adults with dementia.

Subanalysis 2. One of the interesting findings from the generalized linear model was that in general, risk of readmission increased with an increased number of chronic conditions, but when dementia was present, the risk of readmission decreased as the number of chronic conditions increased. The number of chronic conditions an older adult has can be reflective of his/her overall health status. Individuals in poorer health are likely to need increased services and assistance post discharge, which may affect discharge disposition.

A subanalysis was calculated to determine if the number of chronic conditions affected the discharge of older adults with and without dementia. Regardless of dementia diagnosis, as the number of chronic conditions increased, the likelihood of routine discharge declined, and the likelihood of discharge to a skilled nursing facility or home health services increased.

For older adults with dementia, the primary discharge location at baseline (0 chronic conditions) was skilled nursing facilities. Skilled nursing facilities continue to be

the primary discharge location for older adults with dementia even as the number of chronic conditions rises. However, a change is demonstrated with the second most likely discharge disposition. With less than seven chronic conditions, older adults with dementia are more likely to be discharge routinely than to be discharged to home health services. However, as the number of chronic conditions increases past seven, older adults with dementia are more likely to be discharged to home health services versus being discharged routinely. This finding is consistent with data presented earlier in the paper during comparison of dementia and non-dementia subgroups.

For older adults without dementia, at baseline (0 chronic conditions), routine discharge is the primary discharge disposition. Routine discharge continues to be the primary discharge disposition until there are approximately 15 chronic conditions present at which time there is equal likelihood of (a) routine discharge, (b) discharge to skilled nursing facilities, and (c) discharge to home health services. With greater than 15 chronic conditions, older adults without dementia have equal likelihood of being discharged to a skilled nursing facility or to home health services, but a decreased likelihood of a routine discharge.

This subanalysis showed differences in both baseline discharge dispositions and changes associated with increased number of chronic conditions for older adults with and without dementia. At baseline, older adults with dementia have greater percentages of discharges to skilled nursing facilities and fewer routine discharges than older adults without dementia. Discharges to home health services are roughly the same between the two groups at baseline. Older adults without dementia experience a much steeper decline in routine discharges than older adults with dementia as the number of chronic conditions

declines. Older adults without dementia also have a greater increase in home health discharges as chronic conditions increase than older adults with dementia. It is suggested by the findings that both chronic conditions and a dementia diagnosis can significantly affect discharge disposition. These findings are consistent with prior research that has found that a diagnosis of dementia has been shown to influence the discharge disposition of a patient (Callahan et al., 2012; Daiello et al., 2014; Nazir et al., 2013).

The interaction between the number of chronic conditions and discharge location has not been examined in prior research. It is suggested by the findings of the this study that as older adults experience greater chronic conditions and are likely in poorer health, the most likely discharge disposition is skilled nursing facilities followed by home health services. The risk of readmission has been shown to increase when older adults with and without dementia are discharged to skilled nursing facilities (Daiello et al., 2014; Hain et al., 2012). These findings help to explain the effect of chronic conditions on discharge disposition but do not provide further insight into why readmission decrease for older adults as the number of chronic conditions increase.

Implications

This is the first study of all-cause pneumonia readmission rates and predictive factors for older adults with dementia to use a nationally representative sample. The fact that the demographic characteristics of this study are consistent with those reported in population studies further supports the generalizability of the findings of this study. The findings from this study (a) support findings from previous research, (b) expand current understanding of all-cause pneumonia readmissions, and (c) provide insight into the

impact of dementia on all-cause pneumonia readmissions. Significant implications from this study include the following:

1. There is a significant interaction between dementia and discharge disposition.
2. Older adults with dementia who did and did not experience an all-cause pneumonia readmission are characteristically different.
3. Comorbidities have a significant impact on all-cause pneumonia readmissions for older adults.
4. Risk of mortality should be included as a factor in all-cause pneumonia readmission prediction models.
5. Older adults with dementia are a population at high risk for all-cause pneumonia readmissions.

Support of existing literature. Findings from previous research regarding characteristics of (a) older adults with index admissions for pneumonia, (b) older adults who do and do not experience all-cause pneumonia readmissions, and (c) older adults with and without dementia who experienced all-cause pneumonia readmissions are supported by the findings of this study. Of older adults who experienced an index admission for pneumonia, older adults with dementia were (a) older; (b) more often female; and (c) had more hospitalizations, longer lengths of stay, increased costs, more chronic conditions, diagnoses, and greater risk of mortality. Older adults who were readmitted regardless of dementia diagnoses had (a) greater numbers of hospitalizations, (b) increased lengths of stay, (c) more chronic conditions and diagnoses, (d) increased costs, and (e) were more often discharged to skilled nursing facilities than older adults who were not readmitted. Additionally, older adult males were at a greater risk of all-

cause pneumonia readmission than older adult females. Of older adults who were readmitted, older adults with dementia were older and more likely female and had (a) more hospitalizations, (b) longer lengths of stay, (c) more chronic conditions and diagnoses, (d) more discharges to skilled nursing facilities, and (e) had greater risks of mortality.

Dementia and discharge disposition. Skilled nursing facilities have been identified as the most common discharge disposition of older adults with dementia (Daiello et al., 2014). It has also been reported that the risk of a hospital readmission increases when an older adult with dementia is discharged to a skilled nursing facility (Callahan et al., 2012; Nazir et al., 2013). However, it is not clear if the risk is greater because more older adults with dementia are discharged to skilled nursing facilities or if reasons that necessitated a discharge to a skilled nursing facility increase the risk of readmission.

In this study, older adults with dementia regardless of readmission status had approximately the same percentage of discharges to (a) skilled nursing facilities, (b) home health, and (c) routine discharge. For older adults with dementia who were readmitted, there was a 5% increase in discharges to skilled nursing facilities and a 5% decrease in routine discharges. There was no difference in discharges to home health between older adults with and without dementia. However, the likelihood of discharge to home health did increase as the number of chronic conditions increased as demonstrated by the subanalysis. An increased number of chronic conditions may be an indicator of poorer health status or increased acuity of illness. This finding is intriguing because in

general, skilled nursing facilities are the discharge location of choice for patients with increased acuity, not home health services.

As will be discussed later, older adults with dementia who were and were not readmitted were not characteristically the same. However, the patterns of discharge for these two groups are approximately the same. As suggested by the findings, the dementia diagnosis is heavily weighted in discharge decisions, despite differences in other factors. It is possible that inappropriate discharges to skilled nursing facilities are occurring in older adults with dementia due to a disproportionate amount of weight being placed on the dementia diagnosis. Further investigation into clinical factors associated with discharge disposition is warranted and may provide additional insight. Discharge disposition has been linked to prediction of readmission risk in this study and prior studies (Callahan et al., 2012; Daiello et al., 2014; Nazir et al., 2013). However, the interaction between discharge disposition and other patient factors has not been adequately explored.

Comorbidities. The impact of comorbidities on all-cause pneumonia readmissions has been assessed in multiple ways in this study. Overall, older adults with dementia were shown to have more chronic conditions and diagnoses than older adults without dementia. Older adults with dementia who were readmitted had the largest average number of chronic conditions of all groups examined in this study. However, older adults with dementia who were not readmitted had fewer chronic conditions compared with older adults who were readmitted regardless of dementia diagnosis, which suggests that there is a difference in the number of chronic conditions for older adults with dementia who are and are not readmitted and could be an important factor in

identifying older adults with dementia who are at risk for all-cause pneumonia readmissions.

There was an increased risk of all-cause pneumonia readmission for the entire sample when the number of chronic conditions increased. However, the exact opposite was true for older adults with dementia. As chronic conditions increase, the likelihood of all-cause pneumonia readmission decreases. The reason for this finding is not clear. However, as was previously noted, as the number of chronic conditions increases, the likelihood of being discharged to home health increases. This study showed no increased risk of readmission when discharged to home health services as compared with routine discharges. It is plausible that the increased likelihood of discharge to home health services as the number of chronic conditions increases explains the decreased risk of readmission for older adults with dementia.

Subanalysis of specific comorbidities was shown to significantly affect the risk of readmission for older adults with dementia. Specific diagnoses known to be problematic for older adults with dementia that showed greater than 5% difference included (a) anxiety, (b) esophageal dysfunction, (c) nutritional deficits, (d) urinary tract infection, and (e) hip fractures. How each of these diagnoses affects the risk of all-cause pneumonia readmissions needs to be further explored. It is suggested by all these findings that comorbidities play a significant role in all-cause pneumonia readmissions.

Risk of mortality. Readmission rates and mortality rates are often studied as outcome measures. This time is the first that risk of mortality has been included as a factor in an all-cause pneumonia readmission model. For older adults with dementia, there were several significant findings in relation to risk of mortality. First, in all

comparisons, very few (<2%) older adults with dementia were in the minor risk of mortality category. However, those who were in the minor risk category were 2.35 times more likely to be readmitted than older adults without dementia in the same category. Thus, even with minimal risk of mortality, older adults with dementia are at increased risk of readmission. This finding is an important consideration because it is often assumed that patients who are more medically complex or unstable will experience readmissions. It is suggested by the findings that there is an increased risk of readmission for older adults with dementia even with minor risk of mortality and that other factors besides medical complexity are influencing all-cause pneumonia readmissions for this patient population.

There was an initial increase in the risk of readmission as the risk of mortality increased, but when risk of mortality reached extreme levels, the risk of readmission decreased. It is possible that older adults with dementia who have extreme levels of mortality risk are not readmitted because they have died after discharge. Another possibility is that the focus of care has shifted to palliative measures or hospice care. The data used in this study did not include post-discharge information, so it was not possible to answer questions about post discharge status. Future studies should include post-discharge data in order to further explore why there is a decrease in readmission risk with extreme risk of mortality. It is suggested by the findings in this study that risk of mortality is a significant factor in predicting all-cause pneumonia readmissions.

Characteristics of older adults with dementia. To the author's knowledge, this is the first study of all-cause pneumonia readmissions to compare older adults with dementia who were readmitted to older adults with dementia who were not readmitted.

There are characteristic differences between older adults with dementia who were readmitted as compared with older adults with dementia who were not readmitted. Thus, not all older adults with dementia are the same. More importantly, for several variables, older adults with dementia who were not readmitted had values similar to older adults without dementia. These variables included (a) number of hospitalizations, (b) costs, and (c) length of stay. Additional variables that had values that were between the values for older adults without dementia and older adults with dementia who were readmitted included (a) risk of mortality, (b) functional loss, (c) number of chronic conditions and diagnoses, and (d) proportion of females.

The difference in cost per length of stay was $6,000, which is a large difference and indicates that the older adults with dementia who were readmitted received a greater number of services while in the hospital. Because this variable will be calculated after the patient has been discharged, it will not be useful in identifying patients at high risk of readmission during their hospital stay. A variable that will be useful is the number of hospitalizations that an older adult with dementia has experienced. Older adults with dementia who have more prior hospitalizations on admission to the hospital can be identified as high risk for readmission early during hospitalization. Another variable that could be used to identify older adults with dementia at risk for all-cause pneumonia readmissions is the number of chronic conditions present. Older adults with dementia with more chronic conditions will be at a greater risk of readmission. This study is the first in which the differences among older adults with dementia in relation to all-cause pneumonia readmissions were examined. The need to further assess these differences so that older adults with dementia who are at high risk of readmission can be identified early

and intervention strategies implemented to decrease the risk of readmission were supported by the findings of this study.

High-risk population. The main purpose of this study was to determine if there was a difference in all-cause pneumonia readmissions for older adults with dementia as compared with older adults without dementia. Based on previous research, it was hypothesized that older adults with dementia may be at a high risk of all-cause pneumonia readmission due to factors inherent to the pathophysiology and clinical presentation of dementia. Several findings in this study make it clear that older adults with dementia are characteristically different than older adults without dementia. These findings provide justification to consider older adults with dementia a high-risk group for all-cause pneumonia readmissions.

First, the all-cause pneumonia readmission rate for older adults with dementia in this study was approximately 5% greater than older adults without dementia. Likewise, older adults with dementia had three times greater odds of experiencing an all-cause pneumonia readmission as compared with older adults without dementia. At a time when hospitals are being financially penalized for excessive pneumonia readmission rates, this finding is critical. It indicates that this subgroup of the population of older adults who have an index admission for pneumonia is significantly different than those without a dementia diagnosis.

Second, there are characteristic differences between older adults with and without dementia that must be taken into consideration. In this study, older adults with dementia had a mean age of 83, 5 years older than the non-dementia group. Older adults can be broken into three categories based on age: (a) young-old aged 55 to 74 years, (b) old aged

75 to 84 years, and (c) old-old aged 85 and up. Both groups fall into the "old-aged" category, but with a mean age of 83, older adult with dementia are at the high end of the category, and older adults without dementia with a mean age of 78 are at the low end of the category. It makes sense that there would be significant differences between these two groups given that they represent different ends of the category.

Older adults with dementia who were readmitted have the greatest mean number of hospitalizations of all groups assessed in this study. When looking at costs for all older adults in this study, older adults with dementia had higher costs than those without dementia. However, when comparing costs for older adults who were readmitted, older adults with dementia had less costs than older adults without dementia. The reason for this change is not clear.

Finally, in the generalized linear model, four factors significantly interacted with dementia: (a) risk of mortality, (b) discharge disposition, (c) median income by zip code, and (d) number of chronic conditions. With the exception of median income by zip code, each of these has been identified as a significant implication in this study and was addressed in detail in the preceding sections. The fact that dementia did interact with these factors in the generalized linear model further indicates that older adults with dementia are different than older adults without dementia in terms of all-cause pneumonia readmissions. Given the known difficulties that patients with dementia have with pneumonia and the findings from this study, there is sufficient evidence to support classifying older adults with dementia as a high-risk group for all-cause pneumonia readmissions.

It has been suggested that identifying patients at high risk of readmission and focusing efforts towards these high-risk individuals could decrease readmission rates and improve compliance with the HRRP (Allaudeen et al., 2011). Another rationale for focusing efforts on decreasing all-cause pneumonia readmission for older adults with dementia is to decrease undue burden and stress on older adults with dementia. Transitions between care settings for older adults with dementia can cause (a) emotional distress, (b) exacerbation of dementia symptoms, (c) increased vulnerability to poor quality of care, and (c) poor health outcomes (Callahan et al., 2015; Coleman, 2003; Gozalo et al., 2011; Teno et al., 2013).

Additionally, it is suggested by the findings of the this study that the (a) number of hospitalizations, (b) number of chronic conditions, and (c) age of the patient may be important in early identification of older adults with dementia who may be at increased risk of all-cause pneumonia readmission. Future studies are needed to further identify more robust predictive factors. Strategies should be implemented to decrease the risk of all-cause pneumonia readmission for older adults with dementia.

Future Research

This study builds on prior research and expands the understanding of all-cause pneumonia readmissions, particularly for older adults with dementia. However, there are several areas that need further investigation in order fully understand the dynamic factors affecting the risk of all-cause pneumonia readmission. The following paragraphs will highlight areas of importance for future research.

Study design. A majority of the studies regarding all-cause pneumonia readmissions have been retrospective data analyses. While retrospective studies provide

several benefits for research, a significant limitation is control over the variables. Future research should include both retrospective and prospective study designs in order to include variables, such as social support and home environment, which are not usually contained in administrative data. Utilization of prospective designs will also afford the opportunity to gain more details in the variables included. Another consideration in study design is linking multiple databases to obtain greater access to appropriate variables. Using databases that can be linked and track a patient from inpatient services through their care post discharge could provide more information about factors influencing readmissions. A final suggestion regarding study design would be to utilize mixed methods approaches to capture both qualitative and quantitative data in a manner that offsets the weaknesses of both approaches and allowing for triangulation of data. Triangulation would provide greater insight into sociodemographic factors, care transitions, and nursing home placements.

Comparison of older adults with dementia. As was mentioned previously, this study was the first in which older adults with and without dementia were compared in relation to all-cause pneumonia readmissions. While this study provided baseline information, it is important that future studies continue to explore the differences between these two groups. More research into the differences between these two groups may provide a better understanding of which older adults with dementia are at a heightened risk of all-cause pneumonia readmission. Better identification of individuals at high risk for readmission can better inform strategies to mitigate excessive all-cause pneumonia readmissions.

Discharge disposition. It is understood, and supported by this study, that the primary discharge location for older adults with dementia is a skilled nursing facility. It is not understood why skilled nursing facilities are the primary discharge location for older adults with dementia. Future studies should explore the relationship between discharge planning decisions and how clinicians decide between skilled nursing facilities and other options for older adults with dementia. The fact that few older adults with dementia are discharged home with health care services is surprising given that older adult with dementia function best in familiar settings (Alzheimer's Association, 2009; Son et al., 2002). It would seem plausible that older adults with dementia may have more positive outcomes if they were to be discharged to home health services given the link between positive outcomes and familiar settings (Alzheimer's Association, 2009; Son et al., 2002). There also seems to be a lack of differentiation between older adults with dementia who were and were not readmitted in regard to discharge disposition. It is possible that either clinicians are not recognizing differences between these two groups, or the presence of a dementia diagnosis outweighs other factors when making decisions about discharge disposition.

Mortality. This study is the first in which the risk of mortality was included in the model for determining risk of all-cause pneumonia readmissions and it was one of four variables found to significantly interact with dementia. Inclusion of risk of mortality in future studies has the potential to shed light on the patient's acuity level. Future studies should include post-discharge data to determine if extreme risk of mortality resulted in post-discharge mortality that inadvertently decreased all-cause pneumonia readmission rates.

Functional loss. A measure of functional loss in relation to all-cause pneumonia readmissions has been considered by a few studies, including this one. However, all of these studies have relied on a subjective measure or a self-report as the indication of functional loss. Future research should explore different methods of quantifying functional loss that will better reflect the older adult's ability to perform ADL and IADL tasks necessary for self-management after discharge.

Comorbidities. Comorbidities are often included in research regarding all-cause pneumonia readmissions as variables representing systems or clusters of diseases. Future research should identify target diagnoses that are known to be problematic for older adults with dementia and analyze their impact on all-cause pneumonia readmissions. Additionally, the inclusion of a baseline measure of the patient's health status at the time of admission should be included.

Conflicting evidence. Two areas that were discussed in the paper that had conflicting evidence were length of stay and total costs. There is conflicting evidence for both of these variables that needs to be clarified in future research. The finding that longer lengths of stay increases the risk of readmission is both supported and contradicted by prior research (Jasti et al., 2008; Navarro et al., 2012; Scott et al., 2014; Shams et al., 2015). Historically, it has been suggested that older adults with dementia have increased costs when hospitalized as compared with older adults without dementia (Husaini et al., 2015; Zhu et al., 2015). Yet, older adults with dementia who were readmitted had fewer costs than older adults without dementia who were readmitted as demonstrated by the findings in this study. More specific research into the factors affecting all-cause

pneumonia readmission may provide insight into the true relationship between these variables and all-cause pneumonia readmissions for older adults with dementia.

Limitations

Correlational research is limited by an inability to determine cause and the potential influence of extraneous variables (Christensen et al., 2014). A significant limitation of retrospective studies is lack of control over the variables and data. Similarly, an inherent limitation of studies that utilize secondary datasets is a lack of control over the data. This lack of control extends to the accuracy and completeness of the data as well as the manner in which the data was collected and coded (Motheral et al., 2003). The complexity in the coding process and the experience of the coders can negatively affect the results of the study but cannot be controlled or assessed by the researcher. A lack of specificity in the coding of the primary and secondary diagnoses and comorbidities has the potential to interfere with the identification of the subgroup of individuals whose primary diagnosis is pneumonia and who have a secondary diagnosis of dementia. The primary strategy to minimize these potential limitations is to choose a database that (a) best fits the study needs, (b) is from a reputable provider, and (c) has undergone procedures to ensure validity and reliability. HCUP is a reputable and well-respected provider of health care databases. The NRD accounts for approximately 49% of all U.S. hospitalizations and is compiled from 21 geographically dispersed states and are weighted based on the Annual Hospital Survey (Magee et al., 2006). Given these factors, selecting the NRD as the data source for this study assists in minimizing, but not eliminating, these limitations.

Secondary datasets may also be missing variables necessary to address certain research questions. In particular, secondary datasets often lack detailed information about clinical and functional aspects. This gap in information can limit the ability to fully answer some research questions. In particular, the NRD did not contain data about (a) medications, (b) disciplines involved in care, (c) social support and home life, (d) cognitive status, (e) clinical lab values, or (f) functional measures. Additionally, the NRD only contains inpatient records, so there was not data available regarding post-discharge information, such as (a) quality of transition care, (b) quality of care at the discharge location, and (c) mortality rates. Each of these areas could have added to the understanding of all-cause pneumonia readmissions for older adults.

Third, there are limitations to the ability to track patients based on the format of the NRD. Individuals cannot be tracked from state to state due to unique identifiers being assigned by each state. If an individual has an index admission in one state and a readmission in another state, these will be recorded as two separate individuals and the readmission will be not be captured, and because the NRD file is an annual file, individuals cannot be tracked from year to year. Thus in this study, individuals admitted in December could not be tracked for readmission in January. An additional limitation specific to the NRD is that discharge records with ages greater than 90 were set to the age of 90, which may have decreased the mean ages calculated in this study and limits the ability to distinguish differences related to age in older adults aged 90 and above.

Summary

The purpose of this study was to investigate the risk of readmission and associated risk factors for older adults with dementia after an index admission with a

primary diagnosis of pneumonia. A quantitative, cross-sectional analysis of publicly accessible secondary data was performed. Statistical analyses for this study included descriptive and inferential analyses. Discharge weight variables were applied during data analysis to allow the sample contained within the 2013 NRD to be extrapolated to a national estimate. Application of inclusion and exclusion criteria resulted in an unweighted sample of 163,642 discharge records representing 155,861 patients. Weighted, this sample represents 389,198 records and 370,003 patients.

Older adults with dementia comprised 22% of the sample. Older adults with dementia had a higher all-cause pneumonia readmission rate and were three times more likely to experience an all-cause pneumonia readmission than older adults without dementia in this study. Factors that significantly interacted with dementia included (a) discharge disposition, (b) number of chronic conditions, (c) risk of mortality, and (d) median household income. Significant implications from this study are that (a) a diagnosis of dementia significantly affects discharge disposition and risk of readmission, (b) that there are characteristic differences among older adults with dementia, (c) that comorbidities significantly impact all-cause pneumonia readmissions, and (d) that risk of mortality is an important factor in determining risk for readmission. The most important implication from this study is that older adults with dementia are a population at high risk of all-cause pneumonia readmissions. Therefore, strategies should be implemented to identify those older adults with dementia who are at high risk and to decrease the risk of readmission. One potential strategy may be to implement guidelines for the selection of discharge destinations.

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Appendix A

ICD-9 CM Diagnosis Codes for Pneumonia

ICD-9-CM CODE	ICD-9-CM CODE DESCRIPTION
'4800 '	ADENOVIRAL PNEUMONIA
'4801 '	RESP SYNCYT VIRAL PNEUM
'4802 '	PARINFLUENZA VIRAL PNEUM
'4803 '	PNEUMONIA DUE TO SARS-ASSOCIATED CORONAVIRUS
'4808 '	VIRAL PNEUMONIA NEC
'4809 '	VIRAL PNEUMONIA NOS
'481 '	PNEUMOCOCCAL PNEUMONIA
'4820 '	K. PNEUMONIAE PNEUMONIA
'4821 '	PSEUDOMONAL PNEUMONIA
'4822 '	H.INFLUENZAE PNEUMONIA
'4823 '	STREPTOCOCCAL PNEUMONIA (Begin 1980 End 1992)
'48230'	STREP PNEUMONIA UNSPEC (Begin 1992)
'48231'	GRP A STREP PNEUMONIA (Begin 1992)
'48232'	GRP B STREP PNEUMONIA (Begin 1992)
'48239'	OTH STREP PNEUMONIA (Begin 1992)
'4824 '	STAPHYLOCOCCAL PNEUMONIA (End 1998)
'48240'	STAPH PNEUMONIA UNSP (Begin 1998)
'48241'	STAPH AUREUS PNEUMON (Begin 1998)
'48242'	METH RES PNEU D/T STAPH (Begin 2008)
'48249'	STAPH PNEUMON OTH (Begin 1998)
'4828 '	BACTERIAL PNEUMONIA NEC (Begin 1980 End 1992)
'48281'	ANAEROBIC PNEUMONIA (Begin 1992)
'48282'	E COLI PNEUMONIA (Begin 1992)
'48283'	OTH GRAM NEG PNEUMONIA (Begin 1992)
'48284'	LEGIONNAIRES DX (Begin 1997)
'48289'	BACT PNEUMONIA NEC (Begin 1992)
'4829 '	BACTERIAL PNEUMONIA NOS
'483 '	PNEUMONIA: ORGANISM NEC (Begin 1980 End 1992)
'4830 '	MYCOPLASMA PNEUMONIA (Begin 1992)
'4831 '	CHLAMYDIA PNEUMONIA (Begin 1996)
'4838 '	OTH SPEC ORG PNEUMONIA (Begin 1992)
'485 '	BRONCOPNEUMONIA ORG NOS
'486 '	PNEUMONIA- ORGANISM NOS
4870'	INFLUENZA WITH PNEUMONIA
48811'	INFLUENZA DUE TO IDENTIFIED H1N1 INFLUENZA VIRUS WITH PNEUMONIA

Appendix B

ICD-9 CM Diagnosis Codes for Dementia

ICD-9-CM CODE'	'ICD-9-CM CODE DESCRIPTION'
2900	Senile dementia uncomplicated
29010	Pre-senile dementia uncomplicated
29011	Pre-senile dementia with delirium
29012	Pre-senile dementia with delusional features
29013	Pre-senile dementia with depressive features
29020	Senile dementia with delusional features
29021	Senile dementia with depressive features
2903	Senile dementia with delirium
29040	Vascular dementia uncomplicated
29041	Vascular dementia with delirium
29042	Vascular dementia with delusions
29043	Vascular dementia with depressive mood
2941	Dementia in conditions classified elsewhere without behavioral disturbance
29410	Dementia in conditions classified elsewhere without behavioral disturbance
29411	Dementia in conditions classified elsewhere with behavioral disturbance
29420	Dementia unspecified, without behavioral disturbances
29421	Dementia unspecified, with behavioral disturbances
2948	Other persistent mental disorders due to cognitions issues elsewhere
3310	Alzheimer's disease
3311	Picks disease
33119	Other frontotemporal dementia
3312	Senile degeneration of brain
33182	Dementia with Lewy bodies

Appendix C

Single-Level Diagnoses: Clinical Classification Software (CCS)

Single-Level Diagnoses	ICD-9 Codes
Anxiety disorder	29384, 30000, 30001, 30002, 30009, 30010, 30020, 30021, 30022, 30023, 30029, 3003, 3005, 30089, 3009, 3080, 3081, 3082, 3083, 3084, 3089, 30981, 3130, 3131, 31321, 31322, 3133, 31382, 31383
Congestive heart failure	39891,4280, 4281, 42820, 42821, 42822, 42823, 42830, 42831, 42832, 42833, 42840, 42841, 42842, 42843, 4289
Chronic skin ulcers	7070, 70700, 70701, 70702, 70703, 70704, 70705, 70706, 70707, 70709, 7071, 70710, 70711, 70712, 70713, 70714, 70715, 70719, 70720, 70721, 70722, 70723, 70724, 70725, 7078, 7079,
Delirium	2930
Esophageal dysfunction	4561, 45621, 5300, 5301, 53010, 53011, 53012, 53013, 53019, 5302, 53020, 53021, 5303, 5304, 5305, 5306, 5308, 53081, 53083, 53084, 53085, 53089, 5309
Hip fracture	82000, 82001, 82002, 82003, 82009, 82010, 82011, 82012, 82013, 82019, 82020, 82021, 82022, 82030, 82031, 82032, 8208, 8209, 9053, V5413, V5423
Myocardial infarct	4100, 41000, 41001, 41002, 4101, 41010, 41011, 41012, 4102, 41020, 41021, 41022, 4103, 41030, 41031, 41032, 4104, 41040, 41041, 41042, 4105, 41050, 41051, 41052, 4106, 41060, 41061, 41062, 4107, 41070, 41071, 41072, 4108, 41080, 41081, 41082, 4109, 41090, 41091, 41092
Nutritional deficits	260, 261, 262, 2630, 2631, 2632, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2660, 2661, 2662, 2669, 267, 2680, 2681, 2682, 2689, 2690, 2691, 2692, 2693, 2698, 2699, 7994, V121
Urinary tract infection	03284, 59000, 59001, 59010, 59011, 5902, 5903, 59080, 59081, 5909, 5950, 5951, 5952, 5953, 5954, 59581, 59582, 59589, 5959, 5970, 59780, 59781, 59789, 59800, 59801, 5990

Appendix D

Multilevel Diagnoses: Clinical Classification Software (MCCS)

Multilevel Diagnoses	Single-level CCS diagnoses
Bacterial infection	1- Tuberculosis 2- Septicemia 3- Bacterial infection, unspecified 9- Sexually transmitted infections (not HIV)
Circulatory system	96- Heart valve disorders 97- Peri, endo, myocarditis, cardiomyopathy 98- Essential hypertension 99- Hypertension with complications and secondary hypertension 100- Acute myocardial infarct 101- Coronary atherosclerosis and other heart disease 102- Nonspecific chest pain 103- Pulmonary heart disease 104- Other and ill-defined heart disease 105- Conduction disorders 106- Cardiac dysrhythmias 107- Cardiac arrest and ventricular fibrillation 109- Acute cerebrovascular disease 110- Occlusion or stenosis of pre-cerebral arteries 111- Other and ill defined cerebrovascular disease 112- Transient cerebral ischemia 113- Late effects of cerebrovascular disease 114- Peripheral and visceral atherosclerosis 115- Aortic, peripheral, and visceral artery aneurysms 116- Aortic and peripheral arterial embolism/thrombosis 117- Other circulatory disease 118- Phlebitis; thrombophlebitis and thromboembolism 119- Varicose veins of lower extremity 120- Hemorrhoids 121- Other diseases of veins and lymphatics ***Single-level CCS 108- Congestive heart failure was pulled out of the multilevel diagnosis and examined individually***
Digestive system	135- Intestinal infection 136- Disorders of teeth and jaw 137- Disease of the mouth 139- Gastroduodenal ulcer 140- Gastritis and duodenitis 141- Other disorders of stomach and duodenum 142- Appendicitis and other appendiceal conditions 143- Abdominal hernia 144- Regional enteritis and ulcerative colitis 145- Intestinal obstruction without hernia 146- Diverticulosis and diverticulitis

	147- Anal and rectal conditions 148- Peritonitis and intestinal abscess 149- Biliary tract disease 151- Other liver disease 152- Pancreatic disorders 153- Gastrointestinal hemorrhage 154- Noninfectious gastroenteritis 155-Other gastrointestinal disorders ***Single-level CCS 138- Esophageal disorders was pulled out of the multilevel diagnosis and examined individually***
Diseases of the blood	59- Deficiency and other anemia 60- Acute post hemorrhagic anemia 61- Sickle cell anemia 62- Coagulation and hemorrhagic disorders 63- Diseases of white blood cells 64-Other hematologic conditions
Endocrine & Metabolic	48- Thyroid disorders 49- Diabetes mellitus without complications 50- Diabetes mellitus with complications 51- Other endocrine disorders 53- Disorders of lipid metabolism 54- Gout and other crystal arthropathies 55- Fluid and electrolyte disorders 56- Cystic fibrosis 57- Immunity disorders 58- Other nutritional, endocrine, or metabolic disorders ***Single-level CCS 52- Nutritional deficiencies was pulled out of the multilevel diagnosis and examined individually***
Genitourinary	156- Nephritis, nephrosis, renal sclerosis 157- Acute and unspecified renal failure 158- Chronic kidney disease 160- Calculus or urinary tract 161- Other diseases of kidney and ureters 162- Other diseases of bladder and urethra 163- Genitourinary symptoms and ill-defined conditions 164- Hyperplasia of prostate 165- Inflammatory conditions of male genital organs 166- Other male genital disorders 167- Nonmalignant breast conditions 168- Inflammatory diseases of female pelvic organs 169- Endometriosis 170- Prolapse of female genital organs 171- Menstrual disorders 172- Ovarian cyst 173- Menopausal disorders 174- Female infertility

	175- Other female genital disorders ***Single-level CCS 159- Urinary tract infections was pulled out of the multilevel diagnosis and examined individually***
Injury/Poisoning	225- Joint disorders and dislocations 227- Spinal cord injury 228- Skull and face fractures 229- Fracture of upper limb 230- Fracture of lower limb 231- Other fractures 232- Sprains and strains 233- Intracranial injury 234- Crushing injury or internal injury 235- Open wounds of head, neck, and trunk 236- Open wounds of extremities 237- Complication of devices 238- Complications of surgical procedures 239- Superficial injury 240- Burns 241- Poisoning by psychotropic agents 242- Poisoning by other medications and drugs 243- Poisoning by nonmedical substance 244- Other injuries and conditions due to external causes ***Single-level CCS 226- Fracture of neck of femur was pulled out of the multilevel diagnosis and examined individually***
Mental illness	650- Adjustment disorders 652- Attention deficit disorder 654- Developmental disorders 655- Disorders usually diagnosed in infancy, childhood, adolescence 656- Impulse control disorder 657- Mood disorder 658- Personality disorders 659- Schizophrenia and other psychotic disorders 660- Alcohol-related disorders 661- Substance related disorders 662- Suicide and intentional self-inflicted injury 663- Screening and history of mental health and substance abuse 670- Miscellaneous disorders ***Single-level CCS 651- Anxiety disorders and Single-level CCS 653 Delirium and dementia were pulled out of the multilevel diagnosis and examined individually***
Musculoskeletal	201- Infective arthritis and osteomyelitis 202- Rheumatoid arthritis and related disease 203- Osteoarthritis 204- Other non-traumatic joint disorders 205- Spondylosis

	206- Osteoporosis 207- Pathological fracture 208- Acquired foot deformities 209- Other acquired deformities 210- Systemic lupus erythematous 211- Other connective tissue disorders 212-Other bone disease and musculoskeletal deformities
Neoplasms	11- Cancer of head and neck 12- Cancer of esophagus 13- Cancer of stomach 14- Cancer of colon 15- Cancer of rectum and anus 16- Cancer of liver and intrahepatic bile duct 17- Cancer of pancreas 18- Cancer of other GI organs; peritoneum 19- Cancer of bronchus; lung 20- Cancer; other respiratory and intrathoracic 21- Cancer of bone and connective tissue 22- Melanomas of skin 23- Other non-epithelial cancer of skin 24- Cancer of breast 25- Cancer of uterus 26- Cancer of cervix 27- Cancer of ovary 28- Cancer of other female genital organs 29- Cancer of prostate 30- Cancer of testis 31- Cancer of other male genital organs 32- Cancer of bladder 33- Cancer of kidney and renal pelvis 34- Cancer of other urinary organs 35- Cancer of brain and nervous system 36- Cancer of thyroid 37- Hodgkin`s disease 38- Non-Hodgkin`s lymphoma 39- Leukemias 40- Multiple myeloma 41- Cancer; other and unspecified primary 42- Secondary malignancies 43- Malignant neoplasm without specification of site 44- Neoplasms of unspecified nature or uncertain behavior 45- Maintenance chemotherapy; radiotherapy 46- Benign neoplasm of uterus 47- Other and unspecified benign neoplasm
Nervous systems	76- Meningitis 77- Encephalitis 78- Other CNS infection and poliomyelitis 79- Parkinson`s disease 80- Multiple sclerosis 81- Other hereditary and degenerative nervous system conditions 82- Paralysis 83- Epilepsy; convulsions 84- Headache; including migraine 85- Coma; stupor; and brain damage 86- Cataract

	87- Retinal detachments; defects; 88- Glaucoma 89- Blindness and vision defects 90- Inflammation; infection of eye 91- Other eye disorders 92- Otitis media and related conditions 93- Conditions associated with dizziness or vertigo 94- Other ear and sense organ disorders 95- Other nervous system disorders
Respiratory system	123-Influenza 124- Acute and chronic tonsillitis 125- Acute bronchitis 126- Other upper respiratory infections 128- Asthma 129- Aspiration pneumonitis; food/vomitus 130- Pleurisy; pneumothorax; pulmonary collapse 131- Respiratory failure; insufficiency; arrest 132- Lung disease due to external agents 133- Other lower respiratory disease ***Single-level CCS 122 Pneumonia was removed. Single-level CCS 127 Chronic obstructive pulmonary disorder and dementia were pulled out of the multilevel diagnosis and examined individually***
Skin/Subcutaneous	197- Skin and subcutaneous tissue infections 198- Other inflammatory condition of skin 200- Other skin disorders ***Single-level CCS 199 Chronic Skin Ulcer was pulled out of the multilevel diagnosis and examined individually***

Appendix E

Generalized Linear Model: Parameter Estimates

Parameter Estimates					
OCRA	Coefficient	Std. Err.	P>z	Lower 95% CI	Upper 95% CI
Dementia	2.91	0.61	0.00	1.93	4.40
Age	0.98	0.00	0.00	0.98	0.98
Dementia-Age	1.00	0.00	0.31	1.00	1.01
Female	0.90	0.01	0.00	0.88	0.93
Dementia-Female	1.00	0.03	0.98	0.94	1.06
Number of diagnoses (NDX)	1.00	0.00	0.39	1.00	1.01
Dementia- Number of diagnoses (NDX)	0.99	0.01	0.16	0.98	1.00
Number of chronic conditions (NCHRONIC)	1.04	0.00	0.00	1.04	1.05
Dementia- Number of chronic conditions (NCHRONIC)	0.97	0.01	0.00	0.95	0.98
Single-level diagnosis codes (CCS)	2.70	0.23	0.00	2.29	3.18
Dementia- Single-level diagnosis codes (CCS)	1.18	0.19	0.28	0.87	1.61
Multilevel diagnosis codes (MCCS)	0.94	0.08	0.46	0.80	1.11
Dementia- Multilevel diagnosis codes (MCCS)	1.44	0.23	0.03	1.05	1.98
Length of stay (LOS)	1.01	0.00	0.00	1.00	1.01
Dementia-Length of stay (LOS)	1.00	0.00	0.31	0.99	1.00
Loss of Function (APRDRG-Severity)					
Moderate	1.27	0.06	0.00	1.17	1.39
Major	1.57	0.07	0.00	1.43	1.72
Extreme	1.78	0.11	0.00	1.58	2.00
Dementia- Loss of Function (APRDRG-Severity)					
Dementia-Moderate	0.95	0.08	0.57	0.81	1.12
Dementia-Major	0.98	0.09	0.81	0.82	1.17
Dementia-Extreme	1.12	0.12	0.30	0.90	1.39
Risk of mortality (APRDRG-Risk-Mortality)					
Moderate	1.51	0.05	0.00	1.42	1.60
Major	1.53	0.06	0.00	1.43	1.65
Extreme	1.30	0.06	0.00	1.19	1.43
Dementia-Risk of mortality (APRDRG-Risk-Mortality)					
Dementia-Moderate	0.62	0.07	0.00	0.50	0.77
Dementia-Major	0.60	0.07	0.00	0.48	0.76
Dementia-Extreme	0.65	0.08	0.00	0.51	0.84
Discharge Disposition (DISPUNIFORM)					
Short-Term Hospital	1.54	0.11	0.00	1.33	1.78
Skilled Nursing Facility	1.79	0.04	0.00	1.72	1.87
Home Health Care	1.51	0.03	0.00	1.46	1.57
Alive, destination unknown	1.19	0.32	0.53	0.70	2.03
Dementia- Discharge Disposition (DISPUNIFORM)					
Dementia-Short-Term Hospital	0.78	0.11	0.08	0.60	1.03
Dementia-Skilled Nursing	0.72	0.03	0.00	0.67	0.78

Facility					
Dementia-Home Health Care	0.79	0.03	0.00	0.72	0.86
Dementia-Alive, destination unknown	1.30	0.47	0.48	0.64	2.64
Patient location (PL-NCHS)					
Fringe	1.03	0.02	0.15	0.99	1.08
Counties Medium	1.01	0.05	0.78	0.93	1.11
Counties Large	1.07	0.05	0.17	0.97	1.17
Micropolitan Counties	1.11	0.06	0.04	1.00	1.22
Non-metro and Non-micro	1.10	0.06	0.05	1.00	1.22
Dementia- Patient location (PL-NCHS)					
Dementia-Fringe	1.01	0.04	0.81	0.93	1.10
Dementia-Counties Medium	0.92	0.09	0.40	0.76	1.12
Dementia-Counties Large	0.97	0.10	0.80	0.80	1.19
Dementia-Micropolitan Counties	0.87	0.10	0.20	0.70	1.08
Dementia-Non-metro and Non-micro	0.82	0.09	0.07	0.66	1.01
Median household income by zip code (Zipinc-QRTL)					
50th	0.98	0.02	0.23	0.94	1.02
75th	0.96	0.02	0.06	0.92	1.00
100th	0.93	0.02	0.01	0.89	0.98
Dementia- Estimated median household income by zip code (Zipinc-QRTL)					
Dementia-50th	0.93	0.04	0.07	0.86	1.01
Dementia-75th	0.89	0.04	0.00	0.82	0.96
Dementia-100th	0.89	0.04	0.01	0.81	0.97
Hospital bed size (Hosp-bedsize)					
Medium	1.01	0.02	0.82	0.96	1.06
Large	1.03	0.02	0.25	0.98	1.07
Dementia- Hospital bed size (Hosp-bedsize)					
Dementia-Medium	1.05	0.05	0.31	0.96	1.15
Dementia-Large	1.02	0.05	0.58	0.94	1.12
Hospital location (Hosp-URCAT4)					
Small Metropolitan	0.95	0.04	0.23	0.88	1.03
Micropolitan	0.85	0.04	0.00	0.77	0.94
Not metro or micro	0.92	0.05	0.12	0.82	1.02
Dementia- Hospital location (Hosp-URCAT4)					
Dementia-Small Metropolitan	0.99	0.09	0.89	0.82	1.19
Dementia-Micropolitan	1.05	0.12	0.67	0.84	1.30
Dementia-Not metro or micro	1.02	0.12	0.85	0.81	1.29
_Cons	0.23	0.02	0.00	0.19	0.28

Appendix F

Pairwise Comparisons Reporting Odds Ratios: All Categorical Variables

All Predictor Variables							
Pairwise Comparisons Reporting Odds Ratios							
			Contrast	Std. Err.	Lower 95% CI	Upper 95% CI	*P* Value
Sex							
Female	vs	Other	0.90	0.01	0.88	0.93	0.000
Loss of Function (APRDRG-Severity)							
Moderate	vs	Minor	1.24	0.05	1.12	1.38	0.000
Major	vs	Minor	1.55	0.07	1.38	1.75	0.000
Extreme	vs	Minor	1.88	0.10	1.63	2.18	0.000
Major	vs	Moderate	1.25	0.03	1.18	1.32	0.000
Extreme	vs	Moderate	1.51	0.06	1.37	1.68	0.000
Extreme	vs	Major	1.21	0.04	1.12	1.32	0.000
Risk of Mortality (APRDRG-Risk-Mortality)							
Moderate	vs	Minor	1.19	0.07	1.03	1.38	0.008
Major	vs	Minor	1.19	0.07	1.02	1.39	0.014
Extreme	vs	Minor	1.05	0.07	0.89	1.25	1.000
Major	vs	Moderate	1.00	0.02	0.95	1.06	1.000
Extreme	vs	Moderate	0.88	0.03	0.80	0.97	0.003
Extreme	vs	Major	0.88	0.03	0.81	0.96	0.000
Discharge disposition (DISPuniform)							
Short-Term Hospital	vs	Routine	1.36	0.10	1.12	1.66	0.000
Skilled Nursing Facility	vs	Routine	1.52	0.03	1.44	1.61	0.000
Home Health Care	vs	Routine	1.34	0.03	1.26	1.43	0.000
Alive, destination unknown	vs	Routine	1.35	0.25	0.81	2.25	0.962
Skilled Nursing Facility	vs	Short Term Hospital	1.11	0.08	0.92	1.35	1.000
Home Health Care	vs	Short Term Hospital	0.98	0.07	0.81	1.20	1.000
Alive, destination unknown	vs	Short Term Hospital	0.99	0.19	0.58	1.70	1.000
Home Health Care	vs	Skilled Nursing Facility	0.88	0.02	0.84	0.93	0.000
Alive, destination unknown	vs	Skilled Nursing Facility	0.89	0.16	0.54	1.48	1.000
Alive, destination unknown	vs	Home Health Care	1.01	0.18	0.61	1.68	1.000
Patient location (PL-NCHS)							
Fringe	vs	Central	1.04	0.02	0.98	1.11	1.000
Counties Medium	vs	Central	0.97	0.05	0.84	1.12	1.000
Counties Large	vs	Central	1.05	0.05	0.91	1.22	1.000
Micropolitan Counties	vs	Central	1.03	0.06	0.88	1.21	1.000
Non-metro and Non-micro	vs	Central	1.00	0.06	0.85	1.17	1.000
Counties Medium	vs	Fringe	0.93	0.05	0.81	1.08	1.000
Counties Large	vs	Fringe	1.01	0.05	0.87	1.18	1.000
Micropolitan Counties	vs	Fringe	0.99	0.06	0.84	1.17	1.000
Non-metro and Non-micro	vs	Fringe	0.96	0.05	0.81	1.13	1.000
Counties Large	vs	Counties Medium	1.08	0.03	1.00	1.18	0.049

Micropolitan Counties	vs	Counties Medium	1.06	0.05	0.93	1.21	1.000
Non-metro and Non-micro	vs	Counties Medium	1.03	0.05	0.90	1.17	1.000
Micropolitan Counties	vs	Counties Large	0.98	0.05	0.85	1.13	1.000
Non-metro and Non-micro	vs	Counties Large	0.95	0.04	0.82	1.09	1.000
Non-metro and Non-micro	vs	Micropolitan Counties	0.97	0.05	0.84	1.11	1.000
Median household income (ZIPINC-QRTL)							
50th	vs	25th	0.94	0.02	0.89	0.99	0.013
75th	vs	25th	0.90	0.02	0.85	0.95	0.000
100th	vs	25th	0.88	0.02	0.83	0.93	0.000
75th	vs	50th	0.96	0.02	0.91	1.01	0.263
100th	vs	50th	0.93	0.02	0.88	0.99	0.014
100th	vs	75th	0.97	0.02	0.92	1.03	1.000
Hospital size (Hosp-bedsize)							
Medium	vs	Small	1.03	0.02	0.97	1.09	0.622
Large	vs	Small	1.04	0.02	0.99	1.10	0.253
Large	vs	Medium	1.01	0.02	0.97	1.05	1.000
Hospital location (Hosp-urcat4)							
Small Metropolitan	vs	Large Metropolitan	0.94	0.04	0.84	1.07	1.000
Micopolitan	vs	Large Metropolitan	0.87	0.05	0.75	1.01	0.075
Not metro or micro	vs	Large Metropolitan	0.93	0.06	0.79	1.08	1.000
Micopolitan	vs	Small Metropolitan	0.92	0.04	0.82	1.04	0.421
Not metro or micro	vs	Small Metropolitan	0.98	0.05	0.86	1.12	1.000

Appendix G

Pairwise Comparisons Reporting Odds Ratios: Risk of Mortality and Dementia

Risk of Mortality (APRDRG-Risk of Mortality) and Dementia							
Pairwise Comparisons Reporting Odds Ratios							
Risk Mortality		Risk Mortality	OR	SE	Lower 95% CI	Upper 95% CI	P-Value
No Dementia Moderate	vs.	No Dementia Minor	1.51	0.03	1.37	1.66	0.000
No Dementia Major	vs.	No Dementia Minor	1.53	0.04	1.37	1.72	0.000
No Dementia Extreme	vs.	No Dementia Minor	1.30	0.05	1.12	1.51	0.000
No Dementia Extreme	vs.	No Dementia Major	0.85	0.03	0.77	0.94	0.000
Dementia Minor	vs.	No Dementia Minor	2.35	0.22	1.20	4.61	0.002
No Dementia Extreme	vs.	No Dementia Moderate	0.86	0.04	0.77	0.97	0.002
Dementia Moderate	vs.	No Dementia Minor	2.21	0.21	1.15	4.25	0.004
Dementia Major	vs.	No Dementia Minor	2.17	0.21	1.13	4.19	0.006
Dementia Extreme	vs.	No Dementia Minor	2.00	0.21	1.02	3.91	0.035
Dementia Minor	vs.	No Dementia Extreme	1.80	0.22	0.91	3.58	0.204
Dementia Moderate	vs.	No Dementia Extreme	1.70	0.21	0.87	3.30	0.367
Dementia Major	vs.	No Dementia Extreme	1.67	0.21	0.86	3.25	0.468
No Dementia Major	vs.	No Dementia Moderate	1.02	0.02	0.95	1.09	1.000
Dementia Minor	vs.	No Dementia Moderate	1.56	0.22	0.79	3.08	1.000
Dementia Moderate	vs.	No Dementia Moderate	1.47	0.21	0.76	2.84	1.000
Dementia Major	vs.	No Dementia Moderate	1.44	0.21	0.74	2.79	1.000
Dementia Extreme	vs.	No Dementia Moderate	1.33	0.22	0.67	2.61	1.000
Dementia Minor	vs.	No Dementia Major	1.53	0.22	0.77	3.03	1.000
Dementia Moderate	vs.	No Dementia Major	1.44	0.21	0.74	2.79	1.000
Dementia Major	vs.	No Dementia Major	1.42	0.21	0.73	2.75	1.000
Dementia Extreme	vs.	No Dementia Major	1.30	0.22	0.66	2.57	1.000
Dementia Extreme	vs.	No Dementia Extreme	1.53	0.22	0.77	3.04	1.000
Dementia Moderate	vs.	Dementia Minor	0.94	0.10	0.68	1.30	1.000
Dementia Major	vs.	Dementia Minor	0.92	0.11	0.66	1.30	1.000
Dementia Extreme	vs.	Dementia Minor	0.85	0.12	0.58	1.24	1.000
Dementia Major	vs.	Dementia Moderate	0.98	0.04	0.88	1.10	1.000
Dementia Extreme	vs.	Dementia Moderate	0.90	0.06	0.75	1.09	1.000
Dementia Extreme	vs.	Dementia Major	0.92	0.05	0.78	1.09	1.000

Appendix H

Pairwise Comparisons Reporting Odds Ratios: Discharge Disposition and Dementia

Discharge Disposition (DISPUNIFORM) and Dementia							
Pairwise Comparisons Reporting Odds Ratios							
Dementia and Skilled Nursing Facility		Dementia and Skilled Nursing Facility	OR	SE	Lower 95% CI	Upper 95% CI	P-Value
No Dementia Short Term Hospital	vs.	No Dementia Routine	1.54	0.11	1.21	1.96	0.000
No Dementia Skilled Nursing Facility	vs.	No Dementia Routine	1.79	0.04	1.68	1.92	0.000
No Dementia Home Health Care	vs.	No Dementia Routine	1.51	0.03	1.42	1.61	0.000
No Dementia Alive, Destination unknown	vs.	No Dementia Routine	2.38	0.46	1.28	4.45	0.000
Dementia Routine	vs.	No Dementia Skilled Nursing Facility	0.84	0.02	0.79	0.90	0.000
Dementia Short Term Hospital	vs.	Dementia Routine	1.29	0.04	1.16	1.44	0.000
Dementia Skilled Nursing Facility	vs.	Dementia Routine	1.19	0.05	1.05	1.35	0.000
Dementia Home Health Care	vs.	No Dementia Routine	2.20	0.42	1.17	4.12	0.002
Dementia Alive, Destination unknown	vs.	No Dementia Routine	2.23	0.49	1.09	4.59	0.013
No Dementia Skilled Nursing Facility	vs.	No Dementia Routine	2.85	0.87	1.05	7.73	0.029
No Dementia Home Health Care	vs.	No Dementia Routine	1.85	0.35	1.00	3.43	0.054
No Dementia Alive, Destination unknown	vs.	Dementia Skilled Nursing Facility	0.92	0.03	0.83	1.02	0.564
Dementia Routine	vs.	No Dementia Home Health Care	1.58	0.31	0.84	2.96	0.853
Dementia Short-Term Hospital	vs.	No Dementia Routine	1.19	0.32	0.49	2.90	1.000
Dementia Skilled Nursing Facility	vs.	No Dementia Short-Term Hospital	1.16	0.09	0.91	1.48	1.000
Dementia Home Health Care	vs.	No Dementia Short-Term Hospital	0.98	0.07	0.77	1.25	1.000
Dementia Alive, Destination unknown	vs.	No Dementia Short-Term Hospital	0.77	0.22	0.31	1.94	1.000
No Dementia Home Health Care	vs.	No Dementia Short-Term Hospital	1.20	0.24	0.62	2.33	1.000
No Dementia Alive, Destination unknown	vs.	No Dementia Short-Term Hospital	1.45	0.34	0.68	3.10	1.000
Dementia Routine	vs.	No Dementia Short-Term Hospital	1.55	0.32	0.79	3.02	1.000
Dementia Short Term Hospital	vs.	No Dementia Short-Term Hospital	1.43	0.29	0.73	2.80	1.000
Dementia Skilled Nursing Facility	vs.	No Dementia Short-Term Hospital	1.85	0.58	0.66	5.16	1.000
Dementia Home Health Care	vs.	No Dementia Skilled Nursing Facility	0.66	0.18	0.27	1.62	1.000

Discharge Disposition (DISPUNIFORM) and Dementia							
Pairwise Comparisons Reporting Odds Ratios							
Dementia and Skilled Nursing Facility		Dementia and Skilled Nursing Facility	OR	SE	Lower 95% CI	Upper 95% CI	P-Value
Dementia Alive, Destination unknown	vs.	No Dementia Skilled Nursing Facility	1.03	0.20	0.55	1.93	1.000
No Dementia Alive, Destination unknown	vs.	No Dementia Skilled Nursing Facility	1.24	0.28	0.60	2.58	1.000
Dementia Routine	vs.	No Dementia Skilled Nursing Facility	1.33	0.26	0.70	2.51	1.000
Dementia Short-Term Hospital	vs.	No Dementia Skilled Nursing Facility	1.23	0.24	0.65	2.32	1.000
Dementia Skilled Nursing Facility	vs.	No Dementia Skilled Nursing Facility	1.59	0.49	0.58	4.34	1.000
Dementia Home Health Care	vs.	No Dementia Home Health Care	0.79	0.21	0.32	1.92	1.000
Dementia Alive, Destination unknown	vs.	No Dementia Home Health Care	1.22	0.23	0.65	2.28	1.000
Dementia Routine	vs.	No Dementia Home Health Care	1.48	0.33	0.71	3.05	1.000
Dementia Short-Term Hospital	vs.	No Dementia Home Health Care	1.46	0.28	0.77	2.74	1.000
Dementia Skilled Nursing Facility	vs.	No Dementia Home Health Care	1.88	0.58	0.69	5.14	1.000
Dementia Home Health Care	vs.	No Dementia Alive, Destination unknown	1.56	0.52	0.53	4.61	1.000
Dementia Alive, Destination unknown	vs.	No Dementia Alive, Destination unknown	1.88	0.66	0.60	5.92	1.000
Dementia Short-Term Hospital	vs.	No Dementia Alive, Destination unknown	2.00	0.67	0.67	5.96	1.000
Dementia Skilled Nursing Facility	vs.	No Dementia Alive, Destination unknown	1.85	0.62	0.62	5.51	1.000
Dementia Home Health Care	vs.	No Dementia Alive, Destination unknown	2.39	0.98	0.63	9.15	1.000
Dementia Alive, Destination unknown	vs.	Dementia Routine	1.21	0.14	0.82	1.77	1.000
Dementia Skilled Nursing Facility	vs.	Dementia Routine	1.54	0.37	0.71	3.36	1.000
Dementia Home Health Care	vs.	Dementia Short Term Hospital	1.07	0.12	0.73	1.56	1.000
Dementia Alive, Destination unknown	vs.	Dementia Short Term Hospital	0.99	0.12	0.67	1.45	1.000
Dementia Home Health Care	vs.	Dementia Short Term Hospital	1.27	0.34	0.54	3.01	1.000
Dementia Alive, Destination unknown	vs.	Dementia Skilled Nursing Facility	1.19	0.28	0.55	2.59	1.000
Dementia Alive, Destination unknown	vs.	Dementia Home Health Care	1.29	0.31	0.59	2.81	1.000

Appendix I

Pairwise Comparisons Reporting Odds Ratios: Median Household Income and Dementia

Median household income (ZIPNC-QRTL) and Dementia							
Pairwise Comparisons Reporting Odds Ratios							
Dementia and Income		Dementia and Income	OR	SE	Upper 95% CI	Lower 95% CI	P-Value
Dementia 100th	vs.	Dementia 25th	0.83	0.04	0.73	0.94	0.000
Dementia 75th	vs.	Dementia 25th	0.85	0.04	0.76	0.95	0.000
Dementia 25th	vs.	No Dementia 100th	1.92	0.21	1.00	3.67	0.047
Dementia 25th	vs.	No Dementia 75th	1.86	0.21	0.98	3.56	0.072
Dementia 25th	vs.	No Dementia 50th	1.83	0.21	0.96	3.49	0.093
Dementia 50th	vs.	Dementia 25th	0.91	0.03	0.82	1.01	0.120
No Dementia 100th	vs.	No Dementia 25th	0.93	0.02	0.86	1.01	0.128
Dementia 25th	vs.	No Dementia 25th	1.79	0.21	0.94	3.41	0.133
Dementia 50th	vs.	No Dementia 100th	1.74	0.21	0.91	3.34	0.213
Dementia 50th	vs.	No Dementia 75th	1.69	0.21	0.89	3.24	0.311
Dementia 50th	vs.	No Dementia 50th	1.67	0.21	0.87	3.19	0.386
Dementia 100th	vs.	Dementia 50th	0.91	0.04	0.80	1.03	0.444
Dementia 50th	vs.	No Dementia 25th	1.63	0.21	0.85	3.11	0.529
Dementia 75th	vs.	No Dementia 100th	1.63	0.21	0.85	3.14	0.552
Dementia 75th	vs.	No Dementia 75th	1.58	0.21	0.82	3.04	0.776
Dementia 100th	vs.	No Dementia 100th	1.59	0.21	0.82	3.07	0.812
Dementia 75th	vs.	No Dementia 50th	1.56	0.21	0.81	2.99	0.941
No Dementia 75th	vs.	No Dementia 25th	0.96	0.02	0.90	1.03	1.000
No Dementia 100th	vs.	No Dementia 50th	0.96	0.02	0.89	1.03	1.000
No Dementia 50th	vs.	No Dementia 25th	0.98	0.02	0.92	1.04	1.000
No Dementia 100th	vs.	No Dementia 75th	0.97	0.02	0.90	1.05	1.000
Dementia 75th	vs.	Dementia 50th	0.93	0.04	0.84	1.05	1.000
No Dementia 75th	vs.	No Dementia 50th	0.98	0.02	0.92	1.05	1.000
Dementia 100th	vs.	Dementia 75th	0.97	0.04	0.86	1.10	1.000
Dementia 100th	vs.	No Dementia 25th	1.48	0.21	0.77	2.85	1.000
Dementia 75th	vs.	No Dementia 25th	1.52	0.21	0.79	2.91	1.000
Dementia 100th	vs.	No Dementia 50th	1.52	0.21	0.79	2.92	1.000
Dementia 100th	vs.	No Dementia 75th	1.54	0.21	0.80	2.97	1.000