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# The Association between Clinical Recognition of Depression and Unplanned Hospital Readmission among Older Adults

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# THE ASSOCIATION BETWEEN CLINICAL RECOGNITION OF DEPRESSION AND UNPLANNED HOSPITAL READMISSION AMONG OLDER ADULTS

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# DEDICATION

I dedicate this dissertation research to my parents. They have made and continue to make countless sacrifices for our family. Their love, support, kindness, and encouragement have been the fuel to my drive. My parents have instilled a great work ethic in me and have always told me to never 'settle'. I live by one of my father's favorite mantras, 'Pay now, or pay later,' as it pushes me work harder. I love you both endlessly.

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# ABSTRACT

*Purpose*

The likelihood of a depression diagnosis may differ based on whether the patient was seen in an inpatient or outpatient setting. Depression has been associated with an increased risk of a 30-day readmission. The purpose of this study was to determine the level of agreement (concordance) between depression diagnosis as identified by inpatient and outpatient records and examine the relationship between depression diagnostic concordance and 30-day readmission.

*Methods*

Using universal administrative claims data from South Carolina, we examined inpatient and outpatient records. The analysis was restricted to Medicaid recipients aged 55 years and older with a primary admitting diagnosis of acute myocardial infraction (AMI), chronic obstructive pulmonary disease (COPD), heart failure (HF), and pneumonia (PN) from 2013 – 2015 (n = 8,621 patients). Depression diagnostic concordance was determined by comparing secondary diagnosis codes in inpatient records and primary or secondary diagnosis codes in prior outpatient records. Diagnostic concordance was analyzed as concordant/not concordant and as a categorical variable (concordant-no depression, concordant-depression, not concordant-inpatient only, and not concordant-outpatient only). Using log-binomial regression, we modeled diagnostic concordance and 30-day readmission, while adjusting for covariates of interest in both models.

*Results*

The agreement between inpatient and outpatient data for a recorded depression diagnosis was poor. Diagnostic concordance was significantly associated with patient age, sex, race/ethnicity, and health condition. The risk of a 30-day readmission was significantly associated with an outpatient history of depression, but not for patients with depression recorded in inpatient data. Patients with not concordant-outpatient only had a 30-day readmission rate of 8.1%, adjusted relative risk, 1.42 ($p = 0.001$). Patients with concordant-depression had lower 30-day readmission rates, but not statistically significant.

*Conclusions*

Patients may be at a greater risk of a 30-day readmission when a history of depression was not detected during a hospitalization. Depression, particularly when it is not detected during a hospitalization, leads to a higher risk of a readmission. Diagnostic concordance between depression recorded in inpatient and outpatient settings needs improvement to ensure patients with depression receive appropriate care during and after a hospitalization. Improving diagnostic concordance for depression may reduce untimely hospital readmissions.

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# LIST OF ABBREVIATIONS

AECOPD ..... Acute Exacerbation of Chronic Obstructive Pulmonary Disease

AHRQ ..... Agency for Healthcare Research and Quality

AMI ..... Acute Myocardial Infarction

CES-D ..... Center for Epidemiological Studies–Depression scale

CHF ..... Congestive Heart Failure

CI ..... Confidence Interval

CMS ..... Center of Medicare & Medicaid Services

COPD ..... Chronic Obstructive Pulmonary Disease

DRG ..... Diagnosis Related Group

DSM-V ..... Diagnostic and Statistical Manual of mental disorders, Fifth edition

ED ..... Emergency Department

GDS ..... Geriatric Depression Scale

HAM-D ..... Hamilton Rating Scale for Depression

HF ..... Heart Failure

HR ..... Hazard Ratio

HRPP ..... Hospital Readmissions Reduction Program

ICD-9 ..... International Classification of Diseases, Ninth revision

ICD-10 ..... International Classification of Diseases, Tenth revision

MedPAC ..... Medicare Payment Advisory Commission

MI ..... Myocardial Infarction

NQS .....National Quality Strategy

OR..... Odds Ratio

PHQ-9 ..... Patient Health Questionnaire

RFAO.....Revenue and Fiscal Affairs Office

SC.....South Carolina

SCID-NP .....Structured Clinical Interview for the Diagnostic and Statistical Manual of Mental Disorders– Non-patient Edition

SD ..... Standard Deviation

U.S. .....United States

# CHAPTER 1

# INTRODUCTION

The Patient Protection and Affordable Care Act (ACA) was passed into law in 2010 and contained health care reforms to expand health coverage, control health care costs, and enhance the quality of care through improving the health care delivery system (*Patient Protection and Affordable Care Act, 42 U.S.C. § 18001*, 2010). The ACA mandated the establishment of the National Quality Strategy in part to increase access to high quality and affordable health care. The *better care* aim under the *National Quality Strategy* includes hospital quality amendments to improve patient outcomes. Adequate care during a hospital stay and during the transition to home, will likely improve patient outcomes, such as functional ability, survival, quality of life, and hospital readmissions (Agency for Healthcare Research and Quality, n.d.). The Medicare Payment Advisory Commission (MedPAC) identified that unplanned readmissions were prevalent, costly, and mostly preventable. Unplanned hospital readmissions are a measure of inadequate quality of care, and have been associated with increased health care spending. (Medicare Payment Advisory Comission, 2010).

The Centers for Medicare and Medicaid Services (CMS) defined a readmission as an admission to any unit of the hospital within 30 days of a discharge from the same or another unit of the hospital (Centers for Medicare & Medicaid Services, n.d.). According to a Medicare claims analysis study, nearly 1 in 5 Medicare patients were readmitted

within 30 days after being discharged from a hospital (Jencks, Williams, & Coleman, 2009). Among adults 18 years and older who experienced a planned or unplanned readmission in 2011, Medicare beneficiaries had the highest total 30-day readmission rates (55.9% or 17.2 per 100 admissions), and were responsible for the greatest share of readmission costs (58.2%) (Hines, Barrett, Jiang, & Steiner, 2014). In 2011, 3.3 million adult 30-day hospital readmissions occurred, which generated approximately $41.3 billion in hospital costs (Hines, Barrett, Jiang, & Steiner, 2014). MedPAC determined that 12.3% of readmissions were potentially preventable in 2011 (Medicare Payment Advisory Commission, 2013). To incentivize hospitals to reduce preventable readmissions, CMS began tracking hospital readmissions and reducing payments to eligible hospitals with excess readmissions (Medicare Payment Advisory Commission, 2013).

Unplanned hospital readmissions may indicate that patients received inadequate care during the hospital stay, inadequate discharge planning, poor or lack of care coordination between hospital and community-based providers, and inadequate long-term and continual community-based care (Robert Wood Johnson Foundation, 2013). Readmission rates vary by hospital and geographic region, patient factors, including severity of illness and comorbidities, and organizational factors, such as the proportion of vulnerable populations served and the quality of post-discharge care. Readmission disparities exist across hospital and patient characteristics (CMS Office of Minority Health, 2015).

Select comorbidities may place patients at a higher risk of a readmission. Psychological conditions, such as depression, have been associated with poor medical treatment adherence (Benner et al., 2002; R. M. Carney, Freedland, Eisen, Rich, & Jaffe, 1995; Ciechanowksi, Katon, & Russo, 2000; Dowson, Town, Frampton, & Mulder, 2004; Luyster, Hughes, & Gunstad, 2009; Wagner, Tennen, & Osborn, 2010). Patients discharged from a hospital, may be more vulnerable given the health condition that led to the initial hospital stay, and the increased psychological stress of recovery; this vulnerability places the patient at an increased risk for health complications and potentially a readmission (Krumholz, 2013). Depression is a common comorbidity after a hospital stay, particularly among older adults (Al Aqqad et al., 2016; Frasure-Smith et al., 2000; Fulop, Strain, & Stettin, 2003; Horold G. Koenig, 1998; Lesman-Leegte et al., 2009; Ng et al., 2007; Papaioannou et al., 2013).

Current research provides evidence that comorbid depression is associated with a readmission. Thus, patients suffering from chronic depression should be considered high-risk and included as a target group for readmission-reduction interventions. However, hospital personnel may not have access to the patient's complete history prior to discharge, and so may be unaware of a depression diagnosis made in another setting. A hospital-based readmission-reduction program relies on inpatient data to identify high-risk patients. Inpatient hospital data may not capture chronic depression, particularly if the patient does not disclose this health condition during the initial hospital admission. Detection may be difficult because depression may not be recorded

in a patient's inpatient medical records, it may occur prior to or after a hospital admission, and it may be undiagnosed.

This study focuses on older adults because they experience high rates of hospital readmissions and are the target for readmission-reduction programs created by CMS. The proposed study will examine the association between comorbid depression and 30-day hospital readmissions among patients hospitalized for acute myocardial infarction (AMI), chronic obstructive pulmonary disease (COPD), heart failure (HF), and pneumonia (PN). The specific aims of the study are:

1) Determine the level of concordance of a recorded diagnosis of depression between inpatient and outpatient administrative claims for Medicaid recipients over the age of 55. It is hypothesized that a depression diagnosis will be more frequently recorded in outpatient administrative claims than inpatient administrative claims.

2) Determine the relationship between a concordant depression diagnosis and hospital readmissions. Depression concordance will be examined as four mutually exclusive groups: inpatient depression diagnosis only, outpatient depression diagnosis only, inpatient and outpatient depression diagnosis, and no depression diagnosis. It is hypothesized that (a) Medicaid recipients 55 years and older with a depression diagnosis in the inpatient, outpatient, or both inpatient and outpatient settings will have a greater readmission rate than patients without depression; and (b) readmission rates will be lower when inpatient and outpatient records are concordant.

Chapter 2 provides a literature review on hospital readmission trends among older adults, depression estimates, readmission among older adults with depression,

and limitations of prior research. Chapter 3 provides an overview of the methodology utilized to examine the study aims of this dissertation research. This dissertation is formatted using the manuscript style where Chapter 4 (Results) and 5 (Conclusions) will be replaced with two manuscripts representing the specific research aims studied. Chapter 4 examines the concordance of depression diagnosis between inpatient and outpatient Medicaid administrative claims data, and Chapter 5 explores the association between depression and 30-day hospital readmissions for AMI, COPD, HF, and PN. Lastly, Chapter 6 provides a summary of the major findings for this dissertation research study.

# CHAPTER 2

# LITERATURE REVIEW

The National Strategy for Quality Improvement in Health Care (the National Quality Strategy, or NQS) was established under the Patient Protection and Affordable Care Act (ACA) to increase access to high quality and affordable health care. The NQS has three aims: better care, healthy people and communities, and affordable care. The NQS six priorities are: to make health care safer, deliver person-centered and family-centered care, promote effective communication and coordinated care, prevent and treat the leading causes of morbidity and mortality, encourage the health and well-being of communities, and make quality care more affordable. The efforts of the NQS fall under the broader goals of the ACA and the mission of the Department of Health and Human Services, which is to improve the health care system by providing better individual care, improve the health of the population, and to reduce health care spending (U.S. Department of Health and Human Services, 2011). The Medicare Payment Advisory Commission (MedPAC) identified that unplanned readmissions were prevalent, costly, and mostly preventable. Unplanned hospital readmissions are a measure of inadequate quality of care, and has been associated with increased health care spending (Medicare Payment Advisory Comission, 2010).

## Readmission as an Indicator for Quality of Care

In a 2010 study examining Medicaid only and Medicaid/Medicare dually enrolled patients, reducing the costs associated with extreme uncoordinated care could save Medicaid and Medicare an average of $133.5 billion per year and private and public combined savings of $240.1 billion for 2010–2018 (Owens, 2010). Enhanced care coordination, particularly in a fragmented health care system, has the potential to reduce adverse medical events, prevent unnecessary duplication of diagnostic tests, prevent emergency department utilization, and prevent hospital readmissions (Breslin, Hamilton, & Paynter, 2014; Cerullo, Gani, Chen, Canner, & Pawlik, 2016; Farrell et al., 2015; Hearld & Alexander, 2012; Mosher, 2014).

### *Readmission Definitions*

Hospital readmissions may be planned or unplanned. A planned readmission is an intentional readmission that is a scheduled part of the patient's treatment plan, such as transplant surgery, maintenance chemotherapy, or rehabilitation. An unplanned readmission may be related or unrelated to the initial admission (Yale New Haven Health Services Corporation/Center for Outcomes Research & Evaluation, 2015). The remainder of the chapter will focus on unplanned readmissions.

An index admission is the initial hospitalization for which the readmission outcome will be linked. A readmission occurs when a patient was admitted to the same or another acute care hospital within a defined period after a discharge for an eligible index admission (Centers for Medicare & Medicaid Services, 2016b). This study will use a 30-day period from the date of discharge from an index admission to evaluate

unplanned readmissions. The 30-day period was considered clinically meaningful because during this period, patients' outcomes may be influenced by the hospital's initial care and transition to outpatient services in the community, and this period is consistent with Centers for Medicare and Medicaid Services (CMS) quality measures.

Any readmission is considered an undesirable event for the patient regardless of the documented cause for the readmission or the timeframe after discharge. Determining the cause for the readmission may be difficult as it may spread beyond the cause of the initial admission. For example, an unplanned and related readmission would be a readmission for a hospital-acquired infection after an initial surgery admission. On the other hand, an unplanned and unrelated readmission would be an admission for a hip fracture after a pneumonia admission. Both of these examples would be counted as a readmission. This study will focus on unplanned hospital readmissions related or unrelated to the initial admission, which will be referred to as 'all-cause readmission'.

*CMS Defined Readmission*

CMS uses a risk-adjusted calculation to determine the excess 30-day all-cause readmission ratio per hospital effective for discharges beginning in the 2013 fiscal year. The adjustment variables are age, principal discharge diagnosis, and several co-morbidities. CMS calculates the excess all-cause readmissions for all ages, all health conditions, and all surgical procedures. In addition, CMS currently examines the excess readmissions for acute myocardial infarction (AMI), chronic obstructive pulmonary disease (COPD), elective total hip arthroplasty (THK), elective total knee arthroplasty

(TKK), heart failure (HF), and pneumonia (PN) among adults aged 65 or older; coronary artery bypass graft (CABG) surgery will be examined beginning in the 2017 fiscal year (Centers for Medicare & Medicaid Services, 2016b).

**Readmission Prevention**

As part of the *U.S. Department of Health and Human Services Strategic Plan: Fiscal Years 2010–2015* strategic goal to transform health care, CMS is committed to those strategies that reduce the growth of health care costs while encouraging effective care (U.S. Department Of Health & Human Services, 2010). Reducing unnecessary hospital readmissions has been expected to decrease health care costs. According to the NQS, a 20% reduction in readmissions, would yield 1.6 million less hospitalizations, and save $15 billion (Kocher & Adashi, 2011).

The strategies to reduce hospital readmission rates were proposed under the assumption that the current fragmented health care system would respond and improve under payment reform (U.S. Department Of Health & Human Services, 2010). Medicare is the largest single payer of health insurance in the U.S. with a fee-for-service payment system that incentivizes providers to increase volume of services (Guterman, Davis, Schoenbaum, & Shih, 2009). To reduce readmissions, Medicare will attempt to move to a system that rewards providers for efficient and effective care, reduces delivery system fragmentation, and better aligns reimbursement rates with provider costs (Guterman et al., 2009; Medicare Payment Advisory Comission, 2014). A specific objective under this strategy was to reduce unnecessary hospital readmission rates among Medicare beneficiaries. The objective's target was to reduce hospital all-cause

readmission rates by 5% per year from 2010 to 2015. As a result, multiple readmission-reduction programs were developed at the national level and consequently, at the hospital or health care organizational level. The goals of these programs were to improve the quality, safety, and coordination of patient care across post-discharge care settings to reduce unnecessary hospital readmissions (U.S. Department Of Health & Human Services, 2010).

Accountable care organizations (ACOs) were established in 2012 under the ACA as a new Medicare payment model. ACOs are typically comprised of a group of physicians, hospitals, or other health care providers that voluntarily come together to coordinate patient care. With this approach, the group of health care providers assumes responsibility for patient care, and is eligible for financial incentives when adequate, timely, and cost-effective care is delivered. Improved coordination of patients' care should improve overall quality of health care and slow the growth rate of health care spending (Burke, 2011). Through ACOs, improved care, greater coordination of transitional care between the hospital and community providers may provide an opportunity to reduce unplanned hospital readmissions (Medicare Payment Advisory Comission, 2014).

In addition, the rate of hospital readmissions may be reduced through targeted interventions that focus on improving discharge planning, improving transitions and care coordination between care settings, and improving education and support for patient self-management (Breslin et al., 2014; Farrell et al., 2015; Hearld & Alexander, 2012). Federal programs and hospital or organizational-level programs have been

developed to reduce hospital readmissions by targeting the major causes of readmissions.

*Federal Programs*

Four federal programs were created through the ACA to reduce hospital readmissions. Three programs were voluntary and one program was required nationally. The voluntary programs were termed programs that tested new service delivery models and/or payment models to improve quality of care, improve care transitions, lower costs, and reduce hospital readmissions (Centers for Medicare & Medicaid Services, 2011, 2015a, 2016a; Dummit et al., 2015). Each of the voluntary programs is in the early stages of implementation; however, preliminary results have been positive (Centers for Medicare & Medicaid Services, 2015b; Dummit et al., 2015).

The nationally required program will be described in greater detail because it likely encouraged the development of hospital or organizational-level readmission-reduction programs. CMS established the Hospital Readmission Reduction Program (HRRP) to reduce all-cause readmissions by linking payment to readmissions and promoting coordination across the care continuum (Medicare Payment Advisory Commission, 2013). The penalty for a readmission is determined by a risk-adjusted calculation of the excess 30-day all-cause readmission ratio per hospital for select health conditions among patients 65 years or older. Select conditions included under the HRRP penalty were AMI, COPD, HF, THK, TKK, and PN. CABG surgery will be included in the hospital excess readmissions calculation beginning in the 2017 fiscal year. In addition, HRRP requires public reporting, via web page, on the all-cause readmission rates for all

ages and across all health conditions or surgical procedures (Centers for Medicare & Medicaid Services, n.d.). Public reporting, at Hospital Compare, allows consumers to compare the quality of hospitals (Medicare.gov, n.d.).

Readmission Penalty

Under HRRP, hospitals face a financial penalty for excessive unplanned readmission rates that exceed the national average. Hospitals that are on an inpatient prospective payment system (IPPS) are subject to the penalty; therefore, critical access hospitals, inpatient psychiatric facilities, and post-acute care providers such as long-term acute care hospitals are excluded. Hospitals receive a fixed reimbursement per admission given the patient's diagnoses, regardless of the services utilized. Hospitals will not receive additional payments for excessive unplanned readmissions. The penalty began on October 1, 2013 (fiscal year 2013), and applies to all hospitals paid under Medicare IPPS. The penalty will apply to hospitals with a minimum of 25 discharges for each condition included in the measure (Medicare Payment Advisory Commission, 2013). Excess readmissions are calculated from multiple sources, inpatient, outpatient, and provider administrative claims data, using three full years of prior Medicare administrative claims data. For example, to determine the readmission penalty for the 2013 fiscal year, the performance period is June 2008 – July 2011 (Centers for Medicare & Medicaid Services, 2016b).

The penalty is capped at 1% of the aggregate IPPS base payment for the first year, 2% for the second year, and 3% for each year subsequently. Among eligible hospitals in 2011, 15.3% were penalized for excess unplanned readmissions, and 12.3%

of which were expected to be potentially preventable readmissions (Medicare Payment Advisory Commission, 2013). It was projected that in 2017, total Medicare penalties will be $528 million, which would be a $108 million increase from 2016.

Readmission penalty policy concerns

The readmission penalty methodology generates a few objectives. According to the experts convened by the Commonwealth Fund and the Institute for Healthcare Improvement, many argued that hospitals should not be penalized for readmissions because a readmission could involve factors outside of the hospital's control, such as differences in coordination of care across post-acute care settings. In addition, readmission rates vary based on patient demographics and socioeconomic status, but such factors are not considered in the readmission penalty calculation. Lastly, hospitals are compared to a national benchmark when calculating excess readmission. Critics have suggested the excess readmission determination would be more impactful if a baseline from the hospital or hospitals within the same region were calculated and monitored for improvement overtime (Boccuti & Casillas, 2015; Marks, Loehrer, & McCarthy, 2013). However, despite policy concerns, Medicare beneficiary readmissions rates have fallen since 2012 (Boccuti & Casillas, 2015).

*Hospital Programs to Reduce Readmissions*

To reduce readmissions and potentially avoid penalties, hospitals and health care organizations have developed readmission-reduction programs. Readmission-reduction programs vary across hospitals. Successful hospital readmission strategies vary in the program's target population and intervention components, such as length of support,

post-discharge services organization, health care risk assessment, caregiver education, and patient education and self-management support. The success of reducing hospital readmissions has been documented by randomized clinical trials (Coleman, Chalmers, & Rosenbek, 2006; Jack, Chetty, Anthony, Greenwald, & Sanchez, 2009; M. Naylor et al., 1994; M D Naylor et al., 1999; Mary D Naylor et al., 2004), and other interventions have presented evidence of successfully reducing hospital readmissions (Boutwell, Griffin, Hwu, & Shannon, 2009; Boutwell & Hwu, 2009).

**Estimate of Unplanned Hospital Readmission Rates**

In a 2012 study, researchers found that nearly one out of five Medicare beneficiaries who were hospitalized and discharged alive was readmitted within 30 days (Gerhardt et al., 2013). Readmissions vary by hospital, geographic region, proportion of vulnerable populations served, availability and quality of post-discharge care, and by patient-level factors such as the type of disease, illness severity level, and post-discharge behavior (Goodman, Fisher, & Chang, 2011).

In 2011, 3.3 million adult 30-day all-cause readmissions occurred, which produced approximately $41.3 billion in hospital costs. Medicare beneficiaries, adults 65 years and older, were responsible for the largest total readmissions (55.9%) and the largest total hospital costs (58.2%) across adults 18 years and older (Hines et al., 2014). The readmission rate for Medicare beneficiaries was 17.2 per 100 admissions (Gorina, Pratt, Kramarow, & Elgaddal, 2015). Ten principal diagnoses were responsible for 39.1% of Medicare readmissions occurring within 30 days and were responsible for 39.0% of

Medicare readmission costs at $9.4 billion. AMI, CHF, COPD, and PN accounted for nearly 19% of Medicare readmissions and costs (Hines et al., 2014).

**Factors Related to Unplanned Readmissions**

After a hospital discharge, patients may be readmitted to the hospital for various reasons. Reasons for a readmission that immediately affect the health of the patient include a new medical problem, relapse of initial illness, complication of initial treatment or surgery, discontinuation of medication, adverse drug events, therapeutic errors, hospital-acquired infections, or problems with caregiver or extended care facility (Bell et al., 2011; Forster et al., 2004; Graham & Livesley, 1983; Marcantonio et al., 1999; Merkow et al., 2015). Unplanned hospital readmissions may indicate inadequacies at the provider or health care level, such as insufficient care, poor or lack of care coordination between hospital and community-based providers, lack of long-term and continual community-based care, and lack of patient involvement in developing care/treatment plan (Grimmer, Moss, & Gill, 2000; Harrison & Verhoef, 2002; Robert Wood Johnson Foundation, 2013). Readmissions within 30 days were often due to diagnoses unrelated to the initial admission, which provides evidence for the complexity of managing chronic diseases and other health conditions (Kanel, Elster, & Vrbin, 2010).

Previous research examining patient level risk factors for hospital readmissions has focused on specific health conditions, all adults (18 years and older), and select patient characteristics. Common risk factors examined have ranged from clinical markers or characteristics of the disease, sociodemographic characteristics, and comorbid health conditions (Barnett, Hsu, & McWilliams, 2015; Dunlay et al., 2012;

Krumholz et al., 2011). However, few studies have focused on the organizational or hospital level contributing factors for hospital readmissions, such as transition of care post-discharge, lack of community support, and self-management of care.

Newly discharged patients were at greater risk of health complications and subsequent readmissions given their already compromised health, and the increased psychological stress of recovery (Krumholz, 2013). Treatment nonadherence has been associated with increased hospitalizations (Lo-Ciganic et al., 2016; Simon-Tuval, Triki, Chodick, & Greenberg, 2016; Yang et al., 2016). Upon discharge from a hospital, a patient will be expected to manage his or her health condition, such as follow a medication regimen, self-monitor his or her disease, and adhere to any prescribed life-style changes such as diet, exercise, smoking cessation, or limit alcohol consumption.

Relevant to the research proposed here, depression has been associated with poor self-management of care and may serve as a contributing factor for hospital readmissions (Benner et al., 2002; R. M. Carney et al., 1995; Ciechanowksi et al., 2000; Dowson et al., 2004; Luyster et al., 2009; Wagner et al., 2010). If depression contributes to poor treatment adherence and increases chances of a readmission, recognition of depression during the initial hospital stay may inform changes to discharge procedures to better target this potentially high-risk population.

Depression is commonly associated with hospitalizations, particularly among older adults (Al Aqqad et al., 2016; Frasure-Smith et al., 2000; Fulop et al., 2003; Horold G. Koenig, 1998; Lesman-Leegte et al., 2009; Ng et al., 2007; Papaioannou et al., 2013).

Current research provides evidence that comorbid depression is associated with a readmission.

**Definitions and Estimates of Depression in Older Adults**

Depression can be defined on a wide spectrum, ranging from clinical depression to the presence of depressive symptoms, and sub-classifications are possible based on the severity and duration of symptoms. Symptoms of depression vary across the population. Symptoms may include difficulty sleeping, changes in appetite, problems with digestion, anxiety, fatigue, non-specific aches or pains, feelings of sadness, difficultly concentrating or remembering details, and thoughts of suicide. To be diagnosed with depression, the symptoms must have been present for at least two weeks (Kapfhammer, 2006; U.S. Department of Health and Human Services National Institutes of Health National Institute of Mental Health, 2014).

The global burden of disease for depression may be underestimated because research often focuses on the leading causes of death, and the causes of disability may not be examined (Murray & Lopez, 1996). Mental illness accounts for approximately 1% of deaths; however, mental illness is responsible for nearly 11% of the global disease burden. In 1996, investigators speculated that by 2020, depression will be the source for the second greatest disability adjusted life years (Murray & Lopez, 1996). Furthermore, according to an updated global burden of disease estimate, depression will be the leading cause of disability burden in 2030 (World Health Organization, 2004).

In the U.S., the prevalence of depression varies by age and sex. Depression is more prevalent among younger adults. However, older adults may be more susceptible

to depression, particularly as a result of a serious medical illness (Wells, Golding, & Burnam, 1988). According to the 1998–2008 data from the Health and Retirement Study, 14.2% of adults, 65 years and older suffered from major depression with greater prevalence among women and greater prevalence with increasing age for both sexes (Federal Interagency Forum on Aging-Related Statistics, 2016). Further, the population over the age of 65 in the U.S. has increased to 54.2 million in 2015, which represents 16.9% of the U.S. population. By 2030, the population 65 years and older is expected to increase to 83.4 million, 23.2% of population (U.S. Census Bureau, 2014).

Depression is a common comorbidity among patients with chronic conditions, such as angina, arthritis, asthma, diabetes, and heart failure, with depression prevalence ranging from 10% to nearly 70% (Ciechanowksi et al., 2000; Moraska et al., 2013; Moussavi et al., 2007). Lastly, depressed patients have higher medical costs than non-depressed patients (Frasure-Smith et al., 2000).

**Previous Research on Depression and Readmission**

*Identifying Depression: Method and Timing*

Depression detection methods could be classified into three major categories, 1) clinical interviews, 2) depressive symptom indexes, and 3) patient record review using clinical diagnostic codes. A list of common classification measures is provided in Table 2.1. Among studies that used a depressive symptom index, depression may be analyzed as a categorical variable or analyzed continuously based on the number of depressive symptoms indicated.

A trained mental health professional may record clinical depression in patients' medical records. The mental health professional may use various instruments to conduct a psychiatric interview and determine whether the patient is clinically depressed or depressive symptoms can be accessed using patient self-reported responses to a depressive symptom index (Table 2.1). Clinical interviews and depressive symptom indexes are both considered valid measures for detecting depression (Okun, Stein, Bauman, & Silver, 1996; Ventura, Liberman, Green, Shaner, & Mintz, 1998). The proposed research study will focus on clinically diagnosed depression as indicated by a valid diagnosis code in a patient's administrative records, to be described in Chapter 3.

The timing of depression, and its measurement, can also vary. Depression may occur 1) prior to admission or have history of depression, 2) at hospital, at admission or prior to discharge, or 3) after discharge. Furthermore, depression may be measured at baseline or over multiple times after discharge. When depression was classified after admission, depression may have developed due to the health condition or due to the hospital admission. Being admitted to the hospital for any health condition may create psychological stress (Krumholz, 2013).

The next section will focus on research articles that have examined the relationship between depression, identified at any time with respect to the hospital admission, and long-term and short-term hospital readmissions among adults aged at least 50 years and older. Studies that 1) included younger adults, 2) lacked age-delineated outcomes, 3) non-U.S. based, or 4) included psychiatric patients or hospitals will not be presented here.

**Table 2.1 Depression classification approaches**

| Classification methods | Source | Tools/Methods |
|---|---|---|
| Clinical interviews, administered by health care professional | (First, Spitzer, Gibbon, & Williams, 2002b) | Structured Clinical Interview for the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition |
| | (First, Spitzer, Gibbon, & Williams, 2002a) | Structured Clinical Interview for the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition– Non-patient Edition |
| | (Robins, Helzer, Croughan, & Ratcliff, 1981) | Diagnostic Interview Schedule for Depression |
| | (R. Carney et al., 1987) | Modified Diagnostic Interview Schedule for Depression |
| | (Kessler et al., 2004) | Composite International Diagnostic Interview Short Form |
| | (Hamilton, 1967) | Hamilton Rating Scale for Depression (HDRS or HAM-D) |
| | (Spitzer et al., 2014) | Primary Care Evaluation of Mental Disorders |
| Depressive symptom indexes, patient reported | (Beck, 1978) | Beck Depression Inventory (BDI) |
| | (Zung, 1965) | Zung Self-Rating Depression Scale |
| | (Yesavage et al., 1982) | Geriatric Depression Scale (GDS) |
| | (Radlof, 1977) | Center for Epidemiological Studies–Depression scale (CES-D) |
| | (Zigmond & Snaith, 1983) | Hospital Anxiety and Depression Scale, depression subscale (HAD-D) |
| | (Zimmerman, Sheeran, & Young, 2004) | Diagnostic Inventory for Depression (DID) |
| | (Lipman, Covi, & Shapiro, 1979) | Depression scale from the Hopkins Symptom Checklist |

| | | |
|---|---|---|
| | (Nagel, Lynch, & Tamburrino, 1998) | Medical Outcomes Study–Depression |
| | (Zuckerman & Lubin, 1965) | Multiple Affect Adjective Checklist |
| | (Kroenke, Spitzer, & Williams, 2001) | Patient Health Questionnaire (PHQ-9) (depression severity) |
| Patient record review | | Using ICD-9 or ICD-10 diagnostic codes or documentation of antidepressants for medical hospital data or administrative claims |

**Depression and Long-term Readmission Outcomes**

Eight studies, discussed in more detail below, examined depression across seventeen different long-term readmission outcomes (Table 2.2). Most of the outcomes classified depression using a depressive symptom index or clinical interview while the patient was at the hospital and the readmission follow-up ranged from 3 months to 36 months. A significant relationship between depression and long-term readmission outcomes was not detected for most outcomes.

Three studies detected depression using a depressive symptom index had significantly higher rates of readmissions (Harold G Koenig & Kuchibhatla, 1999; Horold G. Koenig, 1998; Smolderen et al., 2009). Though under different health conditions, two of the studies were conducted by the same researchers, and found readmission occurring at 3–6 months were significant among patients with major, minor, or no depression in both studies. However, across longer-term readmission outcomes, the results were mixed (Harold G Koenig & Kuchibhatla, 1999; Horold G. Koenig, 1998). Unlike other studies that focused on a specific health condition or surgical procedure, the third study found a significant relationship between depression and readmissions across all index hospital admissions (Smolderen et al., 2009). The remainder of the studies failed to find a significant relationship between depression and readmission outcomes at six months (Fulop et al., 2003; Peterson et al., 2002), twelve months (Ketterer, Draus, McCord, Mossallam, & Hudson, 2014), and 36 months (Peterson et al., 2002).

Among the included studies that looked at depression and long-term readmission outcomes, two studies classified depression using a clinical interview; both studies reported outcomes that failed to find a significant relationship (Fulop et al., 2003; Sheeran, Byers, & Bruce, 2010). However, one of the studies found a significant relationship between depression and the time to a readmission (Sheeran et al., 2010).

None of the studies examined depression and long-term readmission outcomes using administrative claims data. However, one study used diagnostic codes from a medical record review to detect depression; this study failed to find a significant relationship (Kociol et al., 2010).

**Depression and Short-term Readmission Outcomes**

Similar to long-term readmission studies, the relationship between depression and short-term readmission outcomes in older adults was mixed. In addition, the depression measures in short-term readmission studies were more evenly distributed. Lastly, nearly all outcomes followed patients for 30 days after discharge, with the shortest follow-up time at 14 days after discharge and the longest at 60 days after discharge.

*Clinical Interviews*

Only two studies examined short-term readmission outcomes using a clinical interview to detect depression; a positive relationship was identified across all study outcomes. Depressed patients had more 30-day medical encounters after a hospital discharge (2.9 encounters verses 2.6 encounters, $p < 0.05$) and more readmission days (4.5 days verses 2.3 days, $p < 0.05$) than non-depressed patients (Fulop et al., 2003).

**Table 2.2 Comparison of studies examining the relationship of depression on long-term readmission outcomes**

| Author, year | Data Source~ | Health Outcome | Depression Measure | Follow-up Period | Readmission | Relationship between depression and readmission |
|---|---|---|---|---|---|---|
| Koenig, 1998 | Medical record review | CHF | CES-D at 16+, HAM-D at 11+, and DIS | 3–6 M | All-Cause | Greater readmissions in depression (major and minor) |
| | | | | 6–9 M | All-Cause | Greater readmissions in depression (major and minor) |
| | | | | 9–12 M | All-Cause | No significant difference |
| Koenig and Kuchibhatla, 1999 | Medical record review | All | CES-D at 16+, HAM-D at 11+, and DIS | 3–6 M | All-Cause | Greater readmissions in depression |
| | | | | 6–9 M | All-Cause | No significant difference |
| | | | | 9–12 M | All-Cause | No significant difference |
| Peterson et l, 2002+ | Medical record review | CABG | CES-D at 16+ | 6 M | Same- or Related-Cause | No significant difference |
| | | | | 36 M | Same- or Related-Cause | No significant difference |
| Fulop G, et l 2003 * ++ | Medical record review | CHF | GDS-15 at 10+ | 6 M | Readmission days | No significant difference |
| | | | | | Medical encounter ^ | No significant difference |
| | | | SCID-NP | 6 M | Readmission days | No significant difference |
| | | | | | Medical encounter ^ | No significant difference |
| Smolderen K, et al., 2009 | Clinical registry | All | PHQ-9 at 10+ | 12 M | All-Cause | Higher risk for readmission among depressed |
| Kociol R, et al, 2010 | Clinical registry | HF | ICD-9 | 12 M | All-Cause | No significant difference |
| Sheeran T et al, 2010 | Medical record review | All | DSM-IV | 60 D | All-Cause | No significant difference |
| | | | | | Time to Readmission | Less time to readmission than non-depressed (8.4 (SD = 5.5) days and 19.5 (SD = 12.8) days)) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Ketterer M, et al., 2014 | Medical record review | CHF | PHQ-9 at 10+ and medication | 12 M | All-Cause | No significant difference |

Significance determined at $p<0.05$
M: months; D: days;
+ Readmissions were restricted to new cardiac or neurologic morbidity or mortality
^ Medical encounter defined as composite measure for physician visit, emergency department visit, readmission, or laboratory testing
~ Data source used to evaluate readmission outcome

Depressed patients had higher rates of hospitalizations at 14 days after a discharge (Sheeran et al., 2010).

*Depressive Symptom Index*

Among included studies that used a depressive symptom index to examine short-term readmission outcomes, the significance of the relationship between depression and short-term readmission outcomes were mixed. Depression was a significant predictor for short-term readmissions (Berges, 2015). Additionally, when depression was identified using a more restrictive depression criteria (depressive symptom index and confirmation of psychiatric treatment in medical records), depression was significantly associated with 30-day readmission in univariate analysis (50% versus 26%, $\chi^2 = 3.29$, p= 0.035); multivariable analysis with depression was not conducted (Ketterer et al., 2014).

On the other hand, depressive symptoms were not significantly associated with all-cause readmissions within 0 – 3 months (Harold G Koenig & Kuchibhatla, 1999; Horold G. Koenig, 1998), unplanned 30-day all-cause readmissions (Albrecht et al., 2014; McManus et al., 2015), 30-day medical encounters (composite measure for physician visit, ED visit, readmission, or laboratory testing) (Fulop et al., 2003), the number of readmission days within 30 days (Fulop et al., 2003), and 60-day unscheduled all-cause readmissions (Burns & Nichols, 1991).

*Medical Record Review*

Among studies that measured a history of depression, the relationship between depression and 30-day all-cause readmission was mixed. Using medical records or

clinical registries, history of depression was significantly associated with 30-day all-cause readmissions in two studies (Marcantonio et al., 1999; Watson et al., 2011), with no significant difference found in one study (Silverstein, Qin, Mercer, Fong, & Haydar, 2008).

*Administrative Claims Review*

Using Medicare claims to classify patients with depression, most studies found a significant relationship between depression and short-term readmission outcomes. Patients with depression were more likely to experience a 30-day readmission (Barnett et al., 2015; Mather, Fortunato, Ash, Davis, & Kumar, 2014; Singh, Zhang, Kuo, & Sharma, 2016) and depression/anxiety was a significant predictor for readmissions (Chen, Popoola, Radhakrishnan, Suzuki, & Homan, 2015). A significant relationship was not found between depression and 30-day same or related cause readmission (Mather et al., 2014) and 30-day all-cause readmission (Keenan et al., 2008).

**Limitations of Previous Research and Proposed Study Design**

The role of depression in hospital readmissions among older adults has been assessed in fewer studies compared to studies that examined all adults, aged 18 and older. The proposed study will fill the gap in the current short-term outcome readmission literature and examine the effect of depression exclusively among older adults. As described in the previous section, the association between depression and readmission has been mixed for both long-term and short-term outcomes. Drawing a comparison across the studies is difficult because the studies varied in their data source,

**Table 2.3 Comparison of studies examining the impact of depression on short-term readmission outcomes**

| Author, Year | Data Source~ | Health Outcome | Depression Measure | Follow-up Period | Readmission | Relationship between depression and readmission |
|---|---|---|---|---|---|---|
| Burns and Nicholos, 1991 | Medical record review | All | CES-D, mean | 60 D | All-Cause | No difference |
| Koenig, 1998 | Medical record review | CHF | CES-D at 16+, HAM-D at 11+, and DIS | 0–3 M | All-Cause | No difference |
| Koenig and Kuchibhatla, 1999 | Medical record review | All | CES-D at 16+, HAM-D at 11+, and DIS | 0–3 M | All-Cause | No difference |
| Marcantonio ER et al., 1999 | Medical record review | All | ICD-9 | 30 D | All-Cause | Increased depression among readmissions |
| Fulop G, et l 2003 ++ | | CHF | GDS-15 at 10+ | 30 D | Readmission Days | No difference |
| | | | | | Medical Encounter | No difference |
| | | | SCID-NP | 30 D | Readmission Days | Increased readmission days |
| | | | | | Medical Encounter | Increased medical encounters |
| Keenan p, et al., 2008 | Claims | CHF | CCS | 30 D | All-Cause | No difference |
| Silverstein MD, et al., 2008 | Clinical registry | All | ICD-9 | 30 D | All-Cause | No difference |
| Sheeran T et al, 2010 | Medical record review | All | DSM-IV | 14 D | All-Cause | Higher rates of readmissions (7% verses 3%) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Watson et al., 2011 | Medical record review | HF | ICD-9 | 30 D | All-Cause | Greater readmission (univariate only) |
| Mather JF, et al, 2013 | Claims | PN | ICD-9 CM | 30 D | All-Cause | Increased readmission for depression/anxiety |
| | | PN | | 30 D | Related-Cause | No significant difference |
| Albrecht, 2014 | Clinical registry | All | GDS-15 at 6+ | 30 D | All-Cause | No significant difference |
| Ketterer M, et al., 2014 | Medical record review | CHF | PHQ-9 at 10+ and medication | 30 D | All-Cause | Greater readmission rates with psychiatric history*** |
| Barnett et al., 2015 | Claims | All | CES-D in quartiles | 30 D | All-Cause | Readmission rate significantly different across quartiles; lowest rate in least depressed |
| Berges et al., 2015 | Medical record review | COPD, respiratory / gastrointestinal problems | CES-D at 16+ | 30 D | All-Cause | Increased readmission (multivariable regression only) |
| Chen et al, 2015 | Claims | Diabetes | ICD-9-CM | 30 D | ACSC readmission ^^ | Increased time to admission |
| McManus et al, 2015 | Medical record review | AMI | PHQ-9 at 20+ | 30 D | All-Cause | No difference (multivariable regression not analyzed) |
| Singh et al., 2015 | Claims | COPD or respiratory failure | ICD-9 | 30 D | All-Cause | Greater readmission |

Significance determined at $p<0.05$

M: months; D: days; CC: CMS hierarchical condition categories

^ Medical encounter defined as composite measure for physician visit, emergency department visit, readmission, or laboratory testing

^^ Preventable ambulatory care sensitive condition (ACSC)-related readmission

*** Depressive symptom index positive, acknowledged history of treatment, and use of antidepressant

~ Data source used to evaluate readmission outcome

depression measure, depression diagnosis timing, readmission outcome, and by specific health conditions. A partial explanation for the discrepant results may be due to differences in data sources. Many of the research studies that examined a short-term readmission outcome were prospective cohort studies conducted in a single hospital (Albrecht et al., 2014; Berges, 2015; Burns & Nichols, 1991; Fulop et al., 2003; Ketterer et al., 2014; Harold G Koenig & Kuchibhatla, 1999; Horold G. Koenig, 1998; Marcantonio et al., 1999; Mather et al., 2014; Peterson et al., 2002; Watson et al., 2011) or multiple hospitals within the same region (McManus et al., 2015; Sheeran et al., 2010; Silverstein et al., 2008). The results of such studies may be limited in their generalization to a larger population.

Another explanation for the conflicting results could be differences in how depression was measured. A greater proposition of studies using a depressive symptom index failed to find a significant relationship (Albrecht et al., 2014; Burns & Nichols, 1991; Fulop et al., 2003; Harold G Koenig & Kuchibhatla, 1999; Horold G. Koenig, 1998; McManus et al., 2015). However, most studies that examined a history of depression using inpatient administrative claims data detected a significant relationship between depression and short-term readmission outcomes (Barnett et al., 2015; Chen et al., 2015; Mather et al., 2014; Singh et al., 2016). The proposed research study will use administrative claims data. Although administrative claims data were not collected for the purposes of health services research, claims-based analyses have a high level of agreement to analyses prepared using medical record data (Krumholz et al., 2011).

Additionally, diagnosis discordance may exist between the classification methods of depression. One study reported 26% discordance between depression classified at the hospital using a clinical interview and depressive symptom index (Fulop et al., 2003). Furthermore, depression diagnosis may disagree between the inpatient and outpatient settings. Very few studies have examined the concordance of depression diagnosis between inpatient and outpatient settings. In a study analyzing Veterans Affairs claims data, depression was more frequently diagnosed in the outpatient than inpatient setting (15.1% versus 5%, respectively). The significance of the relationship between depression and readmissions differed by the setting at which depression was detected (Abrams, Vaughan-Sarrazin, & Rosenthal, 2009). The proposed research study will examine the data concordance between inpatient and outpatient settings for a diagnosis of depression.

Prior research has focused on the identification of readmission risk factors. The depression and readmission literature does not specify a theoretical framework for the development of readmission models. The proposed research study will use a theoretical framework to examine the influence of concordance of depression diagnosis to evaluate the relationship between depression and readmission.

**Theoretical Framework**

This research study will be grounded in Donabedian's 1988 Quality Framework (also known as structure-process-outcome model) to evaluate the impact of organizational-level factors on readmissions (Donabedian, 1988). Donabedian's framework does not account for population perspective factors (e.g., patient, economic,

or social factors), therefore, this research will also incorporate Andersen's Health Behavior Model (Andersen, 1995).

To summarize the study's framework (Figure 2.1), we propose that barriers at the structure or organization level may impair processes. These structural and process deficiencies may lead to poor outcomes, such as a hospital readmission. Several factors may influence readmissions within thirty days of a hospital discharge. Structure or organization level factors have been associated with hospital readmissions, such as hospital teaching status (Aujesky et al., 2009; Merkow et al., 2015), physician staffing capacity (Brown et al., 2014; Epstein, Jha, & Orav, 2011), and hospital size (Brown et al., 2014). Process factors that may impact hospital readmissions, and could include diagnosis concordance (Abrams et al., 2009), discharge planning procedures (Brown et al., 2014; Epstein et al., 2011), or primary care physician visits after discharge (Epstein et al., 2011). Environmental and patient-level factors, such as hospital location (urban/rural) (Epstein et al., 2011), age (Albrecht et al., 2014; Barnett et al., 2015; Chen et al., 2015; Keenan et al., 2008; Marcantonio et al., 1999; McManus et al., 2015; Silverstein et al., 2008; Singh et al., 2016), sex (Barnett et al., 2015; Keenan et al., 2008; Mather et al., 2014; Silverstein et al., 2008; Singh et al., 2016), race/ethnicity (Chen et al., 2015; Silverstein et al., 2008), comorbidities (Albrecht et al., 2014; Barnett et al., 2015; Berges, 2015; Chen et al., 2015; Marcantonio et al., 1999; Mather et al., 2014; McManus et al., 2015; Silverstein et al., 2008; Singh et al., 2016), illness severity (Burns & Nichols, 1991), and patient's residence (Ferraris, Ferraris, Harmon, & Evans, 2001; Silverstein et al., 2008) have been associated with hospital readmissions. In summary,

the proposed theoretical framework provides a clinical and population approach to describe factors associated with a hospital readmission.

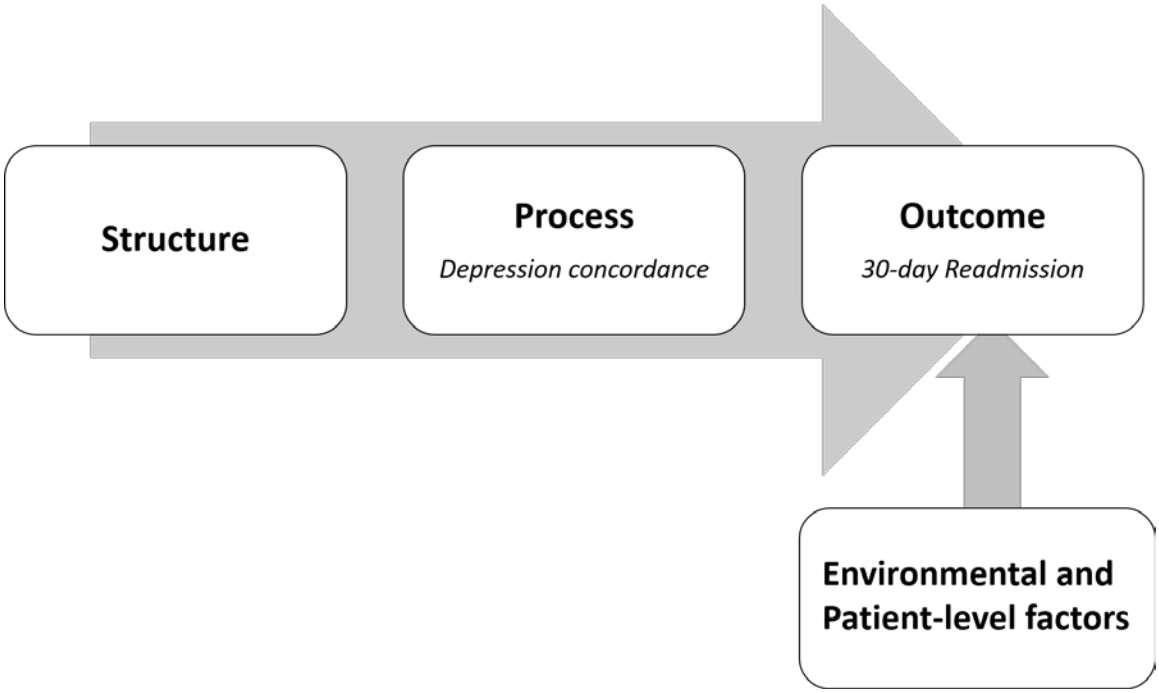


**Figure 2.1 Theoretical Framework**

**Research Aims and Hypotheses**

The specific research aims and corresponding hypotheses of the study are:

*Aim 1: Determine the level of concordance of a recorded diagnosis of depression between inpatient and outpatient administrative claims for Medicaid recipients over the age of 55.*

*Hypothesis 1*: A depression diagnosis will be more frequently recorded in outpatient administrative claims than inpatient administrative claims

*Aim 2: Determine the relationship between a concordant depression diagnosis and hospital readmissions. Depression concordance will be classified into four mutually*

*exclusive groups: inpatient depression diagnosis only, outpatient depression diagnosis only, inpatient and outpatient depression diagnosis, and no depression diagnosis.*

*Hypothesis 2.1*: Medicaid recipients 55 years and older with a depression diagnosis in the inpatient only, outpatient only, or both inpatient and outpatient setting will have a greater readmission rate than patients without depression.

*Hypothesis 2.2*: The readmission rates will be lower among Medicaid recipients 55 years and older when inpatient and outpatient administrative claims are concordant.

# CHAPTER 3

# METHODOLOGY

**Purpose**

This study will provide a population-based, single-state perspective on data concordance for a recorded diagnosis of depression between inpatient and outpatient settings. In addition, the study will provide a population-based, single-state perspective on the relationship between depression and short-term hospital readmission outcomes for older Americans age 55 years and older with a primary inpatient diagnosis of acute myocardial infraction (AMI), chronic obstructive pulmonary disease (COPD), heart failure (HF), and pneumonia (PN). The specific aims and associated hypotheses of this study were:

*Aim 1: Determine the level of concordance for a recorded diagnosis of depression between inpatient and outpatient administrative claims for Medicaid recipients over the age of 55*

*Hypothesis 1*: A depression diagnosis will be more frequently recorded in outpatient administrative claims than inpatient administrative claims.

*Aim 2: Determine the relationship between a concordant depression diagnosis and hospital 30-day all-cause readmission.*

Depression concordance will be classified into four mutually exclusive groups: inpatient depression diagnosis only, outpatient depression diagnosis only, inpatient and outpatient depression diagnosis, and no depression diagnosis.

*Hypothesis 2.1*: Medicaid recipients 55 years and older with a depression diagnosis in inpatient only, outpatient only, and inpatient and outpatient settings will have greater 30-day all-cause readmission rate than patients without depression. Hospital readmissions will increase along the depression recognition continuum (ascending order):

1) Patients with no depression recorded in the inpatient and outpatient claims will experience the lowest 30-day all-cause readmission rates
2) Depression recorded in both inpatient and outpatient claims
3) Depression recorded in inpatient claims, and not recorded in outpatient claims
4) Depression recorded in outpatient claims, but not inpatient claims will experience the highest 30-day all-cause readmission rates.

*Hypothesis 2.2*: The 30-day all-cause readmission rates will be lower among Medicaid recipients 55 years and older when a depression diagnosis recorded in inpatient and outpatient administrative claims are concordant.

**Institutional Review Board (IRB)**

The University of South Carolina IRC approved this study on April 12 2017. The study was categorized as “not human subjects research” and exempt from the Protection of Human Subjects Regulations given the use of de-identified secondary data.

**Data sources**

This study examined health utilization data from the South Carolina (SC) Revenue and Fiscal Affairs Office (RFAO) for SC residents with a primary payer of Medicaid. The SC RFAO collects health and demographic information from administrative billing data on inpatient discharges, emergency department visits, outpatient surgery, imaging, radiation therapy, and other outpatient services from short-term acute care hospitals and licensed freestanding centers in SC that required a Certificate of Need (CON). The SC RFAO data were structured such that patients could be tracked over time and across multiple settings (South Carolina Revenue of Fiscal Affairs Office, n.d.). A unique identification number created by the SC RFAO allowed a single patient's health care utilization to be tracked within the state and across inpatient and outpatient facilities. All patient and medical facility information were de-identified by SC RFAO.

County-level mental health facility estimates were derived from the SC Department of Mental Health's website. The website contains a list of the locations, counties served, and services offered at all mental health centers and their satellite offices ("Mental Health Centers and Their Satellite Offices," 2017).

**Study Sample**

Medicaid recipients 55 years and older with an inpatient primary diagnosis of AMI, COPD, HF, or PN that occurred during January 1, 2013 and December 30, 2015 were eligible for inclusion in this study. To determine if patients were readmitted within 30 days, inpatient claims were examined through December 31, 2015. Among eligible patients, all outpatient claims that occurred between January 1, 2012 and November 29,

2015 were examined. To allow classification of diagnosed depression prior to the index admission, patients without an outpatient visit at least one day before an index admission were excluded.

**Definitions and Estimates of Studied Chronic Conditions**

The study will be restricted to patients with an inpatient primary diagnosis of AMI, COPD, HF, or PN. Heart disease, chronic respiratory diseases, and pneumonia have been the top leading causes of death for the past century (National Center for Health Statistics, n.d.). These health conditions greatly affect older adults (Centers for Disease Control and Prevention, 2016). Heart disease, which includes coronary heart disease (CHD), myocardial infarction (MI) (heart attack), and heart failure (HF), accounts for 23% of all deaths in the U.S. (Johnson, Hayes, Brown, Hoo, & Ethier, 2014; Mozaffarian et al., 2016). In 2014, heart disease was the leading cause of death in the U.S. (National Center for Health Statistics, 2016). Among older adults, nearly 27% of all deaths were due to heart disease (Carroll & Miller, 2013). Over 1 in 3 elders in the U.S. were diagnosed at some time with heart disease, and adults have increasing risk of disease as they age (Carroll & Miller, 2013). Risk factors for heart disease include family history and genetics, physical inactivity, smoking or tobacco use, poor nutrition, high blood cholesterol, high blood pressure, diabetes mellitus, and metabolic syndrome (Mozaffarian et al., 2016). Nationally, men were more likely to be diagnosed with heart disease than women, and non-Hispanic whites were more likely to be diagnosed with heart disease than all other racial/ethnic groups (Carroll & Miller, 2013). However, non-Hispanic blacks have the highest proportion of age-adjusted death rates (Mozaffarian et

al., 2016). Heart disease incurs more direct ($193.1 billion) and indirect ($123.5 billion) costs than any other diagnostic group across all ages (Mozaffarian et al., 2016). Specially, for older adults with heart disease have higher health care utilization, including more inpatient, outpatient, and emergency department visits (Carroll & Miller, 2013). MI and HF are the two most prevalent heart diseases. MI was responsible for the most heart disease deaths with 1 out of 7 deaths, followed by HF with 1 in 9 deaths. Hospitalizations for heart disease and AMI were greater among men, but hospitalizations for CHF were greater among women and non-Hispanic blacks. The southeastern U.S. has the highest HF hospitalizations rates (Mozaffarian et al., 2016). Among adults 65 and older, HF was the leading cause of hospitalizations with more than one million hospitalizations annually (Desai & Stevenson, 2012). At least 50% of patients with a primary diagnoses of heart failure was readmitted to the hospital within six months of discharge (Desai & Stevenson, 2012).

Chronic respiratory diseases, such as COPD was the third leading cause of death (National Center for Health Statistics, 2016). COPD is a group of chronic conditions that cause airflow blockage and breathing-related problems, and it includes, emphysema, chronic bronchitis, and in some cases, asthma. Tobacco smoke, exposure to air pollutants, genetics, and respiratory infections are associated with the development and progression of COPD (Wheaton, Cunningham, Ford, & Croft, 2015).

In 2014, pneumonia and influenza, infectious diseases, were the eighth leading causes of death (National Center for Health Statistics, 2016). The number of deaths from

pneumonia and influenza has increased and decreased slightly in recent years (Johnson et al., 2014). Men and American Indian or Alaska Natives have higher age-adjusted death rates of pneumonia. In 2014, there were over one million hospitalizations due to pneumonia. Eighty-five percent of all pneumonia deaths occurred in adults 65 years and older (American Lung Association, 2015).

For the proposed study, AMI, COPD, HF, and PN will be classified using the *International Classification of Diseases, 9th Revision* (ICD-9) or *10th Revision* (ICD-10) as recorded for the inpatient primary diagnosis. The health conditions were classified based on the CMS HRRP's classifications, as detailed and mapped in Appendix A. CMS has not published standardized methodology for the calculation of the readmission penalty using ICD-10 codes. In lieu of such, this study used CMS's Hospital Inpatient Quality Reporting Program Measures International Classification of Diseases, 10th Edition, Clinical Modification System (ICD-10-CM) DRAFT Code Sets.

**Study Variables**

*Independent Variables: Depression and Depression Diagnostic Concordance*

The primary variable of interest is depression. Depression will be classified using the ICD-9 or ICD-10 for inpatient and outpatient claims. The classification of depression was consistent the following the Diagnostic and Statistical Manual of mental disorders, Fifth edition (DSM-V) depressive disorders: major depressive disorder, persistent depressive disorder, other specified depressive disorder, and unspecified depressive

disorder (American Psychiatric Association, 2013). A list of ICD-9 and ICD-10 codes are printed in Table 3.1 and mapped ICD-9 to ICD-10 codes are printed in Appendix B.

The independent variable for Aim 1 will be the agreement between a depression diagnosis recorded in the inpatient (primary or secondary diagnosis) and prior outpatient (primary or secondary) administrative claims among eligible index admissions (defined in the next section).

The independent variable for Aim 2 will be depression diagnostic concordance classified into four mutually exclusive categories based on the primary or secondary diagnosis in the inpatient setting or a primary or secondary diagnosis in the outpatient setting:

- Concordant-no depression,
- Concordant-depression (inpatient and outpatient),
- Not concordant-inpatient only, and
- Not concordant-outpatient only,

**Table 3.1 Depression ICD-9 and ICD-10 classifications**

| Code | Description |
|---|---|
| ***ICD-9*** | |
| 296.2x | Depressive psychosis, mild, moderate, to severe with partial to full remission |
| 296.3x | Recurrent depressive psychosis, mild, moderate, to severe with partial to full remission |
| 296.82 | Atypical depressive disorder |
| 296.9, 296.99 | Other or unspecified episodic mood disorder |
| 298 | Other nonorganic psychoses |
| 300.4 | Dysthymic disorder |
| 301.12 | Chronic depressive personality disorder |
| 309 | Adjustment reaction |
| 311 | Depressive disorder, not elsewhere classified |
| 313.1 | Misery and unhappiness disorder |

| ***ICD-10*** | |
|---|---|
| F32.0x — 32.1x | Mild to moderate depressive episode, with or without somatic syndrome |
| F32.2 — F32.3 | Severe depressive episode with or without psychotic symptoms |
| F32.8, F32.9 | Other or unspecified depressive episodes |
| F33.0x | Recurrent depressive disorder, current episode mild, with or without somatic syndrome |
| F33.1x | Recurrent depressive disorder, current episode moderate, with or without somatic syndrome |
| F33.2 — F33.3 | Recurrent depressive disorder, current episode severe with or without psychotic symptoms |
| F33.4 | Recurrent depressive disorder, currently in remission |
| F33.8 | Other recurrent depressive disorders |
| F33.9 | Recurrent depressive disorder, unspecified |

*Dependent Variable: 30-day All-cause Readmission*

Index Admission

An eligible index admission was an inpatient admission with a primary diagnosis of AMI, COPD, HF, or PN that occurred between January 1, 2013 and November 30, 2015 who were discharged home or self-care with or without the care of a home health service. Given depression has been associated with treatment non-adherence, patients who were discharged against medical advice were not excluded. Primary diagnosis was classified using ICD-9 or ICD-10 codes (Appendix A). Hospital admissions to specialty medical facilities, such as psychiatric hospitals were excluded. In addition, patients discharged the same day or died during the initial hospital stay, were ineligible as an index admission.

Readmission

An all-cause readmission was the first hospital readmission that occurred after an eligible index admission regardless of the primary diagnosis. A hospital admission could not be both an index admission and eligible readmission. Readmissions to

specialty medical facilities, where the patient had a primary psychiatric diagnosis, or a primary or secondary diagnoses for rehabilitation or treatment of cancer were excluded. The hospital stay that resulted in the patient being discharged or transferred to another hospital was not eligible as a readmission outcome. Planned readmissions were excluded if the primary diagnosis was for bone marrow, kidney, or other organ transplant, or if a readmission for maintenance chemotherapy or rehabilitation. This exclusion of planned readmissions was partially consistent with CMS methodology (Appendix). However, unlike the CMS methodology, this study was unable to exclude planned readmissions based on clinical or surgical procedures. In addition, planned admissions as coded by RFA effective October 1, 2013 were excluded.

A 30-day hospital readmission was classified as a dichotomous variable. The dependent variable for the admission-level analysis for Aim 2 was a 30-day all-cause readmission for Medicaid recipients 55 years and older with an index primary admission of AMI, COPD, HF, or PN. A 30-day readmission was considered an eligible hospital admission that occurred within 30 days of an eligible index hospital admission.

*Control Variables*

The environmental control variables included the number of county-level mental health facilities and the rurality of hospital. The county-level mental health facilities were based on all mental health centers and their satellite offices as listed by the SC Department of Mental Health. Using the counties served, as specified on the website, and the physical address of the mental health facility, each facility was assigned to a county. Mental health centers were classified into the following groups at the county-

level: 1 mental health center, 2 mental health centers, and 3 or more mental health centers for a given county. Rurality of the hospital was pre-defined by SC RAFO according to Metropolitan Statistical Area (MSA) (U.S. Census Bureau, 2013) and defined as rural (non-MSA) and urban (non-MSA).

The population characteristics used as control variables were age, sex, race/ethnicity, comorbidities, and patient's residence. Age, in years, was determined at the time of the index admission as 55 – 64, 65 – 74, 75 – 84, and 85 and greater. Rurality (rural verses urban) will be classified using the county reported for the patient's residence and for the hospital's county of operation, as defined by the Office of Management and Budget's rural county classification. Race/ethnicity was defined as white, black, and other. Comorbidities were defined using the inpatient primary or secondary diagnoses, and classified using the Elixhauser Comorbidity Index, version 3.7 for ICD-9 codes and version 1.1 for ICD-10 codes. To use the Elixhauser Comorbidity Index, Diagnosis Related Groups (DRGs) were computed using ICD-9 version 29 and ICD-10 version 34. The Elixhauser Comorbidity Index creates an indicator for 29 variables: alcohol abuse, blood loss anemia, chronic peptic ulcer disease, chronic pulmonary disease, coagulation deficiency, congestive heart failure, deficiency anemias, depression, diabetes without chronic complications, diabetes with chronic complications, drug abuse, fluid and electrolyte disorder, HIV and AIDS, hypertension (uncomplicated and complicated), hypothyroidism, liver disease, lymphoma, metastatic cancer, obesity, other neurological disorders, paralysis, peripheral vascular disease, psychoses, pulmonary circulation disorders, renal failure, solid tumor without

metastasis, rheumatoid arthritis or collagen vascular diseases, valvular disease, and weight loss. To reduce double-counting health conditions, the comorbidity index was reduced by five due to diagnosis code overlap for the following: chronic pulmonary disease, congestive heart failure, depression, pulmonary circulation disorders, and valvular disease.

**Analytic Approach**

*Aim 1. Analysis of data concordance for a recorded diagnosis of depression between inpatient and outpatient administrative claims for Medicaid recipients over the age of 55.*

The objective of Aim 1 was to determine the level of concordance in depression diagnosis between the inpatient and outpatient administrative claims records in Medicaid recipients adults aged 55 and older. The primary outcome will be the agreement between depression diagnosis measured by inpatient (secondary diagnosis codes) and outpatient (primary or secondary diagnosis codes) as measured using the Cohen's Kappa (κ)-statistic. In addition, the frequency of patients classified with depression between the inpatient and outpatient data will be reported. The following interpretation of kappa for the agreement inpatient and outpatient depression beyond chance were: no agreement ($\kappa \leq 0$), none to slight ($\kappa = 0.01 – 0.20$), fair ($\kappa = 0.21 – 0.40$), moderate ($\kappa = 0.41 – 0.60$), substantial ($\kappa = 0.61 – 0.80$), and almost perfect agreement ($\kappa = 0.81 – 1.00$) (McHugh, 2012). A log-binomial regression model determined the relative risk (RR) of having depression diagnostic concordance among Medicaid

recipients 55 years and older hospitalized for select health conditions while controlling for environmental and population-level characteristics.

Model: $Y = \beta_0 + \beta_1 X_1 + \cdots + \beta_i X_i + \epsilon$ , where $Y$ is depression diagnosis concordance between the inpatient and outpatient settings, $X$ represents the covariates of interest, and $\epsilon$ is the error term.

*Aim 2. Relationship between a concordant depression diagnosis and hospital 30-day all-cause readmissions.*

Depression concordance will be classified into four mutually exclusive groups: 1) concordant-no depression; 2) concordant-depression; 3) not concordant-inpatient only; and 4) not concordant-outpatient only. Bivariate analysis assessed the relationships between the depression diagnostic concordance (as classified by the four mutually exclusive groups), patient-level characteristics, and a 30-day readmission using Chi-square, $\chi^2$, for categorical variables or Student's *t*-tests for continuous variables. A log-binomial regression model was used to determine the risk ratio of 30-day readmissions for Medicaid recipients 55 years and older among depression diagnostic concordance categories while controlling for patient-level characteristics.

Model: $Y = \beta_0 + \beta_1 D + \beta_2 X_2 + \cdots \beta_i X_i + \epsilon$ , where $Y$ is 30-day readmission, $D$ is depression diagnosis concordance categories, $X$ represents the patient-level covariates of interest, and $\epsilon$ is the error term.

Analyses for this study were generated using SAS statistical software version 9.4 (SAS Institute Inc., Cary, NC, USA).

# CHAPTER 4

# MANUSCRIPT ONE

## THE AGREEMENT BETWEEN INPATIENT AND OUTPATIENT DEPRESSION DIAGNOSIS RECORDED IN ADMINISTRATIVE CLAIMS DATA[1]

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[1] Jones KM, Probst JC, McKinney SH, Crouch EL, and Hardin JW. To be submitted to *General Hospital Psychiatry*

**Abstract**

*Purpose*

The likelihood of a depression diagnosis may differ based on whether the patient was seen an inpatient or outpatient setting. The purpose of this study was to identify patient characteristics associated with depression diagnosis and determine the level of agreement between depression diagnoses as identified by inpatient and outpatient diagnosis records.

*Methods*

Using administrative claims data from South Carolina, we examined depression diagnosis concordance between inpatient and outpatient settings. The analysis was restricted to Medicaid recipients aged 55 years and older with an inpatient primary diagnosis of acute myocardial infraction (AMI), chronic obstructive pulmonary disease (COPD), heart failure (HF), and pneumonia (PN) from 2013 – 2015 (n = 8,621 patients). Diagnostic concordance was determined by the depression diagnosis recorded during the initial inpatient hospitalization using secondary diagnosis codes and at least one prior outpatient claim using primary or secondary diagnosis codes. Using log-binomial regression, we modeled diagnostic concordance among selected hospitalizations adjusting for patient-level and environmental-level variables.

*Results*

Overall, 6.8% of patients had a depression diagnosis recorded in inpatient claims, and 20.7% of patients had depression recorded in outpatient claims. Among patients with an inpatient diagnosis of depression, 42.8% had an outpatient diagnosis of depression.

Conversely, among patients with a prior outpatient diagnosis of depression, 14.6% had an inpatient diagnosis of depression. Diagnostic concordance was significantly associated with patient age, sex, race/ethnicity, and health condition. The number of comorbidities, residence of the patient (urban/rural), hospital location (urban/rural), and county-level mental health centers were not significantly associated with diagnostic concordance.

*Conclusions*

Depression is prevalent in the older hospitalized population. The lack of agreement between inpatient and outpatient settings may lead to missed opportunities to address the needs of this population during a hospitalization, discharge procedures, and post-discharge care, which could contribute to greater negative patient outcomes.

**Keywords**: comorbidity, depression

**Introduction**

In 2015, 17.9% or 43.4 million U.S. adults suffered from some form of mental illness. Depression is the most prevalent mental health disorder in the U.S. (Center for Behavioral Health Statistics and Quality, 2016). Depression is a common comorbidity among patients with chronic diseases (Ciechanowksi et al., 2000; Moraska et al., 2013; Moussavi et al., 2007). Older adults are more susceptible to chronic diseases, with over 85% having at least one chronic condition (Ward, Schiller, & Goodman, 2014). Older adults may be more susceptible to depression, particularly after experiencing a significant medical illness, such as one that requires hospitalization (Wells et al., 1988).

Approximately 14% of adults age 65 and older suffer from major depression (Federal Interagency Forum on Aging-Related Statistics, 2016).

Depression is a common comorbidity experienced by older adults in relation to a hospitalization (Al Aqqad et al., 2016; Frasure-Smith et al., 2000; Fulop et al., 2003; Horold G. Koenig, 1998; Lesman-Leegte et al., 2009; Ng et al., 2007; Papaioannou et al., 2013). The relationship between depression and negative hospitalization outcomes, such as a subsequent hospital readmission, among older adults has been previously examined. However, findings have been mixed, with some studies showing increased readmission among patients with depression (Barnett et al., 2015; Berges, 2015; Chen et al., 2015; Fulop et al., 2003; Ketterer et al., 2014; Harold G Koenig & Kuchibhatla, 1999; Horold G. Koenig, 1998; Marcantonio et al., 1999; Mather et al., 2014; Sheeran et al., 2010; Singh et al., 2016; Smolderen et al., 2009; Watson et al., 2011), while other studies have failed to find a significant relationship (Albrecht et al., 2014; Burns & Nichols, 1991; Fulop et al., 2003; Keenan et al., 2008; Ketterer et al., 2014; Kociol et al., 2010; Harold G Koenig & Kuchibhatla, 1999; Horold G. Koenig, 1998; Mather et al., 2014; McManus et al., 2015; Peterson et al., 2002; Silverstein et al., 2008). Differences in outcome measurement (long-term verses short-term) and depression classification may partially explain mixed results. In research studies, depression has been commonly classified using the following tools: clinical interviews (R. Carney et al., 1987; First et al., 2002a, 2002b; Hamilton, 1967; Kessler et al., 2004; Robins et al., 1981; Spitzer et al., 2014), depressive symptom indexes (Beck, 1978; Kroenke et al., 2001; Lipman et al., 1979; Nagel et al., 1998; Radlof, 1977; Yesavage et al., 1982; Zigmond & Snaith, 1983;

Zimmerman et al., 2004; Zuckerman & Lubin, 1965; Zung, 1965), or review of clinical diagnostic codes from patient medical records or administrative claims. Depression diagnosis differed between depression detected during a clinical interview and a depressive symptom index (Fulop et al., 2003). Another possible explanation for the mixed results may be due to the setting in which depression was recorded, i.e., inpatient verses outpatient settings. The majority of studies that have examined the relationship between depression and readmission have relied on the inpatient detection of depression. However, depression may not be recorded during the inpatient stay despite depression being detected in the outpatient setting. The differences in the setting in which depression was diagnosed and its subsequent relationship with hospital readmission has been infrequently examined (Abrams et al., 2009).

This study examined administrative claims data for South Carolina patients admitted to the hospital for select health conditions to address two objectives: 1) determine the level of agreement between depression status as identified by inpatient and outpatient diagnosis codes and 2) compare characteristics of patients with diagnostic concordance, that is, the agreement between the inpatient and outpatient record.

## Methodology

### *Data Sources*

Data were derived from two sources: 1) Medicaid inpatient and outpatient administrative claims and 2) County-level health facility lists. Inpatient and outpatient administrative claims data were obtained for South Carolina (SC) residents with a primary payer of Medicaid from the SC Revenue and Fiscal Affairs Office (RFAO). SC

RFAO collects health and demographic information from administrative claims data from all state health care organizations, including the Department of Mental Health (DMH), as well as various private health care practitioners regarding inpatient discharges and select outpatient services, such as emergency department visits and outpatient surgery. SC mandates that all hospitals and any outpatient facility that offers services that require a Certificate of Need must provide 100% of their patient data to SC RFAO (South Carolina Revenue of Fiscal Affairs Office, n.d.). The number of mental health centers per county was obtained from the SC DMH's website ("Mental Health Centers and Their Satellite Offices," 2017).

*Study Sample*

The sample was restricted to Medicaid recipients aged 55 years and older who experienced an inpatient hospitalization with a primary diagnosis of acute myocardial infarction (AMI), chronic obstructive pulmonary disease (COPD), heart failure (HF), and pneumonia (PN) (Table 4.1) between January 1, 2013 and December 30, 2015 and were discharged to home, self-care, or discharged against medical advice (n = 12,663 claims, n = 8,938 patients). Patients who were discharged against medical advice have been typically excluded in other studies, but were included here (n = 87 patients) because depression has been associated with treatment nonadherence (Benner et al., 2002; R. M. Carney et al., 1995; Ciechanowksi et al., 2000; Dowson et al., 2004; Luyster et al., 2009; Wagner et al., 2010). All health conditions were classified using the *International Classification of Diseases, 9th Revision* (ICD-9) or *10th Revision* (ICD-10) codes. A single patient could have multiple inpatient claims; 2,085 patients had more than one eligible

inpatient hospital claim, with mean 1.63 claims, standard deviation (SD) = 1.49. The analysis of diagnostic concordance was restricted to the first eligible inpatient hospital claim (n = 8,938 patients).

Among those with an eligible inpatient hospitalization (n = 8,938 patients), all outpatient claims that occurred between January 1, 2012 and December 31, 2015 were obtained. The dates, for inpatient and outpatient claim inclusion, were selected to allow adequate time to identify at least outpatient claim before the initial hospitalization. All patients had at least one outpatient claim before the initial hospitalization.

**Table 4.1 Inpatient primary diagnosis health conditions, ICD-9 and ICD-10 classifications**

| Health Condition | ICD-9 | ICD-10 |
|---|---|---|
| Acute myocardial infraction (AMI) | 410.00, 410.01, 410.1, 410.11, 410.2, 410.21, 410.3, 410.31, 410.4, 410.41, 410.5, 410.51, 410.6, 410.61, 410.7, 410.71, 410.8, 410.81, 410.9, 410.91 | I21.09, I21.11, I21.19, I21.29, I21.3, I21.4 |
| Chronic obstructive pulmonary disease (COPD) | 491, 491.1, 491.2, 491.21, 491.22, 491.8, 491.9, 492, 492.8, 496 | J41.0, J41.1, J42, J43.8, J43.9, J44.1, J44.9 |
| Heart failure (HF) | 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 428, 428.1, 428.2, 428.21, 428.22, 428.23, 428.3, 428.31, 428.32, 428.33, 428.4, 428.41, 428.42, 428.43, 428.9 | I11.0, I13.0, I13.2, I50.1, I50.20, I50.21, I50.22, I50.23, I50.30, I50.31, I50.32, I50.33, I50.40, I50.41, I50.42, I50.43, I50.9 |
| Pneumonia (PN) | 481, 485, 486, 480.0, 480.1, 480.2, 480.3, 480.8, 480.9, 482.0, 482.1, 482.2, 482.9, 483.0, 483.1, 483.8, 482.30, 482.31, 482.32, 482.39, 482.40, 482.41, 482.42, 482.49, 482.82, 482.83, 482.84, 482.89 | A48.1, J13 , J14, J15.0, J15.1, J15.20, J15.21, J15.29, J15.3, J15.4, J15.5, J15.6, J15.7, J15.8, J15.9, J16.0, J16.8, J18.0, J18.1, J18.9 |

*Depression Diagnosis*

Depression was classified using ICD-9 or ICD-10 in the inpatient and outpatient data using two approaches: 1) ICD-9 or ICD-10 diagnosis codes reported as the primary or secondary diagnosis during at least one outpatient claim prior to the initial hospitalization; and 2) ICD-9 or ICD-10 codes reported as a secondary diagnosis during the initial hospitalization. The classification of depression was consistent with the Diagnostic and Statistical Manual of mental disorders, Fifth edition (DSM-V) depressive disorders for major depressive disorder, persistent depressive disorder, other specified depressive disorder, and unspecified depressive disorder (Table 4.2) (American Psychiatric Association, 2013). The outcome of interest for this study was the depression diagnosis concordance between an outpatient depression diagnosis (primary or secondary diagnosis codes) recorded prior to the initial hospitalization and an inpatient depression diagnosis (secondary diagnosis codes) recorded during the initial hospitalization. Diagnostic concordance was defined as concordant-no depression; concordant-depression; not concordant-outpatient depression only; or not concordant-inpatient depression only.

**Table 4.2 Depression ICD-9 and ICD-10 classifications**

| Code | Description |
|---|---|
| ***ICD-9*** | |
| 296.2x | Depressive psychosis, mild, moderate, to severe with partial to full remission |
| 296.3x | Recurrent depressive psychosis, mild, moderate, to severe with partial to full remission |
| 296.82 | Atypical depressive disorder |
| 296.9, 296.99 | Other or unspecified episodic mood disorder |
| 298 | Other nonorganic psychoses |
| 300.4 | Dysthymic disorder |

| | |
|---|---|
| 301.12 | Chronic depressive personality disorder |
| 309 | Adjustment reaction |
| 311 | Depressive disorder, not elsewhere classified |
| 313.1 | Misery and unhappiness disorder |
| ***ICD-10*** | |
| F32.0x – 32.1x | Mild to moderate depressive episode, with or without somatic syndrome |
| F32.2 – F32.3 | Severe depressive episode with or without psychotic symptoms |
| F32.8, F32.9 | Other or unspecified depressive episodes |
| F33.0x | Recurrent depressive disorder, current episode mild, with or without somatic syndrome |
| F33.1x | Recurrent depressive disorder, current episode moderate, with or without somatic syndrome |
| F33.2 – F33.3 | Recurrent depressive disorder, current episode severe with or without psychotic symptoms |
| F33.4 | Recurrent depressive disorder, currently in remission |
| F33.8 | Other recurrent depressive disorders |
| F33.9 | Recurrent depressive disorder, unspecified |

*Additional Variables*

Variables used to describe the patient population included: age; sex; race/ethnicity (categorized as white, black, and other); comorbidities, and rural versus urban county of residence. The comorbidities were categorized using Elixhauser Comorbidity Index (version 3.7 for ICD-9 codes and version 1.1 for ICD-10 codes), which classifies 29 chronic health conditions; however, due to the overlap in our study's health conditions of interest, only 24 indicators were examined. Environmental-level data elements examined the rurality of the hospital and mental health centers. Rurality was defined according to the Office of Management and Budget's rural county classification (Ingram & Franco, 2002). The number of mental health facilities were categorized as one, two, and three or more mental health centers for each county based on the center's county served and the location of the mental health center.

*Missing Data*

Patients missing key variables of interest were excluded from the analysis (n = 317, 3.55%). The observations that were excluded from the analysis were not significantly different on age, sex, number of comorbidities, and inpatient or outpatient diagnosis of depression from included observations, but did differ in health condition (AMI, COPD, HF, or PN), race, rurality of the patient, rurality of the hospital, and the number of mental health centers (Table 4.3).

**Table 4.3 Characteristics of selected hospitalized patients by inclusion status, SC Medicaid administrative claims 2012 – 2015**

| | Included in analysis (n=8,621) | | Excluded from analysis (n=317) | | |
|---|---|---|---|---|---|
| Characteristics | n | % | N | % | *P* |
| Patient-level | | | | | |
| Age, years | | | | | |
| Mean ± SD | 67.2 ± 10.2 | | 66.6 ± 10.75 | | 0.2801 |
| Age, years | | | | | |
| 55 – 64 | 4,338 | 50.3 | 184 | 58.04 | 0.0152 |
| 65 – 74 | 2,272 | 26.4 | 64 | 20.19 | |
| 75 or older | 2,011 | 23.3 | 69 | 21.77 | |
| Sex | | | | | 0.8525 |
| Male | 3,192 | 37.0 | 119 | 37.54 | |
| Female | 5,429 | 63.0 | 198 | 62.46 | |
| Race/Ethnicity | | | | | <.0001 |
| White | 3,786 | 43.9 | 139 | 43.85 | |
| Black | 3,459 | 40.1 | 106 | 33.44 | |
| Other* | 9,997 | 16.0 | 369 | 16.4 | |
| Missing | - | 0.0 | 20 | 6.31 | |
| Residence | | | | | <.0001 |
| Urban | 5,969 | 69.2 | 195 | 61.51 | |
| Rural | 2,652 | 30.8 | 119 | 37.54 | |
| Missing | - | 0.0 | 3 | 0.95 | |
| Health | | | | | 0.0432 |
| AMI | 1,192 | 13.8 | 60 | 18.93 | |
| COPD | 2,729 | 31.7 | 88 | 27.76 | |

| | | | | | |
|---|---|---|---|---|---|
| HF | 2,549 | 29.6 | 98 | 30.91 | |
| PN | 2,151 | 25.0 | 71 | 22.4 | |
| Comorbidities[+] | | | | | 0.1853 |
| 0 | 1,360 | 15.8 | 60 | 15.78 | |
| 1 | 2,128 | 24.7 | 87 | 24.68 | |
| 2 | 2,562 | 29.7 | 82 | 29.72 | |
| 3 or more | 2,571 | 29.8 | 88 | 29.82 | |
| Depression diagnosis setting | | | | | |
| Inpatient | 589 | 6.8 | 19 | 5.99 | 0.5604 |
| Outpatient | 1,780 | 20.7 | 62 | 19.56 | 0.6378 |
| Environmental-level | | | | | |
| Inpatient rurality | | | | | <.0001 |
| Urban | 6,653 | 77.2 | 19 | 5.99 | |
| Rural | 1,968 | 22.8 | 4 | 1.26 | |
| Missing | - | 0.0 | 294 | 92.74 | |
| Mental health community centers | | | | | <.0001 |
| 1 | 2,163 | 25.1 | 25 | 7.89 | |
| 2 | 3,759 | 43.6 | 234 | 73.82 | |
| 3 or more | 2,699 | 31.3 | 55 | 17.35 | |
| Missing | - | 0.0 | 3 | 0.95 | |

[*]Other includes Hispanic and "Other"

[+] Elixahauser Comorbidity Index

AMI: Acute Myocardial Infarction; COPD: Chronic Obstructive Pulmonary Disease; HF: Heart Failure; PN: Pneumonia

*Analytic Approach*

Patient characteristics were described across depression status, inpatient and outpatient settings, and diagnostic concordance. Agreement between depression diagnosis recorded by inpatient secondary diagnosis codes and outpatient primary or secondary diagnosis codes were measured using Cohen's Kappa (κ)-statistic. The following interpretation of kappa for the agreement between inpatient and outpatient depression beyond chance was used: no agreement (κ ≤ 0), none to slight (κ = 0.01 – 0.20), fair (κ = 0.21 – 0.40), moderate (κ = 0.41 – 0.60), substantial (κ = 0.61 – 0.80), and

almost perfect agreement (κ = 0.81 – 1.00) (McHugh, 2012). Factors associated with diagnostic concordance were accessed in bivariate analysis using chi-square tests for categorical variables and multivariable analysis using log-binomial regression to produce risk ratios (RR). Statistical analyses for this study were performed using SAS statistical software version 9.4 (SAS Institute Inc., Cary, NC, USA).

**Results**

Health conditions associated with the initial hospitalization varied with COPD as the most common admitting diagnosis at 31.7%, followed by HF (29.6%), PN (25.0%), and AMI (13.8%). The patients included in the analysis had a mean age (SD) of 67.2 (10.22), were largely female (63.0%), residents of urban counties (69.2%), residents of counties that have at least two mental health centers (74.9%), and patients of urban county hospitals (77.2%). Most patients were white (43.9%) or black (40.1%), and most patients had at least one comorbidity (84.2%). Depression was identified in 6.8% (n = 589) of patients using inpatient secondary diagnosis codes and 20.7% (n = 1,780) of patients using primary or secondary outpatient diagnosis codes (Table 4.4).

**Table 4.4 Characteristics of selected hospitalized patients, SC Medicaid administrative claims 2012 – 2015 (n = 8,621)**

| Characteristics | n | % |
|---|---|---|
| Patient-level | | |
| Age, years | | |
| Mean ± SD | 67.2 ± 10.2 | |
| Age, years | | |
| 55 – 64 | 4,338 | 50.3 |
| 65 – 74 | 2,272 | 26.4 |
| 75 or older | 2,011 | 23.3 |
| Sex | | |

| | | |
|---|---|---|
| Male | 3,192 | 37.0 |
| Female | 5,429 | 63.0 |
| Race/Ethnicity | | |
| White | 3,786 | 43.9 |
| Black | 3,459 | 40.1 |
| Other* | 1,376 | 16.0 |
| Residence | | |
| Urban | 5,969 | 69.2 |
| Rural | 2,652 | 30.8 |
| Health | | |
| AMI | 1,192 | 13.8 |
| COPD | 2,729 | 31.7 |
| HF | 2,549 | 29.6 |
| PN | 2,151 | 25.0 |
| Comorbidities+ | | |
| 0 | 1,360 | 15.8 |
| 1 | 2,128 | 24.7 |
| 2 | 2,562 | 29.7 |
| 3 or more | 2,571 | 29.8 |
| Depression diagnosis setting | | |
| Inpatient | 589 | 6.8 |
| Outpatient, prior | 1,780 | 20.7 |
| Environmental-level | | |
| Inpatient rurality | | |
| Urban | 6,653 | 77.2 |
| Rural | 1,968 | 22.8 |
| Mental health community centers | | |
| 1 | 2,163 | 25.1 |
| 2 | 3,759 | 43.6 |
| 3 or more | 2,699 | 31.3 |

*Other includes Hispanic and "Other"
+ Elixahauser Comorbidity Index
SD: Standard deviation
AMI: Acute Myocardial Infarction; COPD: Chronic Obstructive Pulmonary Disease; HF: Heart Failure; PN: Pneumonia

Overall, patients with depression, detected in inpatient or outpatient claims, were younger, more likely to be female, white, had an initial hospitalization due to

COPD versus one of the other studied conditions, had more than one comorbidity, resided in an urban county, resided in a county with two mental health centers, and received care from a hospital within an urban county (Table 4.5). The likelihood of a depression diagnosis, regardless of setting in which depression was recorded, was significantly associated with all patient-level variables. Depression diagnosis and the number of mental health centers in the county the patient resides were significantly different. Hospital location (urban/rural) was significantly associated with diagnosis of depression in the outpatient setting; however, the relationship was not significant in the inpatient setting (Table 4.5).

*Diagnostic Concordance*

The agreement between the identification of depression by inpatient diagnosis and outpatient diagnosis codes was none to slight ($\kappa = 0.1227$, $P < 0.001$). Of the 589 patients identified with depression in inpatient records, 42.8% (n = 252) also were identified by prior outpatient records. Alternatively, of the 1,780 patients identified with depression by prior outpatient records, 14.2% (n = 252) were identified in inpatient records (data not shown).

Diagnostic concordance was significantly associated with all the patient characteristics studied. The hospital location (urban/rural) and the number of mental health centers were not significantly associated with diagnostic concordance (Table 4.6). Further, all patient and environmental-level variables were significantly associated with diagnostic concordance categories across source of diagnosis (Table 4.7).

**Table 4.5 Characteristics of selected hospitalized patients with and without a diagnosis of depression, by setting in which diagnosis was recorded, SC Medicaid administrative claims 2012 – 2015**

| Characteristics | Inpatient Diagnosis of Depression | | | | | Prior Outpatient Diagnosis of Depression | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No (n = 8,032) | | Yes (n = 589) | | *P* | No (n = 6,841) | | Yes (n = 1,780) | | *P* |
| | n | % | n | % | | n | % | n | % | |
| Patient-level | | | | | | | | | | |
| Age, years | | | | | | | | | | |
| Mean ± SD | 67.5 ± 10.3 | | 63.5 ± 7.8 | | | 68.1 ± 10.4 | | 63.7 ± 8.3 | | |
| Age, years | | | | | <.0001 | | | | | <.0001 |
| 55 – 64 | 3,942 | 49.1 | 396 | 67.2 | | 3,155 | 46.1 | 1,183 | 66.5 | |
| 65 – 74 | 2,144 | 26.7 | 128 | 21.7 | | 1,899 | 27.8 | 373 | 21.0 | |
| 75 or older | 1,946 | 24.2 | 65 | 11.0 | | 1,787 | 26.1 | 224 | 12.6 | |
| Sex | | | | | <.0001 | | | | | <.0001 |
| Male | 3,068 | 38.2 | 124 | 21.1 | | 2,762 | 40.4 | 430 | 24.2 | |
| Female | 4,964 | 61.8 | 465 | 79.0 | | 4,079 | 59.6 | 1,350 | 75.8 | |
| Race/Ethnicity | | | | | <.0001 | | | | | <.0001 |
| White | 3,410 | 42.5 | 376 | 63.8 | | 2,736 | 40.0 | 1,050 | 59.0 | |
| Black | 3,341 | 41.6 | 118 | 20.0 | | 3,008 | 44.0 | 451 | 25.3 | |
| Other | 1,281 | 16.0 | 95 | 16.1 | | 1,097 | 16.0 | 279 | 15.7 | |
| Residence | | | | | 0.0401 | | | | | <.0001 |
| Urban | 5,539 | 69.0 | 430 | 73.0 | | 4,668 | 68.2 | 1,301 | 73.1 | |
| Rural | 2,493 | 31.0 | 159 | 27.0 | | 2,173 | 31.8 | 479 | 26.9 | |
| Health | | | | | <.0001 | | | | | <.0001 |
| AMI | 1,145 | 14.3 | 47 | 8.0 | | 989 | 14.5 | 203 | 11.4 | |
| COPD | 2,396 | 29.8 | 333 | 56.5 | | 1,965 | 28.7 | 764 | 42.9 | |
| HF | 2,481 | 30.9 | 68 | 11.5 | | 2,202 | 32.2 | 347 | 19.5 | |
| PN | 2,010 | 25.0 | 141 | 23.9 | | 1,685 | 24.6 | 466 | 26.2 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Comorbidities | | | | | <.0001 | | | | | 0.0248 |
| 0 | 1,223 | 15.2 | 137 | 23.3 | | 1,039 | 15.2 | 321 | 18.0 | |
| 1 | 1,956 | 24.4 | 172 | 29.2 | | 1,689 | 24.7 | 439 | 24.7 | |
| 2 | 2,386 | 29.7 | 176 | 29.9 | | 2,046 | 29.9 | 516 | 29.0 | |
| 3 or more | 2,467 | 30.7 | 104 | 17.7 | | 2,067 | 30.2 | 504 | 28.3 | |
| 30-day Readmission | 438 | 5.5 | 28 | 4.8 | 0.4687 | 329 | 4.8 | 137 | 7.7 | <.0001 |
| Environmental-level | | | | | | | | | | |
| Inpatient rurality | | | | | 0.7959 | | | | | 0.0106 |
| Urban | 6,201 | 77.2 | 452 | 76.7 | | 5,239 | 76.6 | 1,414 | 79.4 | |
| Rural | 1,831 | 22.8 | 137 | 23.3 | | 1,602 | 23.4 | 366 | 20.6 | |
| Mental health community centers | | | | | 0.0123 | | | | | 0.0138 |
| 1 | 1,987 | 24.7 | 176 | 29.9 | | 1,702 | 24.9 | 461 | 25.9 | |
| 2 | 3,529 | 43.9 | 230 | 39.1 | | 3,036 | 44.4 | 723 | 40.6 | |
| 3 or more | 2,516 | 31.3 | 183 | 31.1 | | 2,103 | 30.7 | 596 | 33.5 | |

[*]Other includes Hispanics and "Other"

[+] Elixahauser Comorbidity Index

AMI: Acute Myocardial Infarction; COPD: Chronic Obstructive Pulmonary Disease; HF: Heart Failure; PN: Pneumonia

**Table 4.6 Proportion of selected hospitalized patients with diagnostic concordance, SC Medicaid administrative claims 2012 – 2015 (n = 8,621)**

| Characteristics | n | % | *P* |
|---|---|---|---|
| Patient-level | | | |
| Age, years | | | |
| Mean ± SD | 68.1 ± 10.4 | | <.0001 |
| Age, years | | | <.0001 |
| 55 – 64 | 3,127 | 72.1 | |
| 65 – 74 | 1,869 | 82.3 | |
| 75 or older | 1,760 | 87.5 | |
| Sex | | | <.0001 |
| Male | 2,720 | 85.2 | |
| Female | 4,036 | 74.3 | |
| Race/Ethnicity | | | <.0001 |
| White | 2,688 | 71.0 | |
| Black | 2,996 | 86.6 | |
| Other | 1,072 | 77.9 | |
| Residence | | | |
| Urban | 4,626 | 77.5 | |
| Rural | 2,130 | 80.3 | |
| Health | | | <.0001 |
| AMI | 982 | 82.4 | |
| COPD | 1,924 | 70.5 | |
| HF | 2,180 | 85.5 | |
| PN | 1,670 | 77.6 | |
| Comorbidities | | | 0.0447 |
| 0 | 1,032 | 75.9 | |
| 1 | 1,671 | 78.5 | |
| 2 | 2,002 | 78.1 | |
| 3 or more | 2,051 | 79.8 | |
| Environmental-level | | | |
| Inpatient rurality | | | 0.2968 |
| Urban | 5,197 | 78.1 | |
| Rural | 1,559 | 79.2 | |
| Mental health community centers | | | 0.1203 |
| 1 | 1,694 | 78.3 | |
| 2 | 2,980 | 79.3 | |
| 3 or more | 2,082 | 77.1 | |

*Other includes Hispanics and "Other"

[+] Elixahauser Comorbidity Index
SD: Standard deviation
AMI: Acute Myocardial Infarction; COPD: Chronic Obstructive Pulmonary Disease; HF: Heart Failure; PN: Pneumonia

The relationship between diagnostic concordance and all patient-level variables were significant ($p < 0.05$) in bivariate analysis. All patient- and environmental-level variables were included in the multivariable analysis. The unadjusted and adjusted risk ratios for diagnostic concordance were similar. However, patient residence (urban/rural) was no longer significant in the adjusted analysis. Older adults, women, and minorities were less likely to have diagnostic concordance compared to their reference groups, youngest adults, men, and white, respectively. Patients with COPD, HF, and PN had significantly greater likelihood of diagnostic concordance than patients with AMI. The environmental-level variables were not significant in the adjusted analysis (Table 4.8).

**Discussion**

Only 14.2% of patients with a depression diagnosis in the outpatient setting had depression recorded in their inpatient administrative claims. This study examined the agreement between depression as identified using inpatient secondary diagnosis codes and prior outpatient primary and secondary diagnosis codes for patients initially admitted to the hospital for AMI, COPD, HF, or PN. Older adults, men, and minorities were less likely to experience diagnostic concordance than their respective comparison groups.

**Table 4.7 Characteristics of selected hospitalized patients with or without a diagnosis of depression in the inpatient or outpatient setting, by diagnostic concordance, SC Medicaid administrative claims 2012 – 2015**

| | Concordant | | | | Discordant | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No depression (n=6,504) | | Depression (n=252) | | Outpatient only (n = 1,528) | | Inpatient only (n = 337) | | |
| Characteristics | n | % | n | % | n | % | n | % | *P* |
| Patient-level | | | | | | | | | |
| Age, years | | | | | | | | | |
| Mean ± SD | 68 | 10.5 | 62 | 7.2 | 64 | 8.4 | 64 | 8.2 | <.0001 |
| Age, years | | | | | | | | | <.0001 |
| 55 – 64 | 2943 | 67.8 | 184 | 4.2 | 999 | 23.0 | 212 | 4.9 | |
| 65 – 74 | 1820 | 80.1 | 49 | 2.2 | 324 | 14.3 | 79 | 3.5 | |
| 75 or older | 1741 | 86.6 | 19 | 0.9 | 205 | 10.2 | 46 | 2.3 | |
| Sex | | | | | | | | | <.0001 |
| Male | 2679 | 83.9 | 41 | 1.3 | 389 | 12.2 | 83 | 2.6 | |
| Female | 3825 | 70.5 | 211 | 3.9 | 1139 | 21.0 | 254 | 4.7 | |
| Race/Ethnicity | | | | | | | | | <.0001 |
| White | 2524 | 66.7 | 164 | 4.3 | 886 | 23.4 | 212 | 5.6 | |
| Black | 2943 | 85.1 | 53 | 1.5 | 398 | 11.5 | 65 | 1.9 | |
| Residence | | | | | | | | | 0.0004 |
| Urban | 4432 | 74.3 | 194 | 3.3 | 1107 | 18.6 | 236 | 4.0 | |
| Rural | 2072 | 78.1 | 58 | 2.2 | 421 | 15.9 | 101 | 3.8 | |
| Health | | | | | | | | | <.0001 |
| AMI | 962 | 80.7 | 20 | 1.7 | 183 | 15.4 | 27 | 2.3 | |
| COPD | 1778 | 65.2 | 146 | 5.4 | 618 | 22.7 | 187 | 6.9 | |
| HF | 2157 | 84.6 | 23 | 0.9 | 324 | 12.7 | 45 | 1.8 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| PN | 1607 | 74.7 | 63 | 2.9 | 403 | 18.7 | 78 | 3.6 | |
| Comorbidities | | | | | | | | | <.0001 |
| 0 | 967 | 71.1 | 65 | 4.8 | 256 | 18.8 | 72 | 5.3 | |
| 1 | 1594 | 74.9 | 77 | 3.6 | 362 | 17.0 | 95 | 4.5 | |
| 2 | 1936 | 75.6 | 66 | 2.6 | 450 | 17.6 | 110 | 4.3 | |
| 3 or more | 2007 | 78.1 | 44 | 1.7 | 460 | 17.9 | 60 | 2.3 | |
| Environmental-level | | | | | | | | | |
| Inpatient rurality | | | | | | | | | 0.0253 |
| Urban | 4992 | 75.0 | 205 | 3.1 | 1209 | 18.2 | 247 | 3.7 | |
| Rural | 1512 | 76.8 | 47 | 2.4 | 319 | 16.2 | 90 | 4.6 | |
| Mental health community centers | | | | | | | | | 0.0044 |
| 1 | 1610 | 74.4 | 84 | 3.9 | 377 | 17.4 | 92 | 4.3 | |
| 2 | 2893 | 77.0 | 87 | 2.3 | 636 | 16.9 | 143 | 3.8 | |
| 3 or more | 2001 | 74.1 | 81 | 3.0 | 515 | 19.1 | 102 | 3.8 | |

[*]Other includes Hispanics and "Other"

[+] Elixahauser Comorbidity Index

SD: Standard deviation

AMI: Acute Myocardial Infarction; COPD: Chronic Obstructive Pulmonary Disease; HF: Heart Failure; PN: Pneumonia



**Table 4.8 Relative risk (unadjusted and adjusted) for diagnostic concordance between inpatient and outpatient settings among selected hospitalized patients, SC Medicaid administrative claims 2012 – 2015 (n = 8,621)**

| | Unadjusted | | | Adjusted | | |
|---|---|---|---|---|---|---|
| Characteristics | RR | 95% CI | *P* | RR | 95% CI | *P* |
| Patient-level | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Age, years | | | | | | | | | | |
| 55 – 64 (ref) | -- | -- | | -- | -- | -- | -- | | -- | -- |
| 65 – 74 | 1.06 | 1.04 | – | 1.09 | <.0001 | 1.02 | 1.01 | – | 1.04 | 0.0072 |
| 75 or older | 0.88 | 0.85 | – | 0.90 | <.0001 | 0.93 | 0.91 | – | 0.95 | <.0001 |
| Sex | | | | | | | | | | |
| Male | 1.15 | 1.12 | – | 1.17 | <.0001 | 1.08 | 1.06 | – | 1.10 | <.0001 |
| Female (ref) | -- | -- | | -- | -- | -- | -- | | -- | -- |
| Race/Ethnicity | | | | | | | | | | |
| White (ref) | -- | -- | | -- | -- | -- | -- | | -- | -- |
| Black | 0.90 | 0.87 | – | 0.93 | <.0001 | 0.97 | 0.94 | – | 0.99 | 0.0038 |
| Other* | 0.82 | 0.80 | – | 0.84 | <.0001 | 0.92 | 0.90 | – | 0.93 | <.0001 |
| Residence | | | | | | | | | | |
| Urban (ref) | -- | -- | | -- | -- | -- | -- | | -- | -- |
| Rural | 0.96 | 0.94 | – | 0.99 | 0.0027 | 1.00 | 0.98 | – | 1.02 | 0.8233 |
| Health | | | | | | | | | | |
| AMI (ref) | -- | -- | | -- | -- | -- | -- | | -- | -- |
| COPD | 1.21 | 1.18 | – | 1.25 | <.0001 | 1.07 | 1.04 | – | 1.09 | <.0001 |
| HF | 1.10 | 1.07 | – | 1.14 | <.0001 | 1.03 | 1.01 | – | 1.06 | 0.0069 |
| PN | 1.17 | 1.13 | – | 1.21 | <.0001 | 1.05 | 1.03 | – | 1.08 | <.0001 |
| Comorbidities+ | | | | | | | | | | |
| 0 (ref) | -- | -- | | -- | -- | -- | -- | | -- | -- |
| 1 | 1.00 | 0.97 | – | 1.03 | 0.7515 | 0.99 | 0.97 | – | 1.01 | 0.4099 |
| 2 | 1.02 | 0.99 | – | 1.05 | 0.2947 | 1.00 | 0.98 | – | 1.02 | 0.7711 |
| 3 or more | 0.97 | 0.93 | – | 1.00 | 0.0721 | 0.99 | 0.97 | – | 1.01 | 0.3831 |
| Environmental-level | | | | | | | | | | |
| Inpatient rurality | | | | | | | | | | |
| Urban (ref) | -- | -- | | -- | -- | -- | -- | | -- | -- |
| Rural | 0.99 | 0.96 | – | 1.01 | 0.2900 | 1.00 | 0.98 | – | 1.02 | 0.7751 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Mental health community centers | | | | | | | | | | |
| 1 | 1.01 | 0.98 | – | 1.04 | 0.3864 | 1.00 | 0.98 | – | 1.02 | 0.8170 |
| 2 | 0.99 | 0.96 | – | 1.02 | 0.3259 | 0.99 | 0.97 | – | 1.01 | 0.4154 |
| 3 or more (ref) | -- | -- | | -- | -- | -- | -- | | -- | -- |

*Other includes Hispanic and "Other"

+ Elixahauser Comorbidity Index

RR: Relative risk

AMI: Acute Myocardial Infarction; COPD: Chronic Obstructive Pulmonary Disease; HF: Heart Failure; PN: Pneumonia

Ref: Reference group

The agreement between depression recorded in the inpatient and outpatient setting has been rarely explored. However, the results of this study were consistent with a similar study that examined the agreement of depression diagnosis using Veteran Affairs data sources with depression recorded in 5% and 15.1% of inpatient and outpatient data, respectively (Abrams et al., 2009). Our study provides evidence that improvement is needed by hospital personnel to better record a depression diagnosis for patients with a history of depression during their initial hospitalization.

Depression has been examined as a risk factor for hospital outcomes, such as a readmission after an initial hospitalization. The proportion of depression detected using inpatient diagnoses codes in this study (6.8%) was far less than the rates of depression detected in other depression and readmission studies regardless of the depression classification tool. Among studies that have examined older adults and the relationship between depression and hospital readmission, the rates of depression ranged from 16% to 33% in studies using depressive symptom indexes (Albrecht et al., 2014; Barnett et al., 2015; Berges, 2015; Fulop et al., 2003; Ketterer et al., 2014; Peterson et al., 2002; Smolderen et al., 2009), 20% to 24% in clinical interviews (Fulop et al., 2003; Sheeran et al., 2010), 7% to 37% using diagnostic codes from inpatient medical records (Kociol et al., 2010; Marcantonio et al., 1999; Silverstein et al., 2008; Watson et al., 2011), and 13% to 43% using diagnostic codes from administrative claims (Chen et al., 2015; Keenan et al., 2008; Mather et al., 2014; Singh et al., 2016).

Being readmitted to the hospital after a discharge is a major negative hospital outcome. To fight this, CMS has implemented the Hospital Readmission Reduction

Program that penalizes hospitals for excessive readmissions within 30 days after a discharge (Medicare Payment Advisory Commission, 2013). Hospital readmission reduction programs have been successful at reducing hospital readmission among high-risk patients (Coleman et al., 2006; Jack et al., 2009; M. Naylor et al., 1994; M D Naylor et al., 1999; Mary D Naylor et al., 2004). Given depression has been associated with hospital readmissions, patients with depression are considered a high-risk population and targeted by such programs. To maximize the effectiveness of hospital readmission reduction programs, all high-risk patients should be identified and targeted. However, such programs may be missing a large number of high-risk patients because depression may not recorded during the initial hospitalization according this the results of this study.

Depression is prevalent among patients with chronic illnesses, such as AMI or HF with depression rates ranging from 20% to nearly 40% of the study's population (Lesman-Leegte et al., 2009; Reynolds et al., 2015; Rutledge, Reis, Linke, Greenberg, & Mills, 2006). Patients with depression have been associated with greater nonadherence to medical treatment (Benner et al., 2002; R. M. Carney et al., 1995; Ciechanowksi et al., 2000; Dowson et al., 2004; Luyster et al., 2009; Wagner et al., 2010). Therefore, it would be beneficial for patients to be screened for depression before being discharged from a hospital. Inpatient depression screening could detect newly developed depression or may identify patients with a history of depression. As a result, inpatient depression screening could detect an increased number of patients with depression during the hospitalization.

Depression may be underdiagnosed in both the inpatient and outpatient settings due to depressive symptoms that may be confused with other health conditions or depressive symptoms that fails to meet diagnostic criteria of clinical depression (Allan, Valkanova, & Ebmeier, 2014; Morichi et al., 2015; Mulsant & Ganguli, 1999). Furthermore, inpatient depression recorded in a patient's medical record may indicate newly diagnosed depression that occurred during the hospitalization, the patients' voluntary disclosure of depression diagnosis at the time of hospitalization, or review of patients' medical history by hospital staff. One study found that 33% of patients with psychosocial problems, such as depression, present within two weeks before an office visit with a primary care physician, did not disclose their psychosocial problems (Robinson, 1999). Our study is unable to examine depression diagnosis by physician specialty; however, depression recognition by non-psychiatrist physicians has been low (Cepoiu et al., 2008). In SC, 48% of office-based physicians reported use of a basic electronic medical system, which includes the ability to track patient demographics, patient health conditions, patient medications, and physician clinical notes (Jamoom & Yang, 2016). The proportion of hospitals that have the ability to link to outpatient data would vary by county and health care system, and might have contributed to the low diagnostic concordance found in this study. This research study highlights a need to improve depression diagnosis detection in both the inpatient and outpatient settings. Implementing electronic medical records across inpatient and outpatient settings has the potential to improve depression concordance.

**Limitations**

It is important to acknowledge several limitations of this study. First, these findings are restricted to SC Medicaid recipients. According to county-health rankings, SC is ranked poorly in terms of health (University of Wisconsin Population Health Institute, 2017) and the results of this study may not be generalizable to other states. Furthermore, Medicaid recipients may experience more poor health outcomes. In addition, the study's higher proportion of female patients and younger patient population (55 – 64 years) may also affect the generalizability of these findings.

This study was unable to examine the possible clustering of patients from inpatient or outpatient facilities. The number of mental health centers within each county may not have been an accurate measure for mental health capacity. This study may have under underestimated depression because we excluded the following depression-related DSM-V categories: substance/medication-induced depressive disorder and depressive disorder due to another medical condition. Lastly, the use of diagnosis codes in administrative claims data may vary across health conditions. Administrative claims data were not designed to facilitate health services research; however, claims-based analyses have a high level of agreement to analyses prepared using medical record data (Krumholz et al., 2011).

**Conclusions**

With the growing proportion of older adults in America (U.S. Census Bureau, 2014), the health care system should be prepared for the increasing number of older

adults with depression. In addition, comorbid depression may increase the older adult's risk of other psychiatric disorders, which could worsen their depression and worsen long-term disability (Devanand, 2002; Lenze et al., 2001). This research highlights the need for greater depression detection and concordance between inpatient and outpatient settings. Depression diagnosis concordance is particularly needed among the oldest adults, men, and minorities.

# CHAPTER 5

# MANUSCRIPT TWO

## ASSOCIATION BETWEEN CONCORDANCE IN THE INPATIENT AND OUTPATIENT DIAGNOSIS OF DEPRESSION AND 30-DAY HOSPTIAL READMISSION FOR ACUTE MYOCARDIAL INFARCTION, CHRONIC OBSTRUCTIVE PULMONARY DISEASE, HEART FAILURE, AND PNEMONIA AMONG OLDER ADULTS WITH MEDICAID[1]

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[1] Jones KM, Probst JC, McKinney SH, Crouch EL, and Hardin JW. To be submitted to *Chronic Illness*

**Abstract**

*Purpose*

Depression has been associated with an increased risk of a 30-day readmission in prior studies. The purpose of this study was to determine if the relationship between depression and 30-day readmission varied by setting of depression diagnosis (inpatient verses outpatient) and by depression diagnostic concordance between the two settings.

*Methods*

We examined diagnostic concordance between inpatient and outpatient administrative claims data for South Carolina residents. The analysis was restricted to patients 55 years of age and older with Medicaid as the primary payer of services with an admitting primary diagnosis of acute myocardial infraction (AMI), chronic obstructive pulmonary disease (COPD), heart failure (HF), and pneumonia (PN) during 2013 – 2015 (n = 8,621 patients). Diagnostic concordance was determined by comparing depression diagnosed in inpatient records using secondary diagnosis codes and depression diagnosed in outpatient records using primary or secondary diagnosis codes, yielding four categories: concordant-no depression, concordant-depression, not concordant-inpatient only, and not concordant-outpatient only. The relationship between diagnostic concordance and 30-day readmission was modeled using log-binomial regression.

*Results*

The level of agreement between inpatient and outpatient diagnosis of depression was poor. The risk of 30-day readmission was significantly associated with a history of depression (outpatient depression only), but not for patients with depression recorded

in inpatient data. Patients with outpatient depression only had a 30-day readmission rate of 8.1%, adjusted relative risk, 1.42 (p = 0.001). Patients with depression diagnostic concordance had lower 30-day readmission rates, but not statistically significant.

*Conclusions*

Patients may be at a greater risk of a 30-day readmission when a history of depression was not detected during a hospitalization. This study highlights a major disparity among patients with a history of depression that was not recorded during a hospitalization. Improving diagnostic concordance for depression may reduce untimely hospital readmissions.

**Keywords**: depression, concordance, readmission

**Introduction**

The health care system in the U.S. is fragmented and has contributed to increased health care spending (Berwick, Nolan, & Whittington, 2008). Enhanced care coordination could reduce adverse medical events, duplication of diagnostic tests, emergency department utilization, and unplanned hospital readmissions (Breslin et al., 2014; Cerullo et al., 2016; Farrell et al., 2015; Hearld & Alexander, 2012; Mosher, 2014). Reducing the costs associated with poor or lack of care coordination could save Medicare and Medicaid billions per year (Owens, 2010).

One out of five Medicare beneficiaries will be readmitted within 30 days after a hospitalization (Gerhardt et al., 2013). Depression is a common comorbidity among hospitalizations, particularly for older adults (Al Aqqad et al., 2016; Frasure-Smith et al.,

2000; Fulop et al., 2003; Horold G. Koenig, 1998; Lesman-Leegte et al., 2009; Ng et al., 2007; Papaioannou et al., 2013). Unplanned readmissions can lead to billions in hospital costs (Hines et al., 2014). Targeting risk factors associated with 30-day readmission, such as depression, could reduce untimely readmissions.

Research exploring the relationship between depression and 30-day readmission among older adults has been mixed, with some studies showing increased readmission among patients with depression (Barnett et al., 2015; Berges, 2015; Chen et al., 2015; Ketterer et al., 2014; Marcantonio et al., 1999; Mather et al., 2014; Singh et al., 2016; Watson et al., 2011), while other studies have failed to find a significant relationship (Albrecht et al., 2014; Keenan et al., 2008; Ketterer et al., 2014; Mather et al., 2014; McManus et al., 2015; Silverstein et al., 2008). Differences in depression classification (clinical interviews, depressive symptom index using patient responses, or diagnostic codes obtained from patients' medical or administrative claim records), or the setting in which depression was detected (inpatient or outpatient) may partially explain mixed results.

Prior studies have relied upon depression detected during the initial hospitalization. Low depression diagnosis concordance was observed between depression detected during a clinical interview and depressive symptom index (Fulop et al., 2003). Furthermore, differences in depression diagnosis detected between inpatient and outpatient settings affected the significance of the relationship between depression and select clinical procedures; the study found low diagnostic concordance between inpatient and outpatient settings (Abrams et al., 2009).

This study examined administrative claims data for South Carolina (SC) residents admitted to the hospital for select health conditions to investigate two aims: 1) determine the relationship between depression and 30-day readmission; and 2) determine the relationship between diagnostic concordance categories, concordant-no depression; concordant-depression; not concordant-inpatient only; and not concordant-outpatient only, and 30-day readmission.

## Methodology

### *Data Sources*

Inpatient and outpatient administrative claims data were obtained from the SC Revenue and Fiscal Affairs Office (RFAO) for select SC residents with Medicaid. The SC RFAO warehouses Medicaid administrative claims data from all state health care practitioners, including the Department of Mental Health (DMH) and private health care providers delivering inpatient and select outpatient services. The RFAO also contains discharge claims data for 100% of hospitalizations, regardless of payer; thus, Medicare-funded hospitalizations are included (South Carolina Revenue of Fiscal Affairs Office, n.d.).

### *Study Sample*

All health conditions of interest for this study were classified using the *International Classification of Diseases, 9th Revision* (ICD-9) or *10th Revision* (ICD-10) codes. The sample was restricted to Medicaid recipients aged 55 years and older who experienced an inpatient hospitalization with a primary diagnosis of acute myocardial

infarction (AMI), chronic obstructive pulmonary disease (COPD), heart failure (HF), and pneumonia (PN) (Table 5.1) between January 1, 2013 and December 31, 2015. Among patients with an eligible inpatient stay (n = 8,938 patients), all outpatient claims that occurred between January 1, 2012 and December 30, 2015 were obtained. The dates for inpatient and outpatient claim inclusion were selected to allow adequate time to identify at least one outpatient claim before the initial hospital admission and to classify the study variables. All patients had at least one outpatient visit before the initial hospitalization.

**Table 5.1 Inpatient primary diagnosis health conditions, ICD-9 and ICD-10 classifications**

| Health Condition | ICD-9 | ICD-10 |
|---|---|---|
| Acute myocardial infraction (AMI) | 410.00, 410.01, 410.1, 410.11, 410.2, 410.21, 410.3, 410.31, 410.4, 410.41, 410.5, 410.51, 410.6, 410.61, 410.7, 410.71, 410.8, 410.81, 410.9, 410.91 | I21.09, I21.11, I21.19, I21.29, I21.3, I21.4 |
| Chronic obstructive pulmonary disease (COPD) | 491, 491.1, 491.2, 491.21, 491.22, 491.8, 491.9, 492, 492.8, 496 | J41.0, J41.1, J42, J43.8, J43.9, J44.1, J44.9 |
| Heart failure (HF) | 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 428, 428.1, 428.2, 428.21, 428.22, 428.23, 428.3, 428.31, 428.32, 428.33, 428.4, 428.41, 428.42, 428.43, 428.9 | I11.0, I13.0, I13.2, I50.1, I50.20, I50.21, I50.22, I50.23, I50.30, I50.31, I50.32, I50.33, I50.40, I50.41, I50.42, I50.43, I50.9 |
| Pneumonia (PN) | 481, 485, 486, 480.0, 480.1, 480.2, 480.3, 480.8, 480.9, 482.0, 482.1, 482.2, 482.9, 483.0, 483.1, 483.8, 482.30, 482.31, 482.32, 482.39, 482.40, 482.41, 482.42, 482.49, 482.82, 482.83, 482.84, 482.89 | A48.1, J13 , J14, J15.0, J15.1, J15.20, J15.21, J15.29, J15.3, J15.4, J15.5, J15.6, J15.7, J15.8, J15.9, J16.0, J16.8, J18.0, J18.1, J18.9 |

*Dependent variable: 30-day Readmission*

An index admission was defined as an initial hospital stay among the selected health conditions were the patient was discharged to home, self-care, or discharged

against medical advice (n = 12,663 claims, n = 8,938 patients). Patients who were discharged against medical advice were included in the analysis (n = 87 patients) because depression has been associated with treatment nonadherence (Benner et al., 2002; R. M. Carney et al., 1995; Ciechanowksi et al., 2000; Dowson et al., 2004; Luyster et al., 2009; Wagner et al., 2010). A single patient could have more than one index admission claim; 2,085 patients had more than one eligible index admission, with mean 1.63 claims, standard deviation (SD) = 1.49. The analysis was restricted to the first eligible index admission claim (n = 8,938 patients).

A readmission was defined as a hospitalization within 30 days of the index admission. Patients who were still a patient at the time of the claim or who were discharged to law enforcement were excluded from the analysis. Planned readmissions, that is, hospitalizations part of the patients' treatment plan such as rehabilitation, treatment of cancer, or organ transplant, were excluded. An admission cannot be both an index and a readmission. Among patients with a readmission, patients had mean 1.25 (SD = 0.54) eligible readmission claims within 30 days of an index admission. Only the first readmission within 30 days was included in the analysis. The dependent variable for this study was an eligible readmission that occurred within 30 days of an eligible index admission.

*Independent Variable: Diagnostic Concordance*

Depression was classified according to the following depressive disorders using the Diagnostic and Statistical Manual of mental disorders, Fifth edition (DSM-V): major depressive disorder, persistent depressive disorder, other specified depressive disorder,

and unspecified depressive disorder (Table 5.2) (American Psychiatric Association, 2013). Outpatient depression was classified if at least one outpatient claim reported depression as a primary or secondary diagnosis prior to the index admission. Inpatient depression was classified if depression was reported as a secondary diagnosis during the index admission. The independent variable for this study was the depression diagnosis concordance, classified into the following four mutually exclusive categories: concordant-no depression; concordant-depression; not concordant-inpatient only; and not concordant-outpatient only.

**Table 5.2 Depression ICD-9 and ICD-10 classifications**

| Code | Description |
|---|---|
| ***ICD-9*** | |
| 296.2x | Depressive psychosis, mild, moderate, to severe with partial to full remission |
| 296.3x | Recurrent depressive psychosis, mild, moderate, to severe with partial to full remission |
| 296.82 | Atypical depressive disorder |
| 296.9, 296.99 | Other or unspecified episodic mood disorder |
| 298 | Other nonorganic psychoses |
| 300.4 | Dysthymic disorder |
| 301.12 | Chronic depressive personality disorder |
| 309 | Adjustment reaction |
| 311 | Depressive disorder, not elsewhere classified |
| 313.1 | Misery and unhappiness disorder |
| ***ICD-10*** | |
| F32.0x – 32.1x | Mild to moderate depressive episode, with or without somatic syndrome |
| F32.2 – F32.3 | Severe depressive episode with or without psychotic symptoms |
| F32.8, F32.9 | Other or unspecified depressive episodes |
| F33.0x | Recurrent depressive disorder, current episode mild, with or without somatic syndrome |
| F33.1x | Recurrent depressive disorder, current episode moderate, with or without somatic syndrome |
| F33.2 – F33.3 | Recurrent depressive disorder, current episode severe with or without psychotic symptoms |
| F33.4 | Recurrent depressive disorder, currently in remission |
| F33.8 | Other recurrent depressive disorders |
| F33.9 | Recurrent depressive disorder, unspecified |

*Control Variables*

Control variables were derived from the index admission claim. Patient-level variables included age, sex, race/ethnicity, comorbidities, hospital length of stay, and the patient's residence (Andersen, 1995). Age was categorized as 55 – 64, 64 – 74, or 75 and older; race/ethnicity was categorized as white, black, or other (Hispanic and other race not specified). The number of comorbidities was based on the primary and secondary diagnosis codes and classified using the Elixhauser Comorbidity Index (version 3.7 for ICD-9 codes and version 1.1 for ICD-10 codes). The Elixhauser Comorbidity Index creates indicators for 29 chronic health conditions, but due to the overlap in our study's health conditions of interest, only 24 indicators were categorized. The number of comorbidities was categorized as none, one, two, or three or more. Hospital length of stay was classified as 1 – 3, 4 – 6, or 7 or more days. Patient residence was classified as urban or rural according to the Office of Management and Budget's (OMB) rural county classification (Ingram & Franco, 2002).

*Missing Data*

Patients missing the outcome of interest and any control variables were excluded from the analysis (n = 317, 3.6%). The proportion of excluded observations with a 30-day readmission was significantly different from observations included in the analysis. Excluded observations were not significantly different on diagnostic concordance, inpatient or outpatient diagnosis of depression, mean age, sex, number of comorbidities, and length of hospital stay from included observations, but did differ in

health condition (AMI, COPD, HF, and PN) and patient residence (urban/rural) (Table 5.3).

**Table 5.3 Characteristics of selected hospitalized patients by inclusion and exclusion into study, SC Medicaid administrative claims 2012 – 2015**

| | Included in analysis (n=8,621) | | Excluded from analysis (n=317) | | |
|---|---|---|---|---|---|
| Characteristics | n | % | n | % | *P* |
| 30-day readmission | 466 | 5.4 | 26 | 8.2 | 0.0320 |
| Depression diagnosis setting | | | | | |
| Inpatient | 589 | 6.8 | 19 | 5.99 | 0.5604 |
| Outpatient, prior | 1,780 | 20.7 | 62 | 19.56 | 0.6378 |
| Diagnostic concordance | | | | | 0.7563 |
| Concordant, no depression | 6,504 | 75.4 | 242 | 76.3 | |
| Concordant, depression | 252 | 2.9 | 6 | 1.9 | |
| Non-concordant, inpatient only | 337 | 3.9 | 13 | 4.1 | |
| Non-concordant, outpatient only | 1,528 | 17.7 | 56 | 17.7 | |
| *Covariates* | | | | | |
| Age, years | | | | | |
| Mean ± SD | 67.2 ± 10.2 | | 66.6 ± 10.75 | | 0.2801 |
| Age, years | | | | | |
| 55 – 64 | 4,338 | 50.3 | 184 | 58.04 | 0.0152 |
| 65 – 74 | 2,272 | 26.4 | 64 | 20.19 | |
| 75 or older | 2,011 | 23.3 | 69 | 21.77 | |
| Sex | | | | | 0.8525 |
| Male | 3,192 | 37.0 | 119 | 37.54 | |
| Female | 5,429 | 63.0 | 198 | 62.46 | |
| Race/Ethnicity | | | | | <.0001 |
| White | 3,786 | 43.9 | 139 | 43.85 | |
| Black | 3,459 | 40.1 | 106 | 33.44 | |
| Other* | 9,997 | 16.0 | 369 | 16.4 | |
| Missing | - | 0.0 | 20 | 6.31 | |
| Residence | | | | | <.0001 |
| Urban | 5,969 | 69.2 | 195 | 61.51 | |
| Rural | 2,652 | 30.8 | 119 | 37.54 | |
| Missing | - | 0.0 | 3 | 0.95 | |
| Admitting diagnosis | | | | | 0.0432 |
| AMI | 1,192 | 13.8 | 60 | 18.93 | |
| COPD | 2,729 | 31.7 | 88 | 27.76 | |
| HF | 2,549 | 29.6 | 98 | 30.91 | |

| | | | | | |
|---|---|---|---|---|---|
| PN | 2,151 | 25.0 | 71 | 22.4 | |
| Comorbidities[+] | | | | | 0.1853 |
| 0 | 1,360 | 15.8 | 60 | 15.78 | |
| 1 | 2,128 | 24.7 | 87 | 24.68 | |
| 2 | 2,562 | 29.7 | 82 | 29.72 | |
| 3 or more | 2,571 | 29.8 | 88 | 29.82 | |
| Length of stay, Index hospitalization | | | | | |
| Mean ± SD | 4.8 ± 4.2 | | 4.9 ± 4.2 | | 0.7530 |
| Length of stay, Index hospitalization, days | | | | | 0.3897 |
| 1 – 3 | 3,866 | 44.8 | 146 | 46.06 | |
| 4 – 6 | 3,043 | 35.3 | 101 | 31.86 | |
| 7 or more | 1,712 | 19.9 | 70 | 22.08 | |

[*]Other includes Hispanic and "Other"

[+] Elixahauser Comorbidity Index

AMI: Acute Myocardial Infarction; COPD: Chronic Obstructive Pulmonary Disease; HF: Heart Failure; PN: Pneumonia

*Analytic Approach*

Cohen's Kappa (κ)-statistic was used to evaluate the agreement between inpatient and outpatient depression and used the following interpretation: no agreement (κ ≤ 0), none to slight (κ = 0.01 – 0.20), fair (κ = 0.21 – 0.40), moderate (κ = 0.41 – 0.60), substantial (κ = 0.61 – 0.80), and almost perfect agreement (κ = 0.81 – 1.00) (McHugh, 2012). Patient characteristics will be described across diagnostic concordance categories and 30-day readmission status. Factors associated with diagnostic concordance and readmission were examined in bivariate analysis using chi-square tests for categorical variables. Using log-binomial regression, the risk ratio (RR) of a 30-day readmission was calculated for diagnostic concordance categories while controlling for patient characteristics. SAS statistical software version 9.4 was used for all statistical analyses (SAS Institute Inc., Cary, NC, USA).

**Results**

A 30-day readmission was experienced by 5.4% (n = 466) of patients. Depression was identified in 6.8% (n = 589) of patients using inpatient secondary diagnosis codes and 20.7% (n = 1,780) of patients using primary or secondary outpatient diagnosis codes. Overall 78.4% of patients had diagnostic concordance, with most patients falling in the concordant-no depression category (75.4%). COPD (31.7%) was the most common primary diagnosis at index admission, followed with HF (29.6%), PN (25.0%), and AMI (13.8%). Patients included in the analysis had a mean age (SD) of 67.2 (10.2), were largely female (63.0%), had at least one comorbidity (84.2%), and resided in urban counties (69.2%). Most patients were white (43.9%) or black (40.1%) (Table 5.4).

**Table 5.4 Characteristics of selected hospitalized patients, SC Medicaid administrative claims 2012 – 2015 (n = 8,621)**

| Characteristics | n | % |
|---|---|---|
| 30-day readmission | 466 | 5.4 |
| Depression diagnosis setting | | |
| Inpatient | 589 | 6.8 |
| Outpatient, prior | 1,780 | 20.7 |
| Diagnostic concordance | | |
| Concordant, no depression | 6,504 | 75.4 |
| Concordant, depression | 252 | 2.9 |
| Non-concordant, inpatient only | 337 | 3.9 |
| Non-concordant, outpatient only | 1,528 | 17.7 |
| *Covariates* | | |
| Age, years | | |
| Mean ± SD | 67.2 ± 10.2 | |
| Age, years | | |
| 55 – 64 | 4,338 | 50.3 |
| 65 – 74 | 2,272 | 26.4 |
| 75 or older | 2,011 | 23.3 |
| Sex | | |
| Male | 3,192 | 37.0 |

| | | |
|---|---|---|
| Female | 5,429 | 63.0 |
| Race/Ethnicity | | |
| White | 3,786 | 43.9 |
| Black | 3,459 | 40.1 |
| Other* | 1,376 | 16.0 |
| Residence | | |
| Urban | 5,969 | 69.2 |
| Rural | 2,652 | 30.8 |
| Admitting diagnosis | | |
| AMI | 1,192 | 13.8 |
| COPD | 2,729 | 31.7 |
| HF | 2,549 | 29.6 |
| PN | 2,151 | 25.0 |
| Comorbidities+ | | |
| 0 | 1,360 | 15.8 |
| 1 | 2,128 | 24.7 |
| 2 | 2,562 | 29.7 |
| 3 or more | 2,571 | 29.8 |
| Length of stay, Index hospitalization | | |
| Mean ± SD | 4.8 ± 4.2 | |
| Length of stay, Index hospitalization, days | | |
| 1 – 3 | 3,866 | 44.8 |
| 4 – 6 | 3,043 | 35.3 |
| 7 or more | 1,712 | 19.9 |

*Other includes Hispanic and "Other"
+ Elixahauser Comorbidity Index
SD: Standard deviation
AMI: Acute Myocardial Infarction; COPD: Chronic Obstructive Pulmonary Disease; HF: Heart Failure; PN: Pneumonia

*Diagnostic concordance*

The identification of depression by inpatient and outpatient diagnosis codes had poor agreement ($P < 0.001$) (Jones, Probst, McKinney, Crouch, & Hardin, 2017). Overall, 78.4% of patients had a concordant diagnosis status (no depression/depression). The four diagnostic concordance categories were concordant-no depression (75.4%);

concordant-depression (2.9%); not concordant-inpatient only (3.9%); and not concordant-outpatient only (17.7%) (Table 5.4).

*30-Day Readmission*

Patients with a diagnosis of depression, regardless of setting and concordance, had greater 30-day readmission than patients with no depression, 7.1% and 4.8%, respectively ($P = 0.0001$). By setting, a depression diagnosis in the outpatient records was significantly associated with 30-day readmission, but a depression diagnosis in the inpatient records was not significantly associated with 30-day readmission. Concordant diagnosis (no depression/depression) patients had lower 30-day readmission rates than not concordant-depression diagnosis (inpatient only or outpatient only) patients, 4.9% and 7.4%, respectively, ($P < 0.0001$). Thirty-day readmission among concordant-depression patients (5.6%) did not differ statistically from that of concordant-no depression patients (4.8%) (Table 5.5). On the other hand, among patients with outpatient record of depression that was not recorded during inpatient record, the 30-day readmission rate was 8.1%, adjusted relative risk = 1.42, 95% CI: 1.15 – 1.75 (Table 5.6). Examining diagnostic concordance as a categorical variable across 30-day readmission status resulted in small sample sizes for 30-day readmission with concordant-depression and 30-day readmission with not concordant-inpatient only sub-populations. Age, sex, and race/ethnicity were significantly associated with 30-day readmission (Table 5.5).

Patients with a depression diagnosis in the outpatient setting only had a greater risk of 30-day readmission (unadjusted RR = 1.6, $P < 0.0001$), but the relationship was

not significant among patients with an inpatient depression diagnosis only (unadjusted RR = 0.87, *P* = 0.4705) (data not shown).

**Table 5.5 Characteristics of selected hospitalized patients with and without a 30-day readmission, SC Medicaid administrative claims 2012 – 2015**

| | 30-day Readmission | | | | |
|---|---|---|---|---|---|
| | No (n = 8,155) | | Yes (n = 466) | | *P* |
| Characteristics | n | % | n | % | |
| Any diagnosis of depression | | | | | 0.0001 |
| Yes | 1,966 | 92.9 | 151 | 7.1 | |
| No | 6,189 | 95.2 | 315 | 4.8 | |
| Depression diagnosis setting | | | | | |
| Inpatient | 561 | 95.3 | 28 | 4.8 | 0.4687 |
| Outpatient, prior | 1,738 | 92.5 | 142 | 7.6 | <.0001 |
| Diagnostic concordance | | | | | <.0001 |
| Yes | 6,427 | 95.1 | 329 | 4.9 | |
| No | 1,728 | 92.7 | 137 | 7.4 | |
| Diagnostic concordance | | | | | <.0001 |
| Concordant, no depression | 6,189 | 95.2 | 315 | 4.8 | |
| Concordant, depression | 238 | 94.4 | 14 | 5.6 | |
| Non-concordant, inpatient only | 323 | 95.9 | 14 | 4.2 | |
| Non-concordant, outpatient only | 1,405 | 92.0 | 123 | 8.1 | |
| *Covariates* | | | | | |
| Age, years | | | | | <.0001 |
| 55 – 64 | 3,969 | 91.5 | 369 | 8.5 | |
| 65 – 74 | 2,213 | 97.4 | 59 | 2.6 | |
| 75 or older | 1,973 | 98.1 | 38 | 1.9 | |
| Sex | | | | | 0.0158 |
| Male | 2,995 | 93.8 | 197 | 6.2 | |
| Female | 5,160 | 95.1 | 269 | 5.0 | |
| Race/Ethnicity | | | | | <.0001 |
| White | 3,594 | 94.9 | 192 | 5.1 | |
| Black | 3,295 | 95.3 | 164 | 4.7 | |
| Other | 1,266 | 92.0 | 110 | 8.0 | |
| Residence | | | | | 0.2718 |
| Urban | 5,657 | 94.8 | 312 | 5.2 | |
| Rural | 2,498 | 94.2 | 154 | 5.8 | |
| Admitting diagnosis | | | | | 0.2299 |
| AMI | 1,121 | 94.0 | 71 | 6.0 | |
| COPD | 2,600 | 95.3 | 129 | 4.7 | |

| | | | | | |
|---|---|---|---|---|---|
| HF | 2,399 | 94.1 | 150 | 5.9 | |
| PN | 2,035 | 94.6 | 116 | 5.4 | |
| Comorbidities | | | | | 0.0743 |
| 0 | 1,286 | 94.6 | 74 | 5.4 | |
| 1 | 2,035 | 95.6 | 93 | 4.4 | |
| 2 | 2,406 | 93.9 | 156 | 6.1 | |
| ≥ 3 | 2,428 | 94.4 | 143 | 5.6 | |
| Length of stay, Index hospitalization, days | | | | | 0.8362 |
| 1 – 3 | 3,663 | 94.8 | 203.0 | 5.3 | |
| 4 – 6 | 2,876 | 94.5 | 167.0 | 5.5 | |
| 7 or more | 1,616 | 94.4 | 96.0 | 5.6 | |

*Other includes Hispanics and "Other"

+ Elixahauser Comorbidity Index

SD: Standard deviation

AMI: Acute Myocardial Infarction; COPD: Chronic Obstructive Pulmonary Disease; HF: Heart Failure; PN: Pneumonia

In both unadjusted and adjusted analysis, patients with depression that was concordantly diagnosed across both inpatient and outpatient settings did not differ in readmission risk from patients with no diagnosis of depression. The relationship between 30-day readmission and most patient-level variables were not significant in bivariate analysis. All patient-level variables were included in the multivariable model. The unadjusted and adjusted risk ratios for 30-day readmission were similar, but with the relationship between 30-day readmission and sex was no longer significant, and patients with two comorbidities and COPD as primary diagnosis of the index admission were now significant (Table 5.6).

**Table 5.6 Relative risk (unadjusted and adjusted) for 30-day readmission among selected hospitalized patients, SC Medicaid administrative claims 2012 – 2015 (n = 8,621)**

| | Unadjusted | | | | | Adjusted | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | RR | 95% CI | | | *P* | RR | 95% CI | | | *P* |
| Diagnostic concordance | | | | | | | | | | |
| Concordant, no depression (ref) | -- | -- | | -- | | -- | -- | | -- | |
| Concordant, depression | 0.86 | 0.51 | – | 1.45 | 0.5661 | 0.76 | 0.45 | – | 1.29 | 0.3175 |
| Non-concordant, outpatient only | 1.66 | 1.36 | – | 2.03 | <.0001 | 1.42 | 1.15 | – | 1.75 | 0.0010 |
| Non-concordant, inpatient only | 1.15 | 0.68 | – | 1.93 | 0.6052 | 1.03 | 0.61 | – | 1.75 | 0.9047 |
| *Covariates* | | | | | | | | | | |
| Age, years | | | | | | | | | | |
| 55 – 64 (ref) | -- | -- | | -- | | -- | -- | | -- | |
| 65 – 74 | 0.73 | 0.49 | – | 1.09 | 0.1223 | 0.72 | 0.48 | – | 1.08 | 0.1171 |
| 75 or older | 3.28 | 2.50 | – | 4.29 | <.0001 | 3.12 | 2.38 | – | 4.10 | <.0001 |
| Sex | | | | | | | | | | |
| Male | 1.25 | 1.04 | – | 1.49 | 0.0159 | 1.11 | 0.93 | – | 1.34 | 0.2539 |
| Female (ref) | -- | -- | | -- | | -- | -- | | -- | |
| Race/Ethnicity | | | | | | | | | | |
| White (ref) | -- | -- | | -- | | -- | -- | | -- | |
| Black | 1.69 | 1.34 | – | 2.13 | <.0001 | 1.53 | 1.21 | – | 1.93 | 0.0004 |
| Other* | 1.07 | 0.87 | – | 1.31 | 0.5163 | 1.09 | 0.88 | – | 1.34 | 0.4315 |
| Residence | | | | | | | | | | |
| Urban (ref) | -- | -- | | -- | | -- | -- | | -- | |
| Rural | 0.90 | 0.75 | – | 1.09 | 0.2715 | 0.84 | 0.69 | – | 1.01 | 0.0580 |
| Health | | | | | | | | | | |
| AMI (ref) | -- | -- | | -- | | -- | -- | | -- | |
| COPD | 1.24 | 0.99 | – | 1.57 | 0.0609 | 1.43 | 1.13 | – | 1.80 | 0.0032 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| HF | 1.14 | 0.89 | – | 1.46 | 0.2905 | 1.26 | 0.98 | – | 1.60 | 0.0676 |
| PN | 1.26 | 0.95 | – | 1.67 | 0.1075 | 1.27 | 0.95 | – | 1.68 | 0.1013 |
| Comorbidities[+] | | | | | | | | | | |
| 0 (ref) | -- | -- | | -- | | -- | -- | | -- | |
| 1 | 1.39 | 1.08 | – | 1.79 | 0.0094 | 1.39 | 1.09 | – | 1.79 | 0.0086 |
| 2 | 1.27 | 0.99 | – | 1.64 | 0.0635 | 1.30 | 1.01 | – | 1.68 | 0.0441 |
| 3 or more | 1.25 | 0.92 | – | 1.68 | 0.1490 | 1.14 | 0.85 | – | 1.53 | 0.3887 |
| Length of stay, Index hospitalization, days | | | | | | | | | | |
| 1 – 3 (ref) | -- | -- | | -- | | -- | -- | | -- | |
| 4 – 6 | 1.02 | 0.80 | – | 1.30 | 0.8626 | 0.95 | 0.74 | – | 1.21 | 0.6591 |
| 7 or more | 0.96 | 0.78 | – | 1.17 | 0.6639 | 0.90 | 0.74 | – | 1.10 | 0.3016 |

[*]Other includes Hispanic and "Other"

[+] Elixahauser Comorbidity Index

RR: Relative risk

AMI: Acute Myocardial Infarction; COPD: Chronic Obstructive Pulmonary Disease; HF: Heart Failure; PN: Pneumonia

Ref: Reference group

**Discussion**

Depression, when diagnosed using primary or secondary diagnosis codes from prior outpatient claims, was associated with a greater risk of a 30-day readmission compared to patients without depression. Across diagnostic concordance categories, when depression was recorded in the inpatient setting only, these patients experienced 1.42 times greater risk of 30-day readmission compared to patients with no depression in either setting. This study examined the differences in a depression diagnosis between the inpatient and outpatient setting among patients with an index admission of AMI, COPD, HF, or PN. Patients with not concordant-outpatient depression only, older adults, blacks, patients with an index admission condition of COPD, and patients with one or two comorbidities were significantly associated with increased risk of a 30-day hospital readmission compared to their respective comparison groups.

This study found that depression was associated with an increased risk of 30-day readmission (7.1% and 4.8% no depression, $P = .0001$), which is consistent with other studies that have examined hospital readmissions within 30 days among older adults (Barnett et al., 2015; Berges, 2015; Chen et al., 2015; Fulop et al., 2003; Ketterer et al., 2014; Marcantonio et al., 1999; Mather et al., 2014; Singh et al., 2016; Watson et al., 2011). To expand upon similar studies, our study also found 30-day readmission was greater among patients with outpatient depression (7.6%, $P < 0.0001$), but not significant among patients with inpatient depression (4.8%, $P = 0.4687$). Patients with a history of depression, but where depression was not identified during the initial hospitalization (not concordant-outpatient only) experienced a greater risk of 30-day

readmission. Patients with depression when identified in both the inpatient and outpatient setting (concordant-depression) had a lower risk of 30-day readmission compared to all other diagnostic concordance categories. However, this result was not statistically significant; the findings may be due to inadequate sample sizes for the diagnostic concordance categories. Additional research is needed to determine if patients with concordant depression (inpatient and outpatient) experience lower risk of 30-day readmission.

The results of this study highlight the existence of great disparity between inpatient and outpatient detection of depression. Diagnostic concordance for depression has been rarely explored for hospital readmissions (Abrams et al., 2009). The study's findings suggest a need for improvement within hospitals to better record a depression diagnosis for patients with a history of depression during their initial hospitalization.

The concordance of an inpatient and outpatient diagnosis of depression suggests greater sharing of information between the settings via patient disclosure, greater hospital inquiry at ascertaining depression history, or depression screening during the hospitalization. Differences between a prior outpatient diagnosis of depression and depression diagnosed during the hospitalization may be due to depression severity. Depression detected in the outpatient setting only may suggest that the patient has more serious or chronic depression. Patients with chronic depression are at greater risk of treatment non-adherence (Benner et al., 2002; R. M. Carney et al., 1995;

Ciechanowksi et al., 2000; Dowson et al., 2004; Luyster et al., 2009; Wagner et al., 2010), which, in turn, increases the risk of hospitalizations (Lo-Ciganic et al., 2016; Simon-Tuval et al., 2016; Yang et al., 2016). Whereas, depression detected in the inpatient setting only may suggest patients were newly depressed or acquired depression during the initial hospitalization. A hospitalization, regardless of the health condition, may create psychological stress that increases the risk of a readmission (Krumholz, 2013). To mitigate post-hospitalization stressors, patients should be accessed for potential risk factors beyond the reason of the initial hospitalization, and hospitals should implement interventions that target the reduction of readmission risk factors (Krumholz, 2013). Depression coupled with the psychological stress associated with a hospitalization and post-hospitalization stress could result in greater risk of a readmission and other negative outcomes. Given such, it is imperative that hospitals ascertain patients' depression history during the hospitalization.

The 30-day readmission rate detected in this study (5.4%) is much lower than readmission rates detected in studies that have examined a similar population (older adults with chronic health conditions) (Berges, 2015; Chen et al., 2015; Mather et al., 2014; McManus et al., 2015; Watson et al., 2011), even among studies analyzing administrative claims data (Keenan et al., 2008; Singh et al., 2016). The lower readmission rate detected in our study may be partially due to regional differences, as prior studies have involved national data or data collected from sites located primarily in the northeast region of the U.S.

Though, SC is ranked poorly across several health quality indicators (University of Wisconsin Population Health Institute, 2017), lower readmission rates may be partially explained by receipt of adequate care (during hospitalization or transitional care within the community). Lower readmission rates may also indicate a healthier population. Nearly half of the patients included in the analysis were aged 55 – 64 years. According to national readmission data, the top health conditions at the time of the index admission responsible for the most readmissions among Medicaid recipients were mood disorders, schizophrenia, and diabetes (Hines et al., 2014). Although, two of our study's health conditions of interest (congestive heart failure and COPD) were in the top ten conditions for readmissions (Hines et al., 2014), our study's index admission health conditions have not been typically associated with a readmission for this younger population.

Lastly, lower readmission rates may be explained partially by a lack of follow-up information for each patient. Our study is unable to verify that patients included in the analysis were alive at the time a readmission was accessed.

Although our study identified lower depression rates in the inpatient setting, this study's rate of depression detected in the outpatient setting was more consistent with similar studies that used clinical diagnostic codes from inpatient medical records (Watson et al., 2011), and inpatient administrative claims (Chen et al., 2015; Keenan et al., 2008; Mather et al., 2014; Singh et al., 2016).

Hospital-level programs have been successful at reducing hospital readmissions (Coleman et al., 2006; Jack et al., 2009; M. Naylor et al., 1994; M D Naylor et al., 1999;

Mary D Naylor et al., 2004), as well as improving quality of care during hospitalization and post-discharge care transition, and lowering costs (Centers for Medicare & Medicaid Services, 2011, 2015a, 2016a; Dummit et al., 2015). The Centers for Medicare & Medicaid Services (CMS) penalizes hospitals that experience an excess in unplanned hospital readmissions for select health conditions among Medicare beneficiaries, 65 years and older (Medicare Payment Advisory Commission, 2013). Although the CMS penalty adjusts for depression detected in the inpatient and outpatient settings, most hospitals do not have access to patients' outpatient medical records, and may be unaware of a patients' history of depression. Therefore, hospitals may not adequately address the needs of this population, and the patient may experience potentially preventable adverse outcomes stimulated by his/her depression. Further, hospitals may miss a large proportion of patients who would benefit most from readmission reduction interventions. Accountable care organizations (ACOs) may fill this gap partially and could reduce unplanned hospital readmissions through improved care and increased care coordination between hospital and community health providers (Medicare Payment Advisory Comission, 2014). In addition, the use of electronic medical records linking inpatient and outpatient records could improve diagnostic concordance.

**Limitations**

The results of this study may not be generalizable to larger populations because it was restricted to SC residents who were Medicaid recipients, and had select health conditions. In addition, the patients included in the analysis were mostly female and younger. Patients who were excluded from the analysis due to missing data had a higher

proportion of 30-day readmission than patients included in the analysis. The lack of a statistically significant relationship across all diagnostic concordant categories was likely due to the lower number of concordant-depression, and not concordant-inpatient depression only populations. Lastly, although administrative claims data were not intended for such a research study, claims data have a high level of agreement when compared to data obtained from patient medical records (Krumholz et al., 2011).

**Conclusions**

Unplanned hospital readmissions are prevalent and if reduced, can lead to reduced health care spending and better patient outcomes. Depression was a risk for 30-day readmission. If hospital personnel are unaware of a patient's depression status during a hospitalization, the patient may not receive care that considers all of their health needs. Patients with a history of depression that is not recorded during their initial hospitalization have a greater risk of 30-day readmission. Diagnostic concordance, particularly for depression, may be an important risk factor to reduce readmission rates or other adverse hospital outcomes.

# CHAPTER 6

# SUMMARY

The U.S. health care system is fragmented and with the use of improved care coordination, hospital readmissions may be prevented. A hospital readmission may be a measure of inadequate quality of care during a hospitalization or insufficient transitional care to the community. A patient with depression may be at greater risk for a readmission, but the hospital staff may be unware of the patient's depression diagnosis. This dissertation research examined the patient- and environmental-level factors associated with depression diagnostic concordance, and the association between diagnostic concordance and 30-day readmission among older adults with select health conditions in South Carolina.

Manuscript one (Chapter 4) and manuscript two (Chapter 5) were prepared with universal inpatient and outpatient administrative claims data from 2012 – 2015 for Medicaid patients aged 55 years and older with a primary inpatient diagnosis of acute myocardial infarction (AMI), chronic obstructive pulmonary disease (COPD), heart failure (HF), and pneumonia (PN). Chapter 4 determined the agreement between an inpatient and outpatient record of depression (concordance) and the relative risk of diagnostic concordance (concordant / not concordant) while controlling for patient- and environmental-level variables. Chapter 5 builds on the previous analysis and examined the relationship between diagnostic concordance (concordant-no depression,

concordant-depression, not concordant-inpatient only, and not concordant-outpatient only) and 30-day readmission while controlling for patient-level factors. The results from Chapter 4 indicated that diagnostic concordance between inpatient and outpatient data were poor; patient age, race, and health conditions were significant factors predicting the likelihood of diagnostic concordance; and the number of county-level mental health centers was not a significant factor for diagnostic concordance. Results from Chapter 5 indicated that the risk of 30-day readmission differed by diagnostic concordance; not concordant-outpatient only patients had a greater risk of 30-day readmission (significant); and patients with concordant-depression had a lower risk of 30-day readmission (non-significant).

We accurately hypothesized low diagnostic concordance between inpatient and outpatient records. However, while we hypothesized that patients with not concordant depression would have higher 30-day readmission rates, the risk reported for not concordant-outpatient only was the only significant diagnostic concordance category. We believe the low number of concordant-depression and not concordant-inpatient only populations may have affected our ability to detect a significant difference in 30-day readmission rates for all diagnostic concordance categories. In addition, the low readmission rates within our study population may have affected the lack of significance for many of our patient-level risk factors. Lastly, we were unable to account for possible hospital and/or outpatient facility-level clustering of patients.

Although this dissertation research failed to show significant 30-day readmission rates across all diagnostic concordance categories, we believe additional research is

needed to determine the possible effect depression diagnostic concordance has on patient hospital outcomes. Hospitals need to develop strategies to improve diagnostic concordance between inpatient and outpatient records so readmission reduction programs can target high-risk patients, such as elders with depression.

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# APPENDIX A – ICD-9 AND ICD-10 CODES FOR AMI, COPD, HF, AND PN

**Acute myocardial infarction (AMI)**

| *ICD-9* | *Description* |
|---|---|
| 410.00 | Acute myocardial infarction of anterolateral wall, episode of care unspecified |
| 410.01 | Acute myocardial infarction of anterolateral wall, initial episode of care |
| 410.1 | Acute myocardial infarction of other anterior wall, episode of care unspecified |
| 410.11 | Acute myocardial infarction of other anterior wall, initial episode of care |
| 410.2 | Acute myocardial infarction of inferolateral wall, episode of care unspecified |
| 410.21 | Acute myocardial infarction of inferolateral wall, initial episode of care |
| 410.3 | Acute myocardial infarction of inferoposterior wall, episode of care unspecified |
| 410.31 | Acute myocardial infarction of inferoposterior wall, initial episode of care |
| 410.4 | Acute myocardial infarction of other inferior wall, episode of care unspecified |
| 410.41 | Acute myocardial infarction of other inferior wall, initial episode of care |
| 410.5 | Acute myocardial infarction of other lateral wall, episode of care unspecified |
| 410.51 | Acute myocardial infarction of other lateral wall, initial episode of care |
| 410.6 | True posterior wall infarction, episode of care unspecified |
| 410.61 | True posterior wall infarction, initial episode of care |
| 410.7 | Subendocardial infarction, episode of care unspecified |
| 410.71 | Subendocardial infarction, initial episode of care |
| 410.8 | Acute myocardial infarction of other specified sites, episode of care unspecified |
| 410.81 | Acute myocardial infarction of other specified sites, initial episode of care |
| 410.9 | Acute myocardial infarction of unspecified site, episode of care unspecified |
| 410.91 | Acute myocardial infarction of unspecified site, initial episode of care |
| ***ICD-10*** | |
| I21.09 | ST elevation (STEMI) myocardial infarction involving other coronary artery of anterior wall |
| I21.11 | ST elevation (STEMI) myocardial infarction involving right coronary artery |
| I21.19 | ST elevation (STEMI) myocardial infarction involving other coronary artery of inferior wall |
| I21.29 | ST elevation (STEMI) myocardial infarction involving other sites |
| I21.3 | ST elevation (STEMI) myocardial infarction of unspecified site |
| I21.4 | Non-ST elevation (NSTEMI) myocardial infarction |

**Chronic Obstructive Pulmonary Disease (COPD)**

| *ICD-9* | *Description* |
|---|---|
| 491 | Simple chronic bronchitis |
| 491.1 | Mucopurulent chronic bronchitis |
| 491.2 | Obstructive chronic bronchitis without exacerbation |
| 491.21 | Obstructive chronic bronchitis; With (acute) exacerbation; acute exacerbation of COPD, decompensated COPD, decompensated COPD with exacerbation |
| 491.22 | Obstructive chronic bronchitis; with acute bronchitis |
| 491.8 | Other chronic bronchitis. Chronic: tracheitis, tracheobronchitis |
| 491.9 | Unspecified chronic bronchitis |
| 492 | Emphysematous bleb |
| 492.8 | Other emphysema; emphysema (lung or pulmonary): NOS, centriacinar, centrilobular, obstructive, panacinar, panlobular, unilateral, vesicular. MacLeod's syndrome; Swyer-James syndrome; unilateral hyperlucent lung |
| 496 | Chronic: nonspecific lung disease, obstructive lung disease, obstructive pulmonary disease (COPD) NOS. NOTE: This code is not to be used with any code from categories 491-493 |
| ***ICD-10*** | |
| J41.0 | Simple chronic bronchitis |
| J41.1 | Mucopurulent chronic bronchitis |
| J42 | Unspecified chronic bronchitis |
| J43.8 | Other emphysema |
| J43.9 | Emphysema, unspecified |
| J44.1 | Chronic obstructive pulmonary disease with (acute) exacerbation |
| J44.9 | Chronic obstructive pulmonary disease, unspecified |

**Heart Failure**

| *ICD-9* | *Description* |
|---|---|
| 402.01 | Malignant hypertensive heart disease with heart failure |
| 402.11 | Benign hypertensive heart disease with heart failure |
| 402.91 | Unspecified hypertensive heart disease with heart failure |
| 404.01 | Hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified |
| 404.03 | Hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage V or end stage renal disease |
| 404.11 | Hypertensive heart and chronic kidney disease, benign, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified |
| 404.13 | Hypertensive heart and chronic kidney disease, benign, with heart failure and chronic kidney disease stage V or end stage renal disease |
| 404.91 | Hypertensive heart and chronic kidney disease, unspecified, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified |
| 404.93 | Hypertensive heart and chronic kidney disease, unspecified, with heart failure |

| | |
|---|---|
| | and chronic kidney disease stage V or end stage renal disease |
| 428 | Congestive heart failure, unspecified |
| 428.1 | Left heart failure |
| 428.2 | Systolic heart failure, unspecified |
| 428.21 | Acute systolic heart failure |
| 428.22 | Chronic systolic heart failure |
| 428.23 | Acute on chronic systolic heart failure |
| 428.3 | Diastolic heart failure, unspecified |
| 428.31 | Acute diastolic heart failure |
| 428.32 | Chronic diastolic heart failure |
| 428.33 | Acute on chronic diastolic heart failure |
| 428.4 | Combined systolic and diastolic heart failure, unspecified |
| 428.41 | Acute combined systolic and diastolic heart failure |
| 428.42 | Chronic combined systolic and diastolic heart failure |
| 428.43 | Acute on chronic combined systolic and diastolic heart failure |
| 428.9 | Heart failure, unspecified |
| ***ICD-10*** | |
| I11.0 | Hypertensive heart disease with heart failure |
| I13.0 | Hypertensive heart and chronic kidney disease with heart failure and stage 1 through stage 4 chronic kidney disease, or unspecified chronic kidney disease |
| I13.2 | Hypertensive heart and chronic kidney disease with heart failure and with stage 5 chronic kidney disease, or end stage renal disease |
| I50.1 | Left ventricular failure |
| I50.20 | Unspecified systolic (congestive) heart failure |
| I50.21 | Acute systolic (congestive) heart failure |
| I50.22 | Chronic systolic (congestive) heart failure |
| I50.23 | Acute on chronic systolic (congestive) heart failure |
| I50.30 | Unspecified diastolic (congestive) heart failure |
| I50.31 | Acute diastolic (congestive) heart failure |
| I50.32 | Chronic diastolic (congestive) heart failure |
| I50.33 | Acute on chronic diastolic (congestive) heart failure |
| I50.40 | Unspecified combined systolic (congestive) and diastolic (congestive) heart failure |
| I50.41 | Acute combined systolic (congestive) and diastolic (congestive) heart failure |
| I50.42 | Chronic combined systolic (congestive) and diastolic (congestive) heart failure |
| I50.43 | Acute on chronic combined systolic (congestive) and diastolic (congestive) heart failure |
| I50.9 | Heart failure, unspecified |

**Pneumonia (PN)**

| *ICD-9* | *Description* |
|---|---|
| 481 | Pneumococcal pneumonia [Streptococcus pneumoniae pneumonia] |
| 485 | Bronchopneumonia, organism unspecified |
| 486 | Pneumonia, organism unspecified |
| 480.0 | Pneumonia due to adenovirus |
| 480.1 | Pneumonia due to respiratory syncytial virus |
| 480.2 | Pneumonia due to parainfluenza virus |
| 480.3 | Pneumonia due to SARS-associated coronavirus |
| 480.8 | Pneumonia due to other virus not elsewhere classified |
| 480.9 | Viral pneumonia, unspecified |
| 482.0 | Pneumonia due to Klebsiella pneumonia |
| 482.1 | Pneumonia due to Pseudomonas |
| 482.2 | Pneumonia due to Hemophilus influenzae [H. influenzae] |
| 482.9 | Bacterial pneumonia, unspecified |
| 483.0 | Pneumonia due to mycoplasma pneumoniae |
| 483.1 | Pneumonia due to chlamydia |
| 483.8 | Pneumonia due to other specified organism |
| 482.30 | Pneumonia due to Streptococcus, unspecified |
| 482.31 | Pneumonia due to Streptococcus, group A |
| 482.32 | Pneumonia due to Streptococcus, group B |
| 482.39 | Pneumonia due to other Streptococcus |
| 482.40 | Pneumonia due to Staphylococcus, unspecified |
| 482.41 | Methicillin susceptible pneumonia due to Staphylococcus aureus |
| 482.42 | Methicillin resistant pneumonia due to Staphylococcus aureus |
| 482.49 | Other Staphylococcus pneumonia |
| 482.82 | Pneumonia due to escherichia coli [E. coli] |
| 482.83 | Pneumonia due to other gram-negative bacteria |
| 482.84 | Pneumonia due to Legionnaires' disease |
| 482.89 | Pneumonia due to other specified bacteria |
| ***ICD-10*** | |
| A48.1 | Legionnaires' disease |
| J13 | Pneumonia due to Streptococcus pneumoniae |
| J14 | Pneumonia due to Hemophilus influenzae |
| J15.0 | Pneumonia due to Klebsiella pneumoniae |
| J15.1 | Pneumonia due to Pseudomonas |
| J15.20 | Pneumonia due to staphylococcus, unspecified |
| J15.21 | Pneumonia due to staphylococcus aureus |
| J15.29 | Pneumonia due to other staphylococcus |
| J15.3 | Pneumonia due to streptococcus, group B |
| J15.4 | Pneumonia due to other streptococci |
| J15.5 | Pneumonia due to Escherichia coli |

J15.6 Pneumonia due to other aerobic Gram-negative bacteria
J15.7 Pneumonia due to Mycoplasma pneumoniae
J15.8 Pneumonia due to other specified bacteria
J15.9 Unspecified bacterial pneumonia
J16.0 Chlamydial pneumonia
J16.8 Pneumonia due to other specified infectious organisms
J18.0 Bronchopneumonia, unspecified organism
J18.1 Lobar pneumonia, unspecified organism
J18.9 Pneumonia, unspecified organism

# APPENDIX B – ICD-9 AND ICD-10 CODES FOR DEPRESSION

| ***ICD-9*** | ***Description*** |
|---|---|
| 296.2 | Depressive psychosis single episode, unspecified |
| 296.21 | Depressive psychosis, mild |
| 296.22 | Depressive psychosis, moderate |
| 296.23 | Depressive psychosis, severe |
| 296.24 | Depressive psychosis, severe with psychotic features |
| 296.25 | Depressive psychosis, partial remission |
| 296.26 | Depressive psychosis, full remission |
| 296.3 | Recurrent depressive psychosis, unspecified |
| 296.31 | Recurrent depressive psychosis, mild |
| 296.32 | Recurrent depressive psychosis, moderate |
| 296.33 | Recurrent depressive psychosis, severe |
| 296.34 | Recurrent depressive psychosis, psychotic features |
| 296.35 | Recurrent depressive psychosis, partial remission |
| 296.36 | Recurrent depressive psychosis, full remission |
| 296.82 | Atypical depressive disorder |
| 296.9 | Episodic mood disorder, NOS |
| 296.99 | Episodic mood disorder, NEC |
| 298 | Reactive depressive psychosis |
| 300.4 | Dysthymic disorder |
| 301.12 | Chronic depressive person |
| 309 | Adjustment disorder with depressive symptoms |
| 311 | Depressive disorder, NEC |
| 313.1 | Misery & unhappiness disorder |
| ***ICD-10*** | |
| F32.0 | Major depressive disorder, single episode, mild |
| F32.1 | Major depressive disorder, single episode, moderate |
| F32.2 | Major depressive disorder, single episode, severe without psychotic features |
| F32.3 | Major depressive disorder, single episode, severe with psychotic features |
| F32.4 | Major depressive disorder, single episode, in partial remission |
| F32.5 | Major depressive disorder, single episode, in full remission |
| F32.8 | Other depressive episodes |
| F32.9 | Major depressive disorder, single episode, unspecified |
| F33.0 | Major depressive disorder, recurrent, mild |
| F33.1 | Major depressive disorder, recurrent, moderate |

| | |
|---|---|
| F33.3 | Major depressive disorder, recurrent, severe with psychotic symptoms |
| F33.40 | Major depressive disorder, recurrent, in remission, unspecified |
| F33.41 | Major depressive disorder, recurrent, in partial remission |
| F33.42 | Major depressive disorder, recurrent, in full remission |
| F33.8 | Other recurrent depressive disorders |
| F33.9 | Major depressive disorder, recurrent, unspecified |

# APPENDIX C – CCS CODES FOR PLANNED READMISSIONS

| CCS | Description |
|---|---|
| 45 | Maintenance chemotherapy |
| 64 | Bone marrow transplant |
| 105 | Kidney transplant |
| 176 | Other organ transplantation |
| 254 | Rehabilitation (select conditions) |

**CCS 245 Select Conditions**

| | Diagnostic code description |
|---|---|
| **ICD-9** | |
| V520 | Fitting artificial arm |
| V521 | Fitting artificial leg |
| V524 | Fitting breast prosthesis |
| V528 | Fitting prosthesis NEC |
| V529 | Fitting prosthesis NOS |
| **ICD-10** | |
| Z44001 | Encounter for fit/adjst of unspecified right artificial arm |
| Z44002 | Encounter for fit/adjst of unspecified left artificial arm |
| Z44009 | Encounter for fit/adjst of unspecified artificial arm, unspecified arm |
| Z44011 | Encounter for fit/adjst of complete right artificial arm |
| Z44012 | Encounter for fit/adjst of complete left artificial arm |
| Z44019 | Encounter for fit/adjst of complete artificial arm, unspecified arm |
| Z44021 | Encounter for fit/adjst of partial artificial right arm |
| Z44022 | Encounter for fit/adjst of partial artificial left arm |
| Z44029 | Encounter for fit/adjst of partial artificial arm, unspecified arm |
| Z44101 | Encounter for fit/adjst of unspecified right artificial leg |
| Z44102 | Encounter for fit/adjst of unspecified left artificial leg |
| Z44109 | Encounter for fit/adjst of unspecified artificial leg, unspecified leg |
| Z44111 | Encounter for fit/adjst of complete right artificial leg |
| Z44112 | Encounter for fit/adjst of complete left artificial leg |
| Z44119 | Encounter for fit/adjst of complete artificial leg, unspecified leg |
| Z44121 | Encounter for fit/adjst of partial artificial right leg |
| Z44122 | Encounter for fit/adjst of partial artificial left leg |
| Z44129 | Encounter for fit/adjst of partial artificial leg, unsp leg |

| | |
|---|---|
| Z4430 | Encounter for fit/adjst of external breast prosth, unsp breast |
| Z4431 | Encounter for fit/adjst of external right breast prosthesis |
| Z4432 | Encounter for fit/adjst of external left breast prosthesis |
| Z448 | Encounter for fit/adjst of external prosthetic devices |
| Z449 | Encounter for fit/adjst of unspecified external prosthetic device |
| Z4682 | Encounter for fit/adjst of non-vascular catheter |