SERVICE DELIVERY AND QUALITY OF CARE FOR INDIVIDUALS WITH MENTAL ILLNESS

by

Kalyani Gopalan

BSc, University of Madras, India, 1997

MS, Carnegie Mellon University, 2002

Submitted to the Graduate Faculty of

the Department of Health Policy & Management

Graduate School of Public Health in partial fulfillment

of the requirements for the degree of

Doctor of Philosophy

University of Pittsburgh

2017

UNIVERSITY OF PITTSBURGH

Graduate School of Public Health

This dissertation was presented

by

Kalyani Gopalan

It was defended on

April 5, 2017

and approved by

Dissertation Advisor: Julie Donohue PhD, Professor, Department of Health Policy & Management, Graduate School of Public Health, University of Pittsburgh

Nicholas Castle, PhD, Professor, Department of Health Policy & Management, Graduate School of Public Health, University of Pittsburgh

Joyce Chang, PhD, Professor, Department of Biostatistics Graduate School of Public Health, University of Pittsburgh

Frank A Ghinassi, PhD, ABPP, Associate Professor, Rutgers University, New Brunswick, New Jersey

Marcela Horvitz Lennon, MD, Physician Policy Researcher, Full, Rand Corporation, Boston, Massachusetts

SERVICE DELIVERY AND QUALITY OF CARE FOR INDIVIDUALS WITH MENTAL ILLNESS

Kalyani Gopalan, PhD

University of Pittsburgh, 2017

ABSTRACT

Mental illness and substance use illnesses are the most common cause of disease burden in the United States. Over half of individuals with mental illness do not receive appropriate care for their illnesses. This often results in poor outcomes like early mortality, more hospitalizations and increased use of emergency departments (EDs). Provider and payor systems have embarked on delivery system reforms that aim to improve quality of care and reduce health disparities for these individuals. In this dissertation we examine three aspects of health care quality – readmission, ED use and continuity of care – to explore their impact for individuals with mental illness. We show that individuals with mental illness have greater odds of thirty day readmission after acute hospitalization and this odds is increased if medications are dropped after discharge. We categorize individuals with mental illness who frequent the ED and show that high utilizers have a significantly greater rate of substance use comorbidities than occasional utilizers. We also show that high utilizers do not use outpatient services concomitant with their ED use. Finally, we examine the care coordination in physical and behavioral health specialties for seriously mentally ill individuals who have type II diabetes and its association with ED use. We show that increased care coordination in physical health settings is associated with a lower rate of ED visits.

Public Health Significance

We expect our study to inform health care facilities and policy makers in developing health care delivery systems and improve quality of care for individuals with mental illness.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PREFACE

Completing a doctorate is hard in itself. I chose to complete it while climbing the career ladder and setting up my family. At every turn, I would ask myself if I was doing the right thing. I wanted nothing short of excelling at studying, working and being a mother and wife. One thing I learned along this way is that for me to be the star, a lot of people had to power me on. This list of acknowledgments is not exhaustive but I hope it shows how grateful I am to each and every one who has contributed to this success.

First and foremost, I would like to thank my dissertation chair, Dr. Julie Donohue for giving me an opportunity to realize my dreams and making sure that I stayed true to the highest standards that we set. I have enjoyed all our conversations over the years, whether it was on health care delivery system reform and its impact for the mental health services or on life in general. I am extremely fortunate that my guide and advisor is the person I respect and admire the most. I hope that as I set forth in the next stage of my career, I will make you proud.

I would also like to thank my dissertation committee and all the professors at the health policy and management department. I would especially like to thank Dr. Marcela Horvitz Lennon for your patience and support through these years. I consider each of our monthly meetings as lessons in writing, analysis and the conceptualization of a health services research paper. I would also like to thank my friends at University of Pittsburgh and Western Psychiatric Institute and Clinic who have helped me at every stage of the PhD process. Kathy Prutting, Dr.Noreen Fredrick, Jessica Dornin, Caroline Lobo, Aiju Men and everyone else whom I have leaned on over these years.

None of this would have been possible if my then boss and current mentor Dr.Frank Ghinassi had not encouraged me to apply for the PhD. From the very first day of working for you I have learned and cultivated almost every skill I currently have. Your support and guidance all these years has made me the professional that I am now. Every day, I draw on all the advice you have given me to achieve my goals. With you as my advocate and guru, I feel there is little I cannot accomplish. My sincere thanks to you.

A special thank you to David White. You have been a silent supporter from the beginning, when I sent in my application, through the hard years of exams and papers and finally, during my tedious dissertation process. You have listened to my ideas, sympathized with my difficulties and rejoiced in my successes. Even though I have asked you to read my papers again and again, you have done so unflinchingly.

I am so grateful to my family who have shown unbridled enthusiasm throughout my career. I would like to thank my in-law family Vijayalakshmi and Kamalesh for being such a great role models for me. My sweet twin nieces Vidyuta and Vaibhavi have been such cheerleaders that I feel I can never fail in anything. Balajee, you will always be my oldest and dearest friend and ally. Viji, I still remember when you enrolled me in my first college and encouraged me to come to Pittsburgh. I could never have asked for a better sister than you. Rohini Gopalan, my amma, every exam I wrote, every stage of my career, you have stood behind me and celebrated each success. A.R.G, Appa, I hope in heaven you are smiling at me with the twinkle in your eyes, proud of the Gopalan I have become.

I would also like to thank my son and daughter. You both have brought so much joy to my heart that in both the best days and worst days, just one thought of you fills me with so much happiness. Thank you for patiently bearing all my years of studying. When I was pregnant, I

dragged you to the classes, made you write papers and even made you sit through a 3 day comprehensive exam while you kicked and stretched inside. When you were babies, I held you while reading my articles and programming my data. All these years when you obediently trotted off to bed as I began my work, I have longed to come with you. Finally, I am so excited for all the years of fun we have planned ahead. I cannot wait to see both of you achieve your dreams too.

Behind all of this is the love of my life, Raghavan Srinivasan. You have been a partner and witness through all my ordeals, the calm stabilizing force behind my ever outrageous endeavors. I have achieved so many of my dreams and yet the best one is being married to you. I am happy to wake up every morning with you by my side, ready to take on any challenge that day may bring. You are truly my soul mate.

When I was young in Zambia, I saw the many problems faced by people who have poor or inadequate access to health care. Sometimes the absence of the simplest of solutions can be devastating to entire populations. I realized that every one of us have a responsibility to do something to make the world just a little better, to make the natural and unnatural disasters a little more bearable. It has been a true pleasure to work with people who truly understand this and echo these sentiments in their work every day. As a health services researcher, I hope to dedicate a lifetime to partnering with these folks and doing my part.

Dedicated to Raghavan, Aprameya and Harish.

Anything can be done with the right people behind you.

1.0 INTRODUCTION

Mental health and substance abuse disorders are the leading cause of disease burden in the United States. (S. Abuse, 2016) According to the 2015 national survey on drug use and health, an estimated 43.4 million adults aged 18 or older had any mental illness. This constitutes about 18% of the adult population. Of these, 9.8 million had a diagnosis of serious and persistent mental illness such as schizophrenia or bipolar disorder. Additionally, individuals with mental illness also have a high rate of chronic physical health illnesses contributed by health risk behaviors as well as side effects of medications that are used to treat mental illness. (Fagiolini & Goracci, 2008) While people with mental illness have a complex array of illnesses, treatment is often inadequate due to poor access or low quality of care. (Horvitz-Lennon, Kilbourne, & Pincus, 2006) The health disparities faced by people with mental illness often contribute to poor outcomes such as early mortality, greater hospitalization or emergency department use.

There are two main factors that contribute to the health disparities for individuals with mental illness. First, there are patient level factors such as multiple comorbidities, cognitive issues and stigma of mental illness. (Parks, Svendsen, Singer, Foti, & Mauer, 2006) Secondly, system level factors that can influence access or delivery of care can contribute to poor quality of care. One overarching system failure is the fragmentation of health care delivery where providers that treat physical and mental illnesses are separated and often approach their treatment strategies in isolation.(Mechanic & Aiken, 1987) The segregation of payor systems that often carve out mental

health insurance from physical health insurance adds an additional obstacle for patients to overcome. The result being, individuals with mental illness have a higher likelihood of poor treatment outcomes including poor management of their illness and increased use of more acute levels of care.

To address these disparities, a number of payment and delivery system reforms are being rolled out to ensure adequate and good quality care for individuals with mental illness. One of the first steps was the Mental Health Parity and Addiction Equity Act 2008 (Wellstone, 2008) and later the Patient Protection and Affordable Care Act of 2010. (Law, 2015) These laws ensured that mental illness would be treated as an essential benefit in all health insurance plans. The Medicaid expansion according to the ACA also allowed more individuals to be qualified for their program decreasing uninsured rate for the mentally ill. (Garfield, Zuvekas, Lave, & Donohue, 2011) Payors like Medicare and Medicaid have also begun to incentivize good outcomes through pay-for-performance initiatives (such as the readmission reduction program that we will discuss in the second chapter). (Blumenthal, Abrams, & Nuzum, 2015)

Provider systems are also transforming to correspond with these changes. The trend towards integrated delivery models like behavioral health homes or accountable care organizations aims to address all physical and mental health needs under one roof. (Bechtel & Ness, 2010) These facilities regularly screen for depression and anxiety while mental health providers are capturing metabolic monitors like blood pressure and weight. Moreover, urgent care facilities and emergency rooms are equipping themselves to address the specialized needs of those with mental illness or substance use issues through treatment protocols that include screening and appropriate referral. (Solberg, Asplin, Weinick, & Magid)

In this dissertation, we address three specific aspects of treatment and quality of care for individuals with mental illness. We examine the risk of thirty-day readmission from acute physical health facilities and explore whether medication changes or follow up care are moderators for this risk. We also categorize individuals with mental illness who use emergency rooms multiple times and assess whether these visits are substitutes for outpatient care. Finally, we determine whether continuity of care in the physical health or behavioral health specialties is associated with ED use for those individuals who have severe mental illness and type II diabetes.

1.1 READMISSION AFTER ACUTE ILLNESS

In the second chapter of this dissertation, we focus on individuals with mental illness who are admitted to acute care facilities for acute myocardial infarction, heart failure or pneumonia. Due to their predisposition for chronic physical health comorbidities and lack of poor quality health care, mentally ill individuals are highly likely to be admitted for one of these three conditions. A number of factors including complex diagnosis profiles, changing drug regimen and poor follow up after discharge tends to increase the likelihood of unplanned readmission. We examine the this risk of thirty-day readmission according to the criteria chosen by Center for Medicare and Medicaid Hospital Readmission Reduction Program - one of the mandates of the Patient Protection and Affordable Care Act. Hospitals under this program would be pay a penalty through rate-adjustment if their readmission rates are high.

Our analysis on 30-day readmission shows that individuals with mental illness have a greater likelihood of being readmitted than those with chronic physical health illness only. The summary of this chapter is as follows.

1.1.1 Background

Eighteen percent of Medicare hospital admissions are followed by readmission within 30 days, costing the program $1.5 billion per year. The Centers for Medicare and Medicaid Services' (CMS') Hospital Readmissions Reduction Program began to cut payment for readmissions caused by acute myocardial infarction, heart failure, or pneumonia in 2013 and added more conditions in 2014 and 2015. People with mental illness have a high prevalence of medical comorbidities, such as cardiovascular disease, that are often poorly treated. Common strategies employed by hospitals to reduce the likelihood for readmission include discharging patients on adequate medication regimens and facilitating their engagement in outpatient care. However, it is unclear whether the effectiveness of these strategies may be influenced by a patient having a mental illness. To fill this important gap in the evidence, we examined whether mental illness comorbidity influences 30-day readmission rates following acute-care hospital stays for chronic physical illness. We specifically examined whether the association between mental illness comorbidity and readmission risk is modified by changes to medication therapeutic categories and post-acute follow-up care.

1.1.2 Methods

We used Medicare beneficiary enrollment and inpatient data for 2009 and 2010 from a random sample of elderly and disabled adults ages 18 and older with chronic medical conditions enrolled in fee-for-service Medicare and Part D. We estimated a generalized linear model to analyze the association between 30-day readmission and the presence of any mental illness, adjusting first for demographic and health status variables, then including index admission

variables (medication changes [measured through change in the number of medication therapeutic categories before and after admission], discharge disposition and length of stay) as well as presence of outpatient visits post-discharge. We finally added interaction variables for mental illness and medication changes and outpatient visits post discharge to test the incremental effect of these variables on readmission.

1.1.3 Results

When controlling for health status and demographic variables only, people with mental illness had higher adjusted odds of readmission (odds ratio [OR] = 1.33, $p < 0.01$). The interaction of mental illness and index admission variables & outpatient visits post discharge increased the overall odds of readmission (OR = 1.46, $p < 0.001$). Individuals with mental illness who had therapeutic categories dropped after the index admission had 30% greater odds of readmission than those whose number of medication therapeutic classes remained the same. For each day of outpatient utilization in the 30 days after admission, there were 4-percent lower odds of readmission.

1.1.4 Conclusion

People with mental illness with therapeutic categories dropped after index admission are at higher risk for readmission following hospital stays for chronic physical conditions. Reassessing medication regimens during admission and ensuring adequate outpatient engagement are two strategies that hospitals can take to reduce this risk.

1.2 CATEGORIZATION OF FREQUENT EMERGENCY DEPARTMENT UTILIZATION BY INDIVIDUALS WITH MENTAL ILLNESS

In the third chapter, we categorize people with mental illness who frequent emergency department for behavioral health and/or physical health illnesses. These frequent utilizers often use emergency rooms as a substitute for outpatient care. The categories produced in this analysis may assist providers and payors to design interventions that will address the needs of each individual category.

1.2.1 Background

Between 1997 and 2007, there was a 15% rise in ED visits by individuals with mental illness (MI) who sought care in the emergency department (ED) with about one-third of the visits concentrated among a small group of high utilizers. Little is known about whether they are receiving outpatient behavioral or physical health visits concomitant with their high use of ED. Nor is it known whether ED visits are for emergent/non-emergent conditions. Our study aims to fill these research gaps by focusing on mentally ill enrollees in Medicaid. We identify subgroups of enrollees with MI who are high utilizers of the ED and determine whether differences in ED use might be associated with outpatient utilization. We measure the intensity of outpatient primary care, behavioral health, and care management among high vs. low ED utilizers with MI. We also look in to the reason for the ED visit and delineate whether visits are non-emergent vs. emergent, for PH, mental health or SUD needs. This study will inform efforts to improve the efficiency of the delivery of care to this population.

1.2.2 Methods

Our sample includes adult fee-for-service and managed care Pennsylvania Medicaid enrollees with MI diagnosis who have >2 ED visits, and > 18 months continuous enrollment between 2007 and 2012 (n = 54,981). We used group-based trajectory analysis to identify clusters of patients with distinct patterns of ED utilization in the 12 months after index ED visit. We use multivariable logistic regression to examine the characteristics associated with each group at the index ED visit and chi-squared test to compare the primary reason for ED visits between the groups using the primary diagnosis of each visit.

1.2.3 Results

We identified two distinct groups of Medicaid enrollees with MI with ED use. Occasional utilizers (92% of the sample) had an average of 3.6 ED visits/year while high utilizers (8% of the sample) had 14.3 ED visits/year. ED use was stable over the 12-month period in both groups. High utilizers were significantly more likely than occasional utilizers to have comorbid SUD (57.0% vs. 39.7%, $p<0.001$). Among both occasional and high ED utilizers, 45-46% of all ED visits were either non-emergent or primary care treatable PH visits. Only 1.5% of occasional users and 2.1% of high utilizers had any primary care visits, and 8.2% of occasional and 13.2% of high utilizers had and substance use treatment visits in the 6 months prior to the index ED visit. Number of outpatient behavioral health visits in those 6 months was not statistically significantly different between the high (mean =22.3) and occasional (mean =19.5) ($p= 0.059$). Only 12.9% of high utilizers had care-management visits before their index ED visit.

1.2.4 Conclusion

ED utilization among high utilizers was four times higher than those with occasional use. Reasons for ED use, primary care visits, and behavioral health utilization was remarkably similar between groups. The most striking clinical difference between the two groups was prevalence of substance use disorders

1.3 DOES CARE COORDINATION WITHIN PRIMARY CARE AND BEHAVIORAL HEALTH SPECIALTIES REDUCE EMERGENCY DEPARTMENT VISITS FOR INDIVIDUALS WITH SERIOUS MENTAL ILLNESS AND TYPE II DIABETES?

1.3.1 Background

Care coordination among providers is associated with improved health outcomes in patients with chronic illnesses. Two aspects of care coordination are continuity of care (CoC) and care density (extent of patient sharing among providers). Much of what is known about the impact of CoC and care density on quality of care and health outcomes comes from studies of individuals with chronic medical conditions. Less is known about the role of these measures for individuals with chronic serious mental illness (SMI) with comorbid medical conditions like diabetes who typically face even more fragmented delivery systems. We examine the association between a CoC index within both primary care (PC) and behavioral health (BH) settings separately, the care

density variable and emergency department utilization, hypothesizing that greater CoC and care density is associated with less ED utilization among chronically ill enrollees.

1.3.2 Population studied

Sample includes adult Pennsylvania Medicare enrollees with SMI (295.x, 296.0, 296.1, 296.4–296.7, 296.2x and 296.3x) who had type II diabetes (both met CMS Chronic Condition Warehouse criteria for type II diabetes and had a prescription for oral or intravenous diabetes medication) and were continuously enrolled in 2011 and 2012: 5,112 elderly and 5,591 disabled enrollees

1.3.3 Study Design

We implemented an observational study of the association between emergency department visits and CoC (measured through the CoC index and care density) in BH or PC. We used count of PH and BH health providers, the number of patients shared between these providers and the total number of visits made by disabled and elderly enrollees to construct separate measures of CoC and care density. To calculate CoC index we used the he Modified Modified Continuity Index (MMCI) which accounts for total number of visits as well as degree of dispersion among different providers. MMCI-based CoC scores ranged from 0 (each visit was to a different provider) to 1 (all visits to a single provider). The care density variable measures the extent of patient sharing among providers given evidence that patient sharing is associated with between-provider communication. A large care density value shows that the patient is seeing providers that share multiple patients between themselves. We used negative binomial regression to measure association between

number of ED visits and each CoC measure adjusting for demographic, diagnosis and care density among providers. Elderly and disabled enrollees were analyzed separately to account for differences in population type.

1.3.4 Results

During 2012, 41% of the elderly and 44% of the disabled enrollees did not have any ED visits. The mean number of ED visits was 2.6 (standard deviation SD 5.3) by the elderly and 1.7 by the disabled enrollees. Average number of BH providers was 0.84 (SD 0.9) and 1 (SD 1.0) where as BH COC score was 0.6 and 0.7 in the elderly and disabled enrollees respectively. Number of PC providers seen was 2 (SD 1.6) for the elderly and 1.9 (SD 1.6) for the disabled enrollees. PC COC in the elderly and disabled enrollees was 0.8 (SD 0.28) and 0.8(SD 0.32) respectively. Disabled enrollees had a higher care density (19.6, SD 29.6) than the elderly (18.6, SD 25.5).

Negative binomial regression showed that for every 1-point increase in PC CoC there was a 34% (P=<0.01) decrease in rate of ED visits among elderly and 38% (p <0.01) decrease in ED visits among disabled beneficiaries. BH COC was not significantly associated with rate of ED visit. Care density was also associated with a decrease in ED visits (IRR =0.99, P<=0.01)

1.3.5 Conclusion

A high level of care coordination in PC was associated with decreased emergency department use for individuals with SMI and type II diabetes. This finding underscores the importance of care delivery reform that encourages care coordination in PC practices.

1.3.6 Policy Implication

Medicare payment models that incentivize greater care coordination across providers will need to address the complex set of provider relationships that enrollees with SMI navigate.

2.0 IS MENTAL ILNLESS A RISK FACTOR FOR HOSPITAL READMISSION

Approximately 18 percent of all Medicare hospital admissions are followed by a readmission within 30 days, at a cost to the program of $15 billion per year. (Commission, 2007) Given that 27 percent of these readmissions are potentially avoidable(van Walraven, Jennings, et al., 2011), Medicare instituted a program to reduce payments to hospitals with higher rates of readmissions. Initially focused on heart failure, acute myocardial infarction, or pneumonia readmissions, the program is expected to include all conditions in the near future. (Balla, Malnick, & Schattner, 2008; Van Walraven, Bennett, Jennings, Austin, & Forster, 2011) The Hospital Readmissions Reduction Program (HRRP), under the Patient Protection and Affordable Care Act (Law, 2015) authorized the Centers for Medicare and Medicaid Services (CMS) to modify hospital payments based on readmission rate starting in 2014. The HRRP risk-adjusts readmission rates for demographic factors and severity of illness. A hospital's penalty is determined through a complex formula which compares its rates to a national average. Recent data show that 17 percent of hospitals have lost up to 3 percent in Medicare revenue annually since the program's inception. (Boccuti & Casillas, 2015)

People with mental illness have a greater prevalence of chronic medical conditions such as diabetes than those without mental illness, (Barefoot & Schroll, 1996; Kawachi et al., 1994; Stone & Hoffman, 2010; Unützer, Schoenbaum, Druss, & Katon, 2006) leaving them more vulnerable to readmission than the general population. Additionally, mental and physical health care are typically fragmented across multiple providers with limited communication between them. (Horvitz-Lennon et al., 2006) Analysis of Medicare readmission rates shows that some hospitals—for example, safety-net hospitals—have higher rates of admissions by individuals

with mental illness. (Axon & Williams, 2011) This has led to concern that those hospitals will bear a greater burden of this penalty than other hospitals. (Berenson & Shih, 2012; James, 2013)

Two strategies that hospitals adopt to lower readmission rates are improving adequacy of medication regimens and ensuring timely outpatient follow up. (Alper, O'Malley, Greenwald, Aronson, & Park, 2014; Coleman & Williams, 2007; Misky, Wald, & Coleman, 2010)Individuals with mental illness often see different providers for their physical and mental illnesses and there is little coordination between these providers to keep the patient engaged in care (Druss, Rosenheck, Desai, & Perlin, 2002; Yoon & Bernell, 2013) likely contributing to higher rates of missed appointments or dropping out of outpatient care. (Mitchell & Selmes, 2007) Hospitals use teams of care coordinators to increase patient engagement in outpatient care. (Dixon et al., 2009)

During the course of an inpatient hospitalization there could be intentional or unintentional changes in medication regimen. (Harrington et al., 2004; Nieminen et al., 2005)One example of an intentional change is treatment of new or ongoing symptoms through addition or discontinuation of therapeutic category of drugs such as the start of a new antihypertensive. (Woltz et al., 2012) Unintentional changes could be due to a faulty hand off between inpatient and outpatient levels of care, such as unintentional discontinuation of antidepressants during the inpatient stay. (Lang et al., 2010) There could also be modifications to medications within a therapeutic category (e.g. increase or decrease in number of antipsychotic medications or changing from first generation to second generation antipsychotics). (Kasper et al., 2002) While within-class changes in medication can indicate titration/substitution of medications (Gheorghiade, Vaduganathan, Fonarow, & Bonow, 2013), any change in number of therapeutic categories may signal new identification or omission of a

symptom during the inpatient episode. (Cornish et al., 2005; Forster, Murff, Peterson, Gandhi, & Bates, 2003)

Any changes in medication regimen can lead to medication errors at the transition between inpatient and outpatient care and increase the likelihood of readmission. (Bell et al., 2011; Pronovost et al., 2003) Individuals with mental illness have multiple providers (primary care, psychiatrist, inpatient attending) (Jiang et al., 2016), and significant numbers may also have cognitive impairment, sub-optimal health literacy or complex drug regimen. (Brown & Bussell, 2011) Therefore when medication changes occur during hospitalization, the risk for adverse drug reactions that can lead to readmission is high for mentally ill individuals. (Bell, Rahimi-Darabad, & Orner, 2006; Campbell et al., 2012)

However, little is known about whether the quality of medication management during the inpatient stay or the timeliness of outpatient services following discharge can have any effect on the risk of readmission for those individuals with mental illness who are hospitalized for any of the three initial conditions that were impacted by the HRRP program. (HF, AMI and pneumonia) To better understand these issues, we examined 30-day readmission rates for adults with mental illness using data from a random sample of Medicare enrollees. We subsequently examined factors influencing readmission, including changes to medication regimens, and post-hospitalization follow-up care, and whether these factors are moderators of readmission for individuals with mental illness. We finally test whether there is any hospital-level variation in the prevalence of mental illness in our sample that could have led to unfair penalties for those hospitals.

2.1 METHODS

2.1.1 Data and Study Sample

We obtained 2009 and 2010 enrollment and claims data from CMS for a random national sample of 1,529,825 fee-for-service Medicare enrollees who were continuously enrolled in a Part D prescription drug plan (PDP) in 2009. Because the individuals in our sample were enrolled in Part D, they were more likely to be dually eligible (36 percent) compared to 19 percent of enrollees nationally. They are also more likely to be low income and have mental illness compared to all Medicare enrollees.(Boccuti & Casillas, 2015) We restricted our sample to individuals $\geq$ 18 years old with at least one inpatient admission for heart failure, acute myocardial infarction (AMI), or pneumonia—conditions initially subject to HRRP program. To compare people with mental illness to those with other chronic conditions, we limited our study sample to enrollees who had at least one non–mental health chronic condition according to Medicare's Chronic Conditions Data Warehouse (CCW) (N = 1,351,821), excluding people with end-stage renal disease (ESRD).(Warehouse, 2012) Our final sample consisted of 76,916 adult Medicare enrollees.

We obtained patient characteristics from the Beneficiary Annual Summary File (Medicare & Services, 2009) and Medicare Provider Analysis and Review (MEDPAR) data containing the admission date, discharge date, diagnoses, discharge destination, and other information for each inpatient or skilled nursing facility (SNF) stay. We also obtained outpatient, professional, and prescription drug claims.

2.1.2 Index Event

This is the first inpatient hospitalization with a discharge date between July 1, 2009, and November 30, 2010, and a primary discharge diagnosis of AMI, heart failure, or pneumonia. We chose the 17-month range to allow us to observe a six-month blackout period of no inpatient admissions prior to the index admission and a 30 day follow up period after the index event to measure readmission. For people with multiple admissions, we selected the first admission during our time frame.

2.1.3 Outcome Variable: Readmission

Consistent with the CMS policy on all-cause readmissions, we defined the dichotomous yes/no readmission variable based on the observation of an admission to an acute-care hospital within 30 days of the index admission discharge date, regardless of the clinical reason for the admission. We treated discharges from the index hospitalization to another acute-care hospital for which the index discharge date was within one day of the next admission date as transfer cases rather than readmissions. (Medicare & Services, 2014b) For people with multiple readmissions, we consider only the first readmission.

2.1.4 Key Independent Variables

Our key independent variables were any mental illness (defined below), as well as the interaction of mental illness with change in number of medication therapeutic categories to test whether any addition/deletion of a new a new therapeutic category could impact readmission

rates. We also tested whether an added day of outpatient follow up within 30 days of discharge can have an effect on the readmission rate.

Mental illness was defined using a case-ascertainment method adapted from (Gregory Luke Larkin, Claassen, Emond, Pelletier, & Camargo, 2005) based on the observation of a primary diagnosis of International Classification of Diseases, 9th revision, clinical modification [ICD-9-CM] codes 290, 293–302.x, and 306.x–319.x in one inpatient or two outpatient events during the year.

There are several approaches to measuring changes to the medication regimen before and after a hospitalization. One can measure changes in the number of drugs (e.g., paroxetine), pharmacologic classes (e.g., SSRI), or therapeutic categories (e.g., antidepressants). While drug changes could illustrate titration or substitution of medications within that class, the addition(Kasper et al., 2002) or deletion of an entire therapeutic category can indicate a change in symptom treatment before or after the inpatient episode (Cornish et al., 2005). These changes might result from intention on the part of the treating team in inpatient or outpatient settings or may represent inadvertent changes due to disruptions in adherence. We chose to test whether there were any broad level changes in the medication using number of therapeutic categories for which the beneficiary filled prescriptions 30 days before and after index event, and grouped enrollees into those whose post-discharge therapeutic category were greater than (medications were added), less than (medications were dropped), and equal to their counts prior to admission.

Given that 94% of the index admissions had at least one follow up visit post-discharge, we chose to examine the incremental risk of readmission for each day of any physical or psychiatric outpatient service that was delivered using a continuous variable rather than a dichotomous variable that measures the presence or absence of outpatient services. We counted

unique days of outpatient service utilization 30 days after admission using the outpatient and carrier claims submitted for outpatient services.

2.1.5 Covariates

The key explanatory variables were: (i) an indicator of social vulnerability which is beneficiary entitlement to a low-income subsidy (LIS) under Medicare Part D (a sliding scale of enrollment eligibility starts from automatic enrollment for beneficiaries who are at 100% federal poverty level (FPL) to a manual application process if the beneficiary is less than 150% FPL.), (ii) two indicators of illness severity and healthcare need (substance use disorder diagnosis, a binary variable operationalized as at least one inpatient or two outpatient services with the ICD-9-CM codes 303.x–305.x during the analysis period, and count of chronic-condition comorbidities from the chronic condition warehouse.) (iii) Index admission variables such as length of stay, defined as the number of days of the index admission episode, and discharge disposition, defined as discharge to SNF, home health, other (intermediate care facility, hospice home), or home.

We also adjusted for demographic characteristics (age, sex, and race [white, black, or other]), beneficiary entitlement category (aged versus disabled), and dual enrollment in Medicaid. We tested for collinearity between the LIS and dual enrollment in Medicaid and finding none, included both in our model.

2.1.6 Statistical Analysis

We computed descriptive statistics to assess the association between readmission rates and each of the independent variables using chi-square tests. To analyze the association between the readmission rates adjusting for the covariates, we used a generalized linear model (GLM) with a log link function and binomial distribution. To address clustering at the hospital-level, we included hospital random effects. We also conducted an analysis using propensity score matching of the two cohorts (mental illness and physical illness only) adjusting for the likelihood of having a mental illness in the two populations. Since the results were not significantly different, we present the GLM analysis only.

We conducted three sets of GLM analyses: First, we measured readmission risk using the key independent variable –mental illness and demographic and health status variables. Next, we added the 2 key independent variables (change in number of medication therapeutic categories and f outpatient follow-up) as well as length of stay and discharge disposition to test the incremental effects of these variables on readmission rates. Finally, we added interaction effects between mental illness and the two key independent variables to test whether these variables moderate the effect of a mental illness diagnosis on readmission risk.

We conducted a sensitivity analysis stratifying by eligibility category. Since individuals who are eligible to receive Medicare through disability, compared to those the elderly, may have different risks for readmission. Because the results were qualitatively similar to the pooled analysis, we present the pooled results only.

Finally, we assessed the distribution of mental illness within each hospital by using the provider ID in the analytic sample. For the hospitals in the sample, we calculated the percentage of patients with mental illness compared with all those discharged with an index event. To be

consistent with CMS policy, we limited this analysis to hospitals with 11 or more patients in the study sample.(Medicare & Services, 2014a)

2.2 RESULTS

2.2.1 Descriptive characteristics

The final sample consisted of 40,048 enrollees (28,648 elderly and 11,402 disabled) who had $\geq$ 1 inpatient admission for heart failure, myocardial infarction, or pneumonia in 2009 or 2010. (See Table 1). The prevalence of any mental illness in the final population was 51 percent for the elderly and 60 percent for the disabled (see Table 1). Three percent of the elderly and 10 percent of the disabled population with mental illness had co-occurring substance-use disorders.

There was no change in the number of medication therapeutic categories before and after admission for approximately half (53 percent) of the elderly and 47 percent of the disabled enrollees with mental illness. More than one-third (35 percent in elderly and 40 percent in disabled) had a decrease in the medication therapeutic category, and the rest (12 percent in elderly and 14 percent in disabled) showed an increase. This distribution was not significantly different from those with chronic physical illness only.

The average number of outpatient visits in the 30 days after admission was 5.4 in the elderly with mental illness and 5.2 in the disabled population This lower among those with chronic physical illness only (5.2 in elderly and 4.4 in the disabled population) [$p < 0.01$].

Table 1. Characteristics of Medicare Enrollees with Chronic Physical Condition or Mental Illness Hospitalized for Heart Failure, Acute Myocardial Infarction, or Pneumonia, 2009-10

	Elderly		Disabled	
Characteristic	**Mental Illness and Chronic Physical Condition**	**Chronic Physical Condition Only**	**Mental Illness and Chronic Physical Condition**	**Chronic Physical Condition Only**
N (%)	14,665 (51%)	13,981(49%)	6,847 (60%)	4,555 (40%)
Demographics				
Female, (%)*	70	56	57	44
Age, in years;	72 (7.9)	79 (7.9)	62 (14)	64 (12)
Race, (%)*				
White	86	84	80	67
Black	8	9	15	27
Other	6	7	5	6
LIS*	50	34	70	82
Dual	43	28	71	55
Some Mental illness diagnoses, (%)*				
MDD	16		28	
Schizophrenia	3		12	
Bipolar	4		15	
Substance use	3		10	
Medical comorbidities;	7.7 (2.5)	6.5 (2.3)	6.6 (2.8)	6.1 (2.4)
Index				
Length of stay; mean (SD)*	5.2 (4.5)	4.6 (3.5)	4.7 (4.2)	5.1 (4.8)
Discharge disposition, (%)*				
Home	41	69	58	73
Home health	18	17	14	15
SNF	30	9	18	5
Other	11	5	10	3

Table 1 Continued

Characteristic	Elderly		Disabled	
	Mental Illness and Chronic Physical Condition	**Chronic Physical Condition Only**	**Mental Illness and Chronic Physical Condition**	**Chronic Physical Condition Only**
Post index outpatient utilization; mean (SD)*	5.4 (4.4)	4.69 (3.8)	5.2 (4.4)	4.4 (3.9)
Medication: Difference in numbers of Medication **Therapeutic Categories** 30-days pre- and post-hospitalization				
Therapeutic categories dropped; percentage (mean	12 (3)	14 (3)	13 (3)	13 (3)
Therapeutic categories added; percentage (mean change in)	35 (–3)	40 (–2)	40 (–3)	40 (–2)
Therapeutic categories same, (%)*	53	46	47	47

NOTE: Mental Illness is a diagnosis code of 295.x, 296.x, 300.x, or 311.x. Substance-use disorder is diagnosis of 303.x–305.x. *Mental illness and chronic physical condition* refers to people with mental illness and chronic physical conditions. *Chronic physical condition only* refers to people with chronic physical conditions only. We identified chronic physical illnesses using the CCW algorithm and 2009 Medicare data consisting of inpatient, outpatient, and home health events. We considered only first hospitalizations in 2009 for AMI, heart failure, or pneumonia as index events. We considered only hospitalizations from January to November 2009 for 30 days to readmission. We considered hospital events that were less than one day apart a single event. Change in medication therapeutic categories is the number of medication class during the 30 days before and 30 days after inpatient stay. One unit of change is equal to the addition or subtraction of a single therapeutic class. Post-index outpatient utilization is the number of services received in the 30 days after the index hospitalization.
* = $p < 0.001$

The average length of stay at the index admission in the mentally ill population was 5.2 days and 4.7 days, for the elderly and disabled, respectively. Those with chronic physical illness only had a lower length of stay (4.6) for the elderly and 5.1 for the disabled ($p < 0.01$).

2.2.2 Readmission rates and risk factors

In unadjusted analyses, people with mental illness had higher readmission rates (15 percent) than the chronic physical illness only group (10 percent) (see Figure 1).

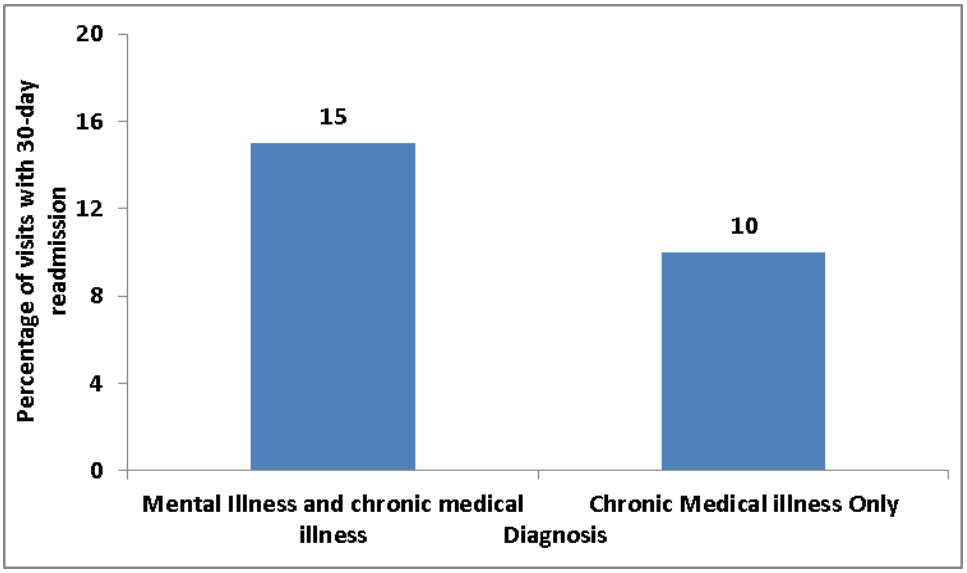


Figure 1. 30-Day Unadjusted Readmission Rater for Chronically Ill Medicare Beneficiaries Admitted to an Acute Care Facility for Acute Myocardial Infarction, Heart Failure or Pneumonia

NOTE: Mental illness is a diagnosis code of 295.x, 296.x, 300.x, or 311.x. Readmission is all admissions to acute-care facilities that were between 1 and 30 days after index admission. We considered only first hospitalization in 2009 for AMI, heart failure, or pneumonia as the index event. We considered only hospitalizations from January to November 2009 for 30 days to readmission. We identified chronic physical illnesses using the CCW algorithm and 2009 Medicare data consisting of inpatient, outpatient, and home health events.

After adjusting for demographic variables and co-occurring physical and substance-use diagnoses, people with mental illness were 33-percent more likely to be readmitted than those without mental illness (Odds ratio OR: 1.33 [CI:1.24, 1.42]; $p < 0.01$) (see Table 2). Women were also less likely than men to be readmitted (OR = 0.85; [CI = 0.80, 0.91]; $p < 0.01$), Individuals with comorbid substance-use diagnoses had higher odds of readmission (OR = 1.26; [CI = 1.03, 1.55]; p < 0.01) than those without a comorbid diagnosis of substance use. After adding variables relevant to follow-up care and medication changes, people with mental illness still had higher odds (OR = 1.33; [CI = 1.23, 1.43]; $p < 0.01$) of readmission than those without mental illness.

Table 2. Adjusted Odds Ratios and 95-Percent Confidence Intervals for 30-Day Readmission Rate for Medicare Enrollees with Chronic Physical Conditions or Mental Illness Hospitalized for Heart Failure, Acute Myocardial Infarction, or Pneumonia, 2009–2010

Characteristic	Demographic and Health Status Variables Only	Including Health Utilization Variables	Health Utilization Variables Interacted with Mental illness
Mental illness	1.33 (1.24, 1.42)*	1.33 (1.23, 1.43) *	1.46 (1.15,1.85) *
Female	0.85 (0.80, 0.91) *	0.91 (0.85, 0.98) *	0.91 (0.84,0.98) *
Entitlement	0.98 (0.89, 1.06)	1.07 (0.97, 1.18)	1.06(0.96,1.17)
Age	0.99 (0.99, 0.99) *	1.00 (1.00, 1.01) *	1.00(1.00,1.01) *
Race: *Reference category is white*			
Black	1.05 (0.96, 1.16)	1.15 (1.02, 1.29) *	1.15(1.03,1.29) *
Other	0.94 (0.82, 1.07)	0.94 (0.81, 1.10)	0.94(0.80,1.09)
LIS	1.03 (0.97, 1.10)	1.33 (1.23, 1.44) *	1.33 (1.23,1.45) *
Dually eligible	1.09 (0.83, 1.43)	1.07 (0.79, 1.46)	1.07 (0.78,1.46)
Substance-use disorder	1.33 (1.13, 1.58)	1.26 (1.03, 1.55) *	1.26 (1.03,1.53) *
Number of chronic illnesses	1.19 (1.17, 1.20) *	1.05 (1.03, 1.06) *	1.05 (1.03,1.07)
Index event–level variables			
Length of stay	-	0.99 (0.98, 0.99) *	0.99 (0.98,1.00) *
Outpatient follow-up	-	1.36 (1.35, 1.38) *	1.40 (1.37,1.41) *

Table 2 Continued

Characteristic	Demographic and Health Status Variables Only	Including Health Utilization Variables	Health Utilization Variables Interacted with Mental illness
Difference in TCM: *Reference category is no difference in therapeutic categories count*			
Therapeutic categories dropped	-	1.11 (0.99, 1.25)	0.95 (0.79,1.14)
Therapeutic categories added	-	1.26 (1.12, 1.41) *	1.16 (0.97,1.39)
Discharge destination: *Reference category is home*			
Home health	-	1.11 (1.01, 1.21) *	1.10 (1.00,1.20) *
SNF	-	0.62 (0.56, 0.69) *	0.62(0.56,0.69) *
Other	-	0.18 (0.14, 0.23) *	0.18(0.14,0.23) *
Mental illness * Outpatient follow-up	-	-	0.96 (0.94,0.97) *
Difference in TCM*: Reference category is no difference in therapeutic categories count*			
Mental illness * Therapeutic categories dropped	-	-	1.30 (1.03,1.65) *
Mental illness * Therapeutic categories added	-	-	1.14 (0.91,1.44)

NOTE: Bold indicates significance at $p < 0.001$. Mental illness is a diagnosis code of 295.x, 296.x, 300.x, or 311.x in one inpatient or two outpatient events during the year. Substance-use disorder is a diagnosis of 303.x–305.x. We identified chronic physical conditions using the CCW algorithm and 2009 Medicare data consisting of inpatient, outpatient, and home health events. We considered only first hospitalization in 2009 for AMI, heart failure, or pneumonia as the index event. We considered only hospitalizations from January to November 2009 for 30 days to readmission. We considered hospital events that were less than one day apart a single event. Outpatient follow-up is the number of outpatient services received in the 30 days after the index admission.

2.2.3 Change in medication therapeutic class and Outpatient Visits as a moderator of readmission for MI

Changes in medication therapeutic categories were not significantly associated with readmission risk for the whole population. However, for individuals with mental illness, decrease in therapeutic categories after discharge from the index event was associated with 30-percent greater odds (OR = 1.30 [CI = 1.02, 1.64]; $p < 0.01$) of readmission than those who had no change in medication therapeutic class. To examine this, further, we list the top 5 most common medication therapeutic classes that were added or dropped after index admission are listed in

table 3. These medications included beta blockers, and antilipidemia drugs for individuals with physical illness only, and antidepressants for individuals with mental illness. These medications were different for the readmitted compared to not readmitted individuals in both physical illness only and the mental illness populations.

Table 3. Ten most common therapeutic categories that were added or dropped after index admission Medicare Enrollees with Chronic Physical Condition or Mental Illness Hospitalized for Heart Failure, Acute Myocardial Infarction, or Pneumonia, 2009–2010

Medication that is Dropped after Index Admission

Physical Health Illness Only				Mental Illness and Physical Health Illness			
Not Readmitted		**Readmitted**		**Not Readmitted**		**Readmitted**	
Therapeutic Category	% of pts	Therapeutic Category	% of pts	Therapeutic Category	% of pts	Therapeutic Category	% of pts
Analgesics - Opioid	3.5%	Analgesics – Opioid	5.0%	Analgesics - Opioid	5.5%	Antidepressants	8.0%
Antihypertensives	3.1%	Antihypertensives	3.4%	Antihyperlipidemics	4.4%	Analgesics - Opioid	5.9%
Antihyperlipidemics	3.0%	Antihyperlipidemics	3.2%	Antihypertensives	4.1%	Antihyperlipidemics	5.7%
Antiasthmatic and Bronco dilators	2.8%	Antidiabetics	2.9%	Antiasthmatic and Bronco dilators	3.3%	Antihypertensives	5.1%
Antidiabetics	2.2%	Antianginal Agents	2.2%	Beta Blockers	2.8%	Beta Blockers	3.6%
Beta Blockers	2.2%	Analgesics – Antiinflamatory	2.1%	Diuretics	2.4%	Antiasthmatic and Bronco dilators	3.4%
Analgesics - Antiinflamatory	2.1%	Antiasthmatic and Bronco dilators	2.1%	Analgesics – Antiinflamatory	2.2%	Analgesics - Antiinflamatory	3.1%
Anticoagulants	1.7%	Beta Blockers	1.9%	Antidiabetics	1.9%	Diuretics	2.6%
Antianginal Agents	1.5%	Calcium Channel Blockers	1.8%	Anticonvulsants	1.7%	Antidiabetics	2.5%
Calcium Channel Blockers	1.4%	Anticoagulants	1.5%	Calcium Channel Blockers	1.6%	Anticonvulsants	2.1%
Other categories	30.7%	Other categories	35.1%	Other categories	34.5%	Other categories	37.6%

Medication that is Added after Index Admission

Table 3 Continued

Physical Health Illness Only				Mental Illness and Physical Health Illness			
Not Readmitted		**Readmitted**		**Not Readmitted**		**Readmitted**	
Therapeutic Category	% of Individuals	Therapeutic Category	% of Individuals	Therapeutic Category	% of Individuals	Therapeutic Category	% of Individuals
Beta Blockers	16.0%	Beta Blockers	17.9%	Beta Blockers	11.1%	Beta Blockers	11.0%
Antihypertensives	14.1%	Diuretics	16.5%	Diuretics	10.7%	Diuretics	10.4%
Diuretics	14.0%	Antihypertensives	13.5%	Antihypertensives	9.5%	Antihypertensives	8.9%
Antihyperlipidemics	13.2%	Antihyperlipidemics	13.4%	Antihyperlipidemics	8.3%	Antihyperlipidemics	8.8%
Hematological Agents - MI	9.4%	Ulcer drugs	9.9%	Ulcer drugs	7.5%	Fluoroquinolones	8.7%
Ulcer drugs	7.4%	Hematological Agents – MI	9.9%	Antianginal agents	6.7%	Ulcer drugs	7.8%
Minerals and electrolytes	6.6%	Analgesics – opioid	8.6%	Minerals and electrolytes	5.8%	Antidepressants	7.0%
Antianginal agents	6.0%	Fluoroquinolones	8.6%	Fluoroquinolones	5.5%	Analgesics – opioid	6.6%
Calcium Channel Blockers	5.6%	Antianginal agents	8.6%	Antiasthmatic and Bronco dilators	5.5%	Hematological Agents - MI	5.9%
Antiasthmatic and Bronco dilators	5.5%	Minerals and electrolytes	8.4%	Analgesics – opioid	5.3%	Minerals and electrolytes	5.9%
Other categories	37.2%	Other categories	42.9%	Other categories	36.5%	Other categories	37.6%

NOTE: individuals may have more than one therapeutic category changed and therefore percentages will not add up to a 100. Mental illness is a diagnosis code of 295.x, 296.x, 300.x, or 311.x in one inpatient or two outpatient events during the year. Substance-use disorder is a diagnosis of 303.x–305.x. We identified chronic physical conditions using the CCW algorithm and 2009 Medicare data consisting of inpatient, outpatient, and home health events. Index admission is first hospitalization in 2009 for AMI, heart failure, or pneumonia. We considered only hospitalizations from January to November 2009 for 30 days to readmission. We considered hospital events that were less than one day apart a single event. Other therapeutic category includes all other therapeutic categories. * = $p < 0.001$

Also, in the entire sample, an increase in outpatient use was associated with a 40 percent greater odds (OR = 1.40; [CI = 1.38-1.43]; p<0.01) of readmission. Conversely, for the mentally ill population, each day of outpatient utilization in the 30 days after admission, there were 4-percent lower odds (OR = 0.96; [CI = 0.94, 0.98]; p<0.01) of readmission.

2.2.4 Difference in prevalence of mental illness across hospitals

There were 3,878 hospitals in our study, the mean percentage of admissions with mental health was 50 with an SD of 15 percent. Of these, 2,408 had more than ten admissions. Figure 2 shows the distribution of mental health patients across hospitals for those hospitals that had more than ten admissions.

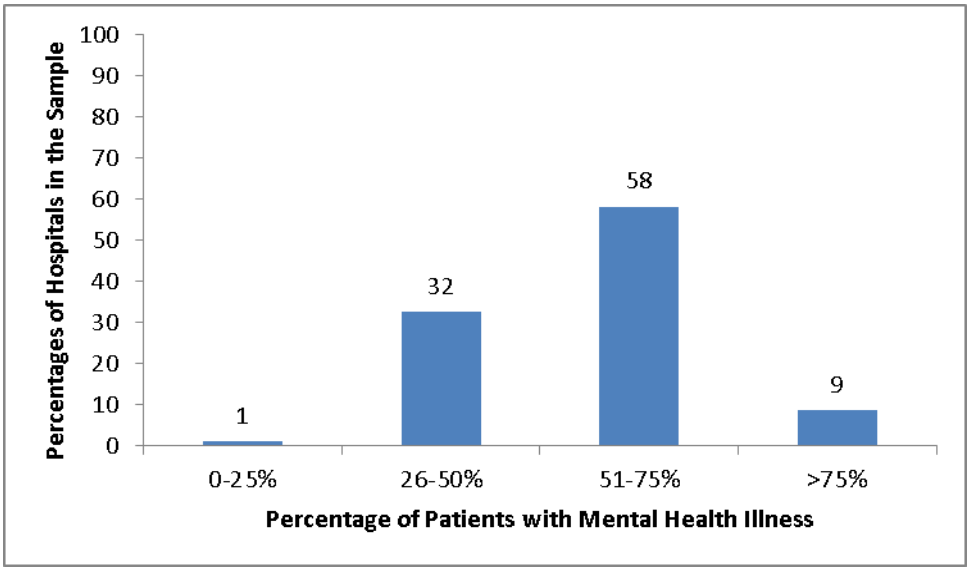


Figure 2. Rate of Mental Illness in Medicare Beneficiaries Admitted for Acute Myocardial Infarction, Heart Failure, or Pneumonia Who Have Mental Illness, 2009–2010

NOTE: Mental illness is a diagnosis code of290, 293–302.x, and 306.x–319.x. To be consistent with CMS reporting rules, we limited the distribution to hospitals that had ten or more admissions (2,408 out of 3,878 hospitals in the analytic sample).

2.3 DISCUSSION

Our study has two main findings that show individuals with mental illness are at significantly higher risk for 30-day readmission after hospitalization for AMI, pneumonia, and heart failure and this association persisted after adjusting for demographic, socioeconomic and other measures of health status. First, beneficiaries with mental illness who have a decrease in medication therapeutic categories after the inpatient stay compared to before are much more likely to be readmitted. Second, for individuals with mental illness, an increase in outpatient visit is associated with a lower risk for readmission.

Any decrease in the number of medication therapeutic categories after an inpatient stay could be intentional or due to medical error. (Kilcup, Schultz, Carlson, & Wilson, 2013) During acute hospitalization, chronic medications like antipsychotics are sometimes held initially while the patient is stabilized. (Bell et al., 2011) When patients are moved from intensive care units to rooms, these medications may not be restarted and subsequently may not be included at discharge. (Unützer et al., 2006) Even during intentional changes to medication regimen such as discontinuation of a diuretic cognitive could impede individuals with mental illness from understanding and complying with the revised medication. (Ziegelstein et al., 2000) However, we realize that there are some constraints to this conclusion. First, the variable change in medication therapeutic categories that we are using is derived from the pharmaceutical claim files, so it calculates the prescriptions that were filled in the 30 days before and after admission. We are attributing any post-discharge changes in these prescriptions to the index admission. If these changes had been initiated by the outpatient provider post-discharge, it might not be a result of medication changes during the inpatient admission. Also, this crude class-level measure does not take into account what medications were changed. For example, it would not capture

reductions in or additions of polypharmacy within a single therapeutic class. Further study may be warranted to investigate whether the decrease in medication therapeutic categories was due to an omission of their psychiatric medication or an intentional change in the medication regimen.

We also found in general that the number of outpatient visits was associated with higher odds of readmission. Increased outpatient service use can be an indicator for underlying health status (Yasaitis, Bynum, & Skinner, 2013) possibly not explained by our covariates. However, even though this would also be true in those with mental illness, the number of outpatient follow-up visits in this population was associated with lower odds of readmission. Literature has shown that individuals with mental illness are often less likely to receive adequate preventive or treatment visits with primary care providers for their physical illnesses.(Leslie & Rosenheck, 2000) One study found that up to 75% of those discharged were not also compliant with their outpatient mental health appointments. (Nelson, Maruish, & Axler, 2000) Hospitals have tried to address this issue to improve outpatient follow-up for the individual with mental illness individuals through patient-centric handoff with outpatient providers specifically including discussions regarding follow-up plans and medication changes. (D McCarthy, 2012) Efforts such as employing multi-disciplinary care management teams have been successful in engaging patients in outpatient care and preventing readmission. (Coleman, Parry, Chalmers, & Min, 2006; D McCarthy, 2012; Viggiano, Pincus, & Crystal, 2012)

Finally, disparities in medical care for the mentally ill population have been widely documented. In fact, some studies have argued that Medicare patients with mental illness are less likely to receive certain surgery and more likely to be referred to outpatient care than those who have no mental illness.(Li et al., 2011) Neighborhood poverty also plays a role in the disparities of health care service utilization by the mentally ill. (Chow, Jaffee, & Snowden, 2003) Our study

also showed that some hospitals have higher proportions of patients with mental illness than others. In response, these hospitals might want to develop strategies like care management services or psychiatry consultation & liaison service that specifically target their mentally ill patient population to reduce their readmission- rates.

Our findings should be viewed in light of several limitations. Identifying mental health or physical health disorders using claims data has limited sensitivity and specificity, and no information is available about the severity of disorders from claims data. (Lurie, Popkin, Dysken, Moscovice, & Finch, 1992; Spettell et al., 2003) We also cannot assess other factors, such as underlying health status not measurable in claims data, social support, or the quality of care all of which are likely to influence readmission rates. We limited our study to Medicare enrollees with Part D benefits so that we could observe their medication use pre- and post-discharge. Part D enrollees are more likely to be low-income, dually eligible for Medicaid, and to be <65 disabled than all Medicare enrollees. They are also likely to have a higher prevalence of mental disorders than Medicare generally therefore our findings may not generalize to non-Part D enrollees.(Donohue, Huskamp, & Zuvekas, 2009)

Our analysis focused on the first three conditions (acute myocardial infarction, pneumonia and heart failure) that were subject to the readmission rule, and may not be generalizable to more recently added conditions or other conditions that will be added in the future.(Medicare & Services, 2014a) Our variable discharge disposition to an SNF or home health facility could be influenced by the beneficiary's health status and functional limitations—factors that could also affect the readmission rates.

Finally, in order to assess whether any mental illness increases the risk of readmission, we included all mental illnesses in our analysis. Individuals with serious and persistent mental

illness could have a greater risk of readmission than those with non-chronic mental illnesses and it may be important to study them separately.

2.4 CONCLUSION

People with mental illness have a higher risk of readmission after inpatient admission for heart failure, pneumonia, or myocardial infarction. This study shows that, medication reconciliation and outpatient follow up may prevent relapse in this vulnerable population. Hospitals may use services like psychiatric consultation and liaison or care management to reduce risk of readmission for individuals with mental illness.

3.0 CATEGORIZATION OF FREQUENT EMERGENCY DEPARTMENT UTILIZATION BY INDIVIDUALS WITH MENTAL ILLNESS

Between 1997 and 2007 there was a fifteen percent increase in emergency department (ED) visits by individuals with mental illness compared to an eleven percent increase by the general population.(Buck, Miller, & Bae, 2000; Niska, Bhuiya, & Xu, 2010; Owens, Mutter, & Stocks, 2006; Smith, Larkin, & Southwick, 2008) Studies show that a third of all these ED visits are made by a small fraction (2 to 8 percent) of individuals with mental illness.(Chang, Weiss, Orav, & Rauch, 2014; Chaput & Lebel, 2007; Ellison, Blum, & Barsky, 1986) What is not clear is whether this high utilization of ED is made as a substitute for more appropriate outpatient services. Alternatively, high utilizers of ED may also have a greater need of care due to the severity of their symptoms and concurrently utilize a high number of outpatient services while they are visiting the ED multiple times. Regardless, these individuals often do not receive quality care concomitant with their health care needs. (Lindamer et al., 2012) Health systems have sought to rectify this issue through the use of care managers who coordinate preventive and follow up visits for individuals with mental illness.(Douglas McCarthy, Cohen, & Johnson, 2013) However, there is little evidence to show whether this has made an impact on the high utilizers of ED.

To provide some insight in to whether high ED utilization is indeed due to a gap in ambulatory care, it is important to look at the reason for ED visits. Visits to the ED for reasons

that could be treated in other ambulatory care settings has been studied at length in the general population. (Begley, Courtney, & Burau, 2006; Billings, Parikh, & Mijanovich, 2000; Chen et al., 2016) While this is important in the mentally ill population which has high rates of physical health diagnoses like cardiovascular or pulmonary diseases,(Catalano, McConnell, Forster, McFarland, & Thornton, 2003; Doran, Raven, & Rosenheck, 2013; Wan & Ozcan, 1991) such classifications largely ignore mental health or substance use issues. Individuals with mental illness could present to the ED for unmet physical or behavioral health issues and analyses on high utilizers should include both in determining reasons for ED use.

To inform effective strategies to improve care for individuals with mental illness who frequently use the ED it is critical to understand the reasons for their ED use and whether it is associated with outpatient care. Our study sought to fill this policy-relevant methodological gap using longitudinal analyses of Pennsylvania Medicaid data for 2007 through 2012. We first identify subgroups of enrollees with mental illness who are high utilizers of the ED. Secondly, we measure the intensity of outpatient primary care, behavioral health, and care management among high vs. low ED utilizers with MI to determine whether differences in ED use might be associated with outpatient use. Finally, we delineate whether visits are non-emergent vs. emergent, for PH, mental health or SUD needs.

3.1 METHODS

3.1.1 Data

We obtained enrollment and health care claims data for Pennsylvania Medicaid enrollees from 2007 to 2012 from the Pennsylvania Department of Human Services. The enrollment file contains information on the beneficiaries, including demographics (e.g., age, race/ethnicity, gender), eligibility category (Supplemental Security Income [SSI], General Assistance, Temporary Assistance for Needy Families [TANF], waiver), and whether they were in the fee-for-service (FFS) or managed-care program. We used inpatient, outpatient, and professional claims for behavioral health and physical health service information (e.g. service date, type of service and diagnosis at service).

3.1.2 Study Sample

The study sample includes every resident of Pennsylvania, age 18 -64 who was continuously enrolled in the Pennsylvania Medicaid program for at least 15 days per month during black out and the one year trajectory period. Because of incomplete claim information, we excluded enrollees who are dually eligible to receive both Medicaid and Medicare coverage. We identified people with mental illnesses as those with International Classification of Diseases, 9th revision, clinical modification [ICD-9-CM] codes 290, 293–302.x, and 306.x–319.x recorded as primary diagnoses at either one inpatient or two separate outpatient encounters.(Gregory L Larkin, Claassen, Emond, & Camargo Jr, 2004)

3.1.3 Emergency Department Visit Identification

Our dependent variable a count of ED visits per month. We identified ED visits using the methodology outlined by Henessy et al. (Hennessy et al., 2010) This method combines the use of revenue codes and procedure codes. ED visits were identified in the inpatient file (using revenue codes 0450, 0451, 0452, 0456, 459, or 0981 in any position), in the outpatient file (using the same revenue codes or using procedure codes 99281 through 99285, G0380 through G0385 or G8354) and in the professional file (using the same procedure codes or place of service code = 23.

We defined the index ED visit as the 1st observed visit to an ED during with a primary discharge diagnosis of MH or PH conditions. We allowed for a 6 month black out period of no ED or inpatient visits to capture a new episode of care. We observed the subjects' healthcare utilization and cost for 1 year following the index ED visit. To allow for the six-month pre-ED period and one-year post-ED trajectory analysis, we identified index events only between July 1, 2007, and December 31, 2011. We counted the number of ED visits per month during the year after the index visit. We counted multiple visits in a single day separately.

3.1.4 Key Independent Variables

3.1.4.1 Outpatient Utilization

In order to examine whether lack of outpatient visits had an effect on ED utilization, we used the professional claims to construct 2 outpatient utilization variables during (i) the six months prior to the index visit and (ii) one year post-index analysis period. We used the National Plan and Provider Enumeration System (NPPES) database to ascertain provider

specialty. We coded the specialty into 3 categories-behavioral health (including MH and substance use), primary care or other. If there was more than one visit to a provider in a single day, we counted each visit separately. We counted the number of the behavioral health, substance use and other outpatient provider visits per month to analyze the incremental effects of each provider visit on the number of ED visits. Since very few enrollees received any primary care visits, we added a binary variable to measure whether or not there was at least one primary care visit.

3.1.4.2 Ambulatory Care–Sensitive PH Emergency Department Visits

We used the criteria developed by Billings, Parikh, and Mijanovich (2000) to determine whether the ED visits in the analysis could be considered emergent and unavoidable. This methodology uses primary diagnosis to classify each visit in to 9 categories:

- Emergent and unavoidable physical health visits: diagnosis indicates that ED care was required and it was neither preventable nor avoidable. E.g. trauma, appendicitis or heart attack
- Preventable/avoidable emergent physical health visits: diagnosis indicates that ED care was needed but could have been avoided if effective ambulatory care had been received e.g. flare-ups of asthma, diabetes
- Primary care treatable emergent physical health visits: diagnosis indicates that care could have been provided effectively and safely in a primary care setting e.g. gastric ulcer, acute upper respiratory infection
- Non-emergent physical health visits: diagnoses not requiring medical care within 12 hours e.g. lump or mass in breast, sunburn, pregnancy examination or test

- Mental health related ED visits: primary diagnosis was mental illness e.g. Psychosis, delirium or dementia
- Drug use related ED visits: primary diagnosis was substance use e.g. opioid dependence, drug-induced delirium
- Alcohol related ED visits: primary diagnosis was alcohol use e.g. alcohol withdrawal, alcohol dependence
- Injury related ED visits e.g. Fracture dislocation of bones

3.1.5 Covariates

Covariates consisted of demographic variables (e.g., age, sex, race or ethnicity), eligibility criteria at the index visit (SSI, TANF, General Assistance, waiver), and several clinical variables (SMI, SUD comorbidity, physical health comorbidities). Previous studies have shown than high utilizers of ED have a larger rate of severe mental illness (SMI). (Aagaard, Aagaard, & Buus, 2014; Richard-Lepouriel et al., 2015) To investigate this, we added a binary SMI variable on the basis of presence of ICD-9 diagnoses indicating schizophrenia (295.0–295.9), bipolar disorder I (296.0, 296.1, and 296.4–296.7), or severe or psychotic major depressive disorder (MDD) (296.2x and 296.3x, with the fifth digit indicating the severe subtype with or without psychosis). For people with more than one SMI diagnosis during the study period, we selected their diagnosis according to a hierarchy that assigns highest weight to schizophrenia and lowest to MDD. We also included an indicator for people who had two or more MH diagnoses (e.g., bipolar disorder and generalized anxiety disorder). We defined presence or absence of SUD on the basis of ICD-9-CM codes 291.x, 292.x, and 303.x–305.x, and used the Elixhauser

comorbidity index (excluding MH diagnoses) to identify physical health comorbidities (count) (Elixhauser, Steiner, Harris, & Coffey, 1998).

To control for regional variation in health care use patterns, we constructed a geographic variable that groups the 67 Pennsylvania counties into five regions using the statewide managed-care map set by the Pennsylvania Department of Health. We used this methodology because Pennsylvania Medicaid population are enrolled largely through the managed care programs ("Pennsylvania Department of Human Services. Statewide managed care map. Pennsylvania Department of Human Services,").

3.1.6 Statistical Analysis

To identify subgroups of high utilizers, we used group based trajectory modeling that estimates developmental trajectories of ED use during the year.(D. Nagin, 2005) Typically high utilizers of ED are classified based on the number of visits with definitions of high utilizers varying markedly from two or more ED visits per year to five or more per month. (Arfken et al., 2004; Bruffaerts, Sabbe, & Demyttenaere, 2004; Dhossche & Ghani, 1998) These techniques do not take in consideration the differences in intervals between visits or whether there are any fluctuations in the number of visits over time. Based on a simple count of visits, individuals who have received four visits in the first 2 weeks of a four-month interval may fall in the same category of as someone who received these visits once a month for four month. The group based trajectory modeling methodology uses a semi parametric classification to identify cohorts with homogenous longitudinal traits. In our analysis we categorized individuals with two or more ED visits in one year based on the counts of ED visits per month after the index ED visit.

Our final model was selected using a two-point strategy. First, we limited the group selection to models in which each group had at least 5-percent membership. (D. S. Nagin & Odgers, 2010) Secondly, we applied Nagin's criteria in which each trajectory curve's order was adjusted and the model with the lowest Bayesian Information Criteria was used.

We then compared the differences in outpatient utilization and reasons for ED use between the groups using a chi-square test or analysis of variance, depending on the measure of interest. Finally, we conducted a multinomial logistic regression analysis (Agresti & Kateri, 2011) to examine the demographic and health utilization differences between the identified groups. We determined statistical significance using 95-percent confidence intervals and two-tailed *p*-values at $p < 0.05$.

Since our sample had a 3,661 outliers with an average of 9 or more ED visits per month, we tested our model after setting the top 1% to the value of the 99th percentile. When our results did not vary significantly we kept the original unaltered sample.

3.2 RESULTS

Our final sample consisted of 54,981 index ED visits for Medicaid enrollees with mental illness who visited EDs 2 or more times within a 12-month period for mental health or physical health reasons between 2007 and 2012. The average number of ED visits during the one-year trajectory period was 4.5 (standard deviation (SD): 4.2). Our final group-based trajectory model estimated using BIC and confirmed using Nagin's criteria shows two distinct trajectory groups of ED users in our study with mental illness (see Figure 3). The occasional users formed ninety-two percent of the total population. This group averaged 3.6 visits during the one-year trajectory

period (SD: 1.8). The second group, the high utilizers formed 8% of the population and made 14.3 ED visits during the trajectory period.

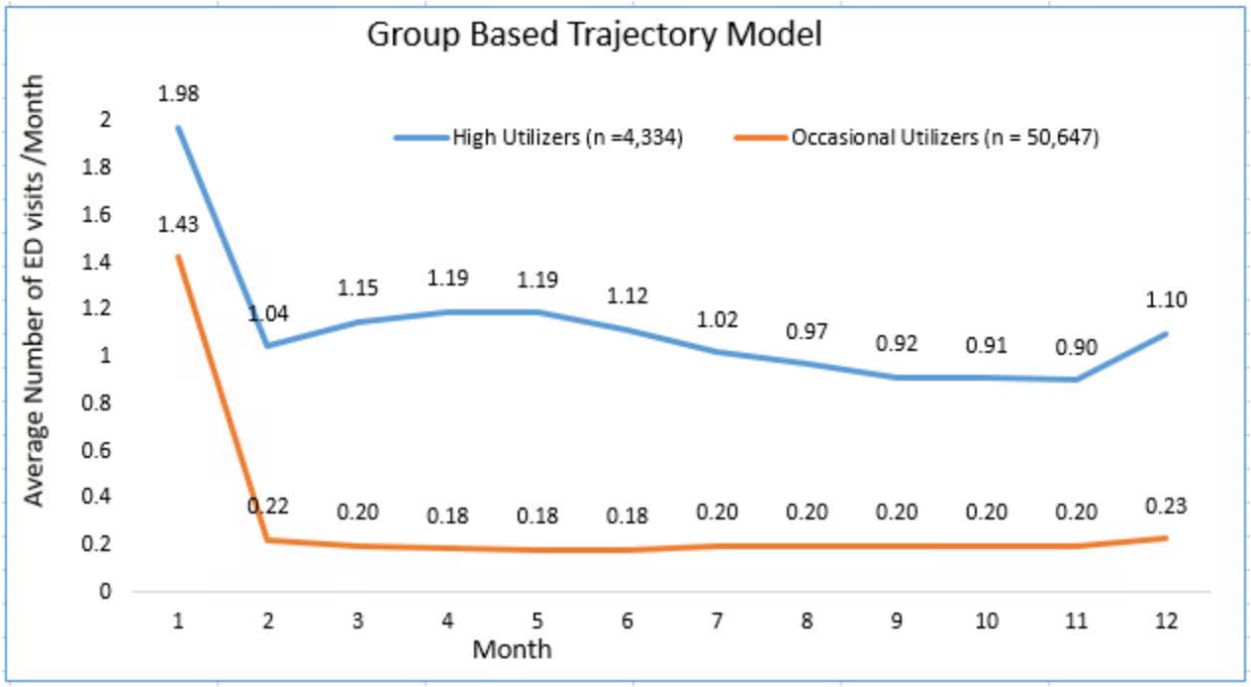


Figure 3. Group Trajectory of Emergency Department Visits by Adult Medicaid Enrollees with Mental Illness Who Made Multiple (>=2) Emergency Department Visits, 2007-2012

NOTE: ED visits could be for MH, substance-use, or physical health issues. We included only nondual enrollees ages 18 to 54 who resided in Pennsylvania.

[a] We identified mental illness using a case-ascertainment method with one inpatient and two outpatient diagnoses in any diagnosis field. We used mental illness ICD-9-CM diagnosis codes 290, 293–302.x, and 306.x–319. Recorded as primary diagnoses at either one inpatient or two separate outpatient encounters.

3.2.1 Characteristics of Frequent Emergency Department Users

The population was mostly white (61%), female (70%), and average age was 40.2 (SD 14.1, p <0.001) and roughly one third (34%) were enrolled in the fee for service program). These characteristics were not significantly different between the occasional users and high utilizers. (Table 4). While, enrollees in the occasional ED user group were much more likely than the high utilizer group to be eligible for Medicaid through SSI (68% vs. 62%)(p<0.001). Almost half the overall population had an SMI (55%). Rates of SMI in the population were lower among the occasional utilizer group (54%) and high utilizers (59%) (p<0.001). Rates of substance use

diagnoses were significantly higher in the high utilizer group (57%) compared to occasional user group (39%)(p<0.001). Individuals in the high utilizing group were also more likely to have multiple psychiatric diagnoses than were the occasional using group (91.7% vs. 82.0%) (p<0.001).

In the 6 months prior to the index ED visit, the overall population had a mean of 10.9 (SD 26.5) BH visits and 1.2 (SD 10.3, p= 0.1574) substance use visits. This was not significantly different from the mean for each trajectory group (see Table 4). Only 2% of the entire population had any PCP visit in the six months prior to the index outpatient visit.

Table 4. Demographics, Diagnoses, and Emergency Department Use of Trajectory Groups of Medicaid Enrollees

Characteristic	Total Population (*N* = 54,981)	High Utilizers (4,334)	Occasional utilizers (*N* = 50,647)	P Value
Demographics				
Female (%)	38,628	3,019 (69)	35,609(70)	0.37
Age [mean(SD)]	40.2 (14.1)	34.9 (19.7)	34.7 (18.2)	<0.001
Race (%)				
Black	14,771(26)	1,185 (27)	13,586 (27)	<0.001
White	33,751	2,731 (63)	31,020 (61)	
Other	11.8	9.7	11.9	
FFS, (%)	34.7	33.3	34.8	0.06
Eligibility, (%)				
SSI	62.6	68.0	62.2	<0.001
TANF	25.3	19.3	25.9	
Other	12.1	12.7	16.9	
Diagnosis				
SMI, (%)[a]	55.3	58.7	54.1	
Schizophrenia, (%)	19.8	25.3	19.3	<0.001
Bipolar disorder, (%)	36.9	48.1	35.9	<0.001
MDD, (%)	51.9	60.5	51.1	<0.001
Other mental illness	30.5	43.3	29.4	<0.001
Substance use, (%)[b]	41.0	57.0	39.7	<0.001

Table 3 Continued

Characteristic	Total Population (*N* = 54,981)	High Utilizers (4,334)	Occasional utilizers (*N* = 50,647)	P Value
Number of psychiatric diagnoses				<0.001
1	17.2	8.3	18.0	
2-4	51.2	38.7	52.3	
5-7	25.2	36.5	24.2	
>8	6.4	16.5	5.5	
Number of physical health comorbidities [c][mean(SD)]	2.3 (2.2)	3.3 (2.5)	2.2 (2.2)	<0.001
Health care utilization six months before index ED visit				
PCP Visits[h] [mean(SD)]	0.1 (0.1)	0.02 (0.1)	0.02 (0.1)	0.0054
% with ≥ 1 visit	2.1	2.1	1.5	
BH outpatient visits[d] [mean(SD)]	10.9 (26.5)	11.1 (26.7)	10.2 (25.1)	0.1574
% with ≥ 1 visit	45.7	46.6	45.6	
MH outpatient visits[e] [mean(SD)]	6.2 (17.9)	6.2 (17.9)	6.0 (17.9)	0.2007
% with ≥ 1 visit	42.8	43.7	42.7	
Substance Use Visits[f] [mean(SD)]	1.2 (9.6)	1.3 (9.7)	1.2 (9.6)	0.0002
% with ≥ 1 visit	8.6	13.2	8.2	
Care management Visits[g] [mean(SD)]	0.1 (0.3) 12.0	0.1 (0.3) 12.9	0.1 (0.3) 11.9	0.0383
Pennsylvania Medicaid Managed Care				
Lehigh	13.8	14.9	13.8	<0.001
New East	8.7	10.5	8.5	
New West	9.1	8.7	9.1	
Southeast	41.3	39.1	41.5	
Southwest	27.2	26.9	27.2	
ED visits in one year[mean(SD)]	4.5 (4.2)	14.3 (8.9)	3.6 (1.8)	

NOTE: The table shows trajectory groups identified according to group-based trajectory modeling for Medicaid enrollees who made multiple ED visits between 2007 and 2012, with a blackout period of six months with no ED or inpatient visits. The ED visits could be for mental or physical health issues. We defined mental illness using a case-ascertainment method and one inpatient and two outpatient diagnoses in any diagnosis field. Each person could have multiple index visits in the period. Each person could be eligible for Medicaid through multiple criteria during the period. Each person had at least 15 days of continuous Medicaid enrollment during the period. * = $p < 0.0$.

[a] SMI is schizophrenia (295.0–295.9), bipolar disorder I (296.0, 296.1, and 296.4–296.7), or severe or psychotic MDD (296.2x and 296.3x).

[b] Substance-use diagnoses are ICD-9-CM codes 291.x, 292.x, and 303.x–305. x.

[c] The number of comorbidities is the count according to the Elixhauser comorbidity index excluding MH diagnoses.

[d] An outpatient BH visit is any visit in which the provider is an MH or Substance use specialist.

[e] An outpatient MH visit is any visit in which the provider is an MH specialist.

Table 3 Continued

[f] An outpatient substance use visit is any visit in which the provider is an substance use specialist.
[g] A Care management visit is any visit in which the provider is an Case management, Case Manager or Care Coordinator specialist.
[h] A PCP visit is any visit to a provider who is a PCP specialist.
[i] The zone is defined according to Pennsylvania Medicaid managed-care regions.

3.2.2 Outpatient Behavioral Health Visits During the trajectory period

In addition to counting behavioral health visits prior to the ED trajectory period we also examined whether high utilizers of ED are any different from occasional users in the number of behavioral health and primary care outpatient visits they receive during the trajectory period. (See Table 5). In the one year after the index ED visit, high utilizers and occasional made an average of 17.9 (SD 37.3, 9<0.001) and 15.8 (39.4, p<0.001) visits respectively to a behavioral health provider (including mental health and substance use). High utilizers received an average of 2.7 (SD 16.7, p<0.001) substance use visits during the year while occasional utilizers had only 2.5 visits (SD 18.5, p<0.001). Percentage of individuals with at least one substance use visit was 6.5 in high utilizers and 8.3 in occasional utilizers. Only 21.8% of high utilizers and 16.2% if occasional utilizers had any care management visits during the one year.

Table 5. Health Utilization of Trajectory Groups of Medicaid Enrollees during the 1 year trajectory Period

Characteristic	Total Population (*N* = 54,981)	High Utilizers (4,334)	Occasional utilizers (*N* = 50,647)	P Value
PCP Visits [mean(SD)][e]	0.02 (0.1)	0.21 (1.35)	0.1 (1.0)	<.0001
% with ≥1 Visit	3.7	6.4	3.5	
BH Visits[a] [mean(SD)]	15.9 (39.2)	17.9 (37.3)	15.8 (39.4)	<.0001
% with ≥1 Visit	61.2	73.1	60.2	
MH visits[b] [mean(SD)]	13.5 (35.1)	15.3 (33.1)	13.3 (35.2)	<.0001
% with ≥1 Visit	58.6	70.7	57.6	
Substance Use Visits[c] [mean(SD)]	2.5 (18.4)	2.66 (16.8)	2.5 (18.5)	<.0001
% with ≥1 Visit	5.2	6.5	8.3	
Care management Visits[d] [mean(SD)]	4.3 (18.5)	5.5 (22.2)	4.2 (18.1)	<.0001
% with ≥1 Visit	16.6	21.8	16.2	

[a] An outpatient BH visit is any visit in which the provider is an MH or Substance use specialist.
[b] An outpatient MH visit is any visit in which the provider is an MH specialist.
[c] An outpatient substance use visit is any visit in which the provider is an substance use specialist.
[d] A Care management visit is any visit in which the provider is an Case management, Case Manager or Care Coordinator specialist.
[e] A PCP visit is any visit to a provider who is a PCP specialist.

3.2.3 Ambulatory Care–Sensitive Emergency Department Visits

During the one-year trajectory period, 16% of ED visits in high utilizers and 17% in occasional utilizers were emergent or unavoidable (see Figure 4)($p<0.001$). One fifth of all ED visits during this trajectory period was Non-emergent ED visits (20% for high utilizers and 19% for occasional users ($p<0.001$)). Primary care–treatable visits were 20% for high utilizers and 22% for occasional users ($p<0.001$). ED Visits, where the primary diagnosis was for a

psychiatric illness, only formed 4% of all visits in both the high utilizer and occasional user population. Finally, injury was the primary reason for 18% of the visits in the high utilizers and 14% in the occasional utilizers (p<0.001).

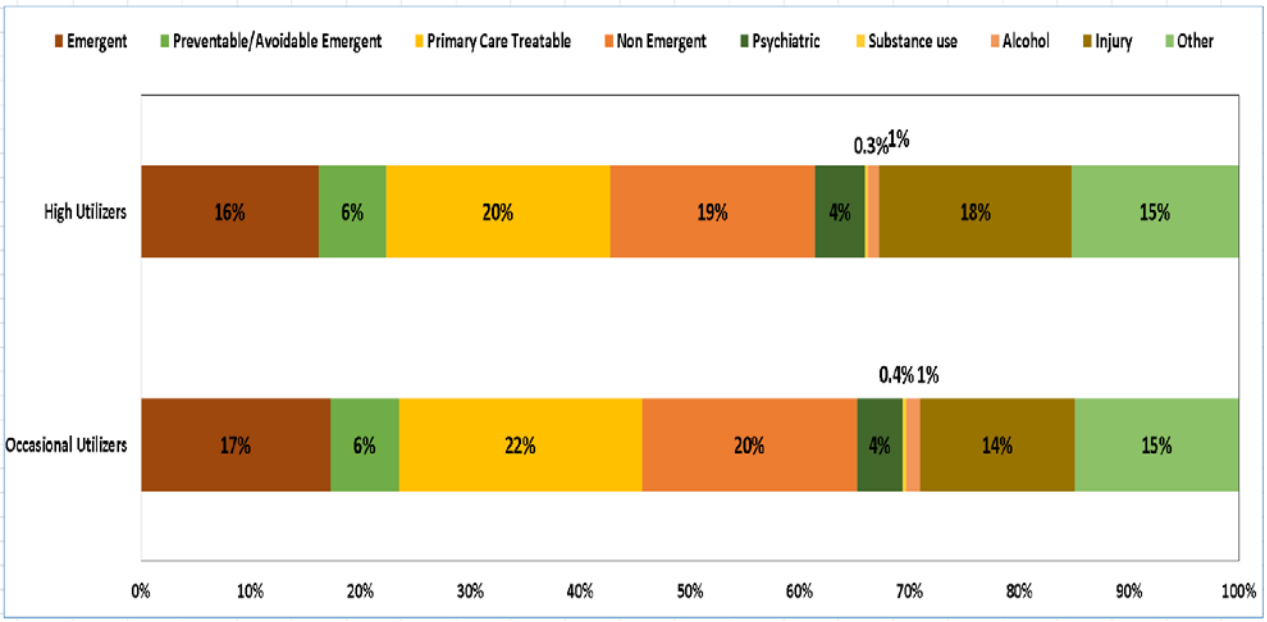


Figure 4. Primary Reasons for Emergency Department Visits by Adult Medicaid Enrollees Who Made Frequent Emergency Department Visits, 2007 to 2012

NOTE: ED visits could be for MH, substance-use, or physical health issues. We included only nondual enrollees ages 18 to 54 who resided in Pennsylvania.

[a] We identified mental illness using a case-ascertainment method with one inpatient and two outpatient diagnoses in any diagnosis field. We used mental illness ICD-9-CM diagnosis codes 290, 293–302.x, and 306.x–319. recorded as primary diagnoses at either one inpatient or two separate outpatients encounters' ED visit categorization used criteria by Billings et al Emergent and unavoidable – physical health visits (diagnosis indicates that ED care was required and it was neither preventable nor avoidable, e.g., trauma, appendicitis). Visits include Preventable/avoidable emergent physical health visits (diagnosis indicates that ED care was needed but could have been avoided if effective ambulatory care had been received), primary care treatable emergent physical health visits (diagnosis indicates that care could have been provided effectively and safely in a primary care setting), non-emergent visits (diagnoses not requiring medical care within 12 hours), mental health related ED visits (primary diagnosis was mental illness), substance use related ED visits (primary diagnosis was substance use), alcohol related ED visits (primary diagnosis was alcohol use),injury related ED visits, other (not otherwise classified)

3.2.4 Multinomial Logistic Regression

The multinomial logistic regression results were consistent with the bivariate analyses. The odds of a high utilizer having a co-occurring substance-use diagnosis were 2.12 times (Confidence Interval (CI): 1.97, 2.26, p<0.001) those of occasional users (see Table 6). Similarly, high utilizers had twice the odds of having multiple psychiatric illnesses than occasional users (Odds Ratio: 2.06, CI: 1.83, 2.32, $p < 0.001$). The odds of a high utilizer having one more physical health comorbidity were 1.31 times (CI: 1.29, 1.33, p<0.001) those of occasional users. High utilizers also had 37% greater odds of making a PCP visit in the six months prior to the index ED visit than occasional users.

Table 6. Adjusted Odds Ratios and 95-Percent Confidence Intervals for Emergency Department Trajectory Groups of Medicaid Enrollees

Comparison Group: Occasional Users	Odds Ratios	95% Confidence Intervals	P Value
Demographics			
Age	0.97	0.96, 0.97	<0.001
Female	1.13	1.05, 1.21	0.002
Race (ref: white)			
Black	0.95	0.87, 1.03	0.222
Other	0.83	0.73, 0.94	0.002
FFS	0.86	0.79, 0.94	0.001
Eligibility (ref: SSI)			
Waiver	1.03	0.76, 1.39	0.84
General Assistance	0.93	0.84, 1.03	0.16
TANF	0.70	0.63, 0.77	<0.001
Diagnosis			
Multiple psychiatric	2.06	1.83, 2.32	<0.001
Substance use[b]	2.12	1.97, 2.26	<0.001
SMI[a]	1.07	1.00, 1.15	0.04
Physical health comorbidities	1.31	1.29, 1.33	<0.001

Table 6 Continued

Comparison Group: Occasional Users	Odds Ratios	95% Confidence Intervals	P Value
Health care utilization six months prior to the index visit			
PCP visits[e]	1.37	1.08, 1.72	0.009
BH visits[d]	1.00	1.00, 1.00	0.02
Zone[f] (ref: Southeast)			
Lehigh	1.24	1.12, 1.38	<0.001
New East	1.43	1.24, 1.64	<0.001
New West	1.08	0.94, 1.24	0.29
Southwest	0.99	0.90, 1.08	0.77

NOTE: The table shows odds ratios and confidence intervals for the 4 trajectory groups of Medicaid enrollees who made multiple ED visits between 2007 and 2012, with a blackout period of six months with no ED or inpatient visits. The ED visits could be for mental or physical health issues. We defined mental illness using a case-ascertainment method and one inpatient and two outpatient diagnoses in any diagnosis field. Each person could have multiple index visits in the period. Each person could be eligible for Medicaid through multiple criteria during the period. Each person had at least 15 days of continuous Medicaid enrollment during the period. * = $p < 0.01$

[a] SMI is schizophrenia (295.0–295.9), bipolar disorder I (296.0, 296.1, and 296.4–296.7), or severe or psychotic MDD (296.2x and 296.3x).

[b] Substance-use diagnoses are ICD-9-CM codes 291.x, 292.x, and 303.x–305.x.

[c] Physical health comorbidities is the count according to the Elixhauser comorbidity index excluding MH diagnoses.

[d] An outpatient BH visit is any visit in which the provider is an MH or substance use specialist.

[e] A PCP visit is any visit to a provider who is a Primary Care specialist.

[f] The zone is defined according to Pennsylvania Medicaid managed-care regions.

3.3 DISCUSSION

Our study yielded three main findings. First, high utilizers of ED had the same number of outpatient behavioral health visits as occasional utilizers during the one year trajectory period. Secondly, about 40% of all ED visits were either non-emergent or primary care treatable physical health visits. Third, there was a large percentage of high utilizers who had substance use comorbidities but very few had any outpatient substance use visits before or during the trajectory period.

This study underscores that despite high utilizers making a significantly larger number of ED visits than occasional users, they are not different in their BH outpatient use during this year. In addition, only 16% percent of the ED visits for high utilizers and 17% for occasional utilizers were for unavoidable emergent reasons. Physical health visits for preventable, primary care treatable or non-emergent reasons totaled 45% and 46% of all ED visits respectively. This result reinforces the idea that the predominant reason for presenting to the ED for individuals with mental illness can be managed in the ambulatory or non-emergent settings. (Kalucy, Thomas, & King, 2005; Young et al., 2005) Individuals with mental illness have complex physical health needs but physical health and behavioral health care are often delivered in silos. The start of new behavioral health homes that provide an array of services including connections to physical health outpatient care attempt to consolidate health care delivery in one location. (Alexander & Druss, 2012)

High utilizers of ED could also benefit from evidence-based care management services which would assist them in managing their behavioral and physical health conditions and navigating both medical systems.(Quality) This could be achieved through an ED-specific patient education and care coordination intervention that uses administrative data to identify frequent utilizers in both physical health and psychiatric settings and assign care managers to them. (Kumar & Klein, 2013; Neighbors et al., 2013; Pope, Fernandes, Bouthillette, & Etherington, 2000) Another model is assertive community treatment (ACT) which is a case management-based intervention for people with SMI and high utilizers of ED or inpatient services. ACT teams use a multidisciplinary approach to prevent acute care ED use, increase community tenure and improve patient outcomes. (Bond, Drake, Mueser, & Latimer, 2001) That

only 12 percent of high utilizers in our study had care-management visits before their index ED visit indicates a large unmet need for this form of treatment

Our study confirms that high utilizers of ED are more likely to have substance use diagnoses and present at the ED for conditions like trauma or injury. (Gentilello, Ebel, Wickizer, Salkever, & Rivara, 2005; Kushel, Perry, Bangsberg, Clark, & Moss, 2002) In our study, the high utilizer group, also had a much higher incidence of injury ED visits (18% vs. 14% in occasional utilizers). However, only 13.2% of high utilizers received any substance use related outpatient visits in the 6 months prior to the index ED visit and only 6.5% during the one year trajectory period. This may indicate that there is unmet need for substance use services in this population. Some EDs have implemented brief alcohol interventions (SBIRT) followed by referral to substance use services and reduced recidivism in this population.(C. o. S. Abuse, 2011; Gentilello et al., 1999)

There are several limitations to this study. First, our study is localized to the Pennsylvania Medicaid population only. However, this population is comparable to that in other states in demographics and health utilization rates. (Statistics, 2013) Also, our study relied on administrative claims data to identify and categorize ED visits for individuals with mental illness population. While this is a common approach, claims data has limited sensitivity and specificity to identify mental illnesses. Also claims data does not provide the specifics of an ED visit that a chart review would show. For instance, it does not reveal the severity of each ED visit or the referral disposition of that visit. Our study may be undercounting some care management visits since we limit our analysis only to those claims billed by providers whose specialty is care management. There may be other services that are billed by hospital entities that are not counted in this study. This study also does not identify other drivers for ED use in this population, such as

lack of family supports, homelessness, or violence. Although we control for within-region variation in health care use patterns, we do not have specific details on these availability of resources that may influence ED use.

3.4 CONCLUSION

Our study has clearly shown that there are 2 categories of adult Medicaid enrollees with mental illness who frequent the ED for physical health or mental health illnesses. High utilizers form 8 percent of this population but use the same number of outpatient services as occasional users. Future studies could evaluate social, as well as medical, drivers for these ED visits, including homeless and family supports.

4.0 DOES CARE COORDINATION WITHIN PRIMARY CARE AND BEHAVIORAL HEALTH SPECIALTIES REDUCE EMERGENCY DEPARTMENT VISITS FOR INDIVIDUALS WITH SERIOUS MENTAL ILLNESS AND TYPE II DIABETES?

4.1 INTRODUCTION

In 2005, the Institute of Medicine identified care coordination as, as one of the primary aims for improving health care quality.(Corrigan, 2005) Efforts by Medicare, Medicaid and other payors to put in place new delivery and payment systems such as health homes and other payment models are primarily aimed to improve the quality of care for individuals with chronic illnesses through better care coordination among various providers seen by these patients. One aspect of care coordination is continuity of care (CoC) defined as the delivery of services in a coordinated and uninterrupted manor within and across provider settings.(Shortell, 1976) High CoC is correlated with improved outcomes such as low hospitalization, controlled symptoms, satisfaction with providers, and decreased utilization of higher acuity services like emergency department (ED) visits. (Ionescu-Ittu et al., 2007) CoC among providers is particularly important for individuals with serious mental illness (SMI), three-quarters of whom have comorbid conditions like diabetes.(Ionescu-Ittu et al., 2007) Individuals with SMI and diabetes often have multiple providers both in behavioral health (BH) settings and in physical health (PH) settings to manage their diabetes and other co-occurring conditions. Continuity of care between these different provider specialties has traditionally been seen as very poor and may be one cause of less than optimal chronic disease management for individuals with SMI. (HERT et al., 2011) However, CoC

within each provider specialty setting is also important because it signals the durability of the patient-provider relationships in each setting.

Independently, CoC indices do not fully capture whether care was coordinated for a particular patient. A patient who sees multiple providers may have a low CoC score, but if the providers are regularly communicating with each other, care delivered may be coordinated well. Therefore, a related but distinct aspect of care coordination – care density -may be necessary to identify relationships between providers. Care density is the degree of patient sharing among providers with the assumption that providers who share more patients (i.e., have higher care density) are more likely to have referral and information sharing relationships with each other.(Barnett, Landon, O'malley, Keating, & Christakis, 2011) Previous studies show that when patients with diabetes are seen by providers who share multiple patients among themselves, they are more likely to have better health outcomes such as low hospitalization rate. What is not clear is whether care density among providers has the same effect for individuals with SMI and chronic medical illnesses like diabetes who visit multiple providers both within and across PC and BH specialties. The expectation would be that if care density is high, the providers have an established relationship that may be beneficial in coordination of care for their patients.(Pollack et al., 2014) In this study, we use the care density measure along with a CoC index to measure care coordination.

Numerous studies show that improved care coordination for individuals with diabetes is likely to result in better management of symptoms and lower risk for adverse events like emergency department (ED) visits.(Cheng, Chen, & Hou, 2010; Gill, Mainous III, & Nsereko, 2000) However, little is known about impact of care coordination for individuals with SMI and its potential effects on ED visits. In this study, we aim to fill this gap by measuring the

association between ED visits and care coordination (measured through CoC and care density) for disabled and elderly Medicare enrollees with SMI and type II diabetes. We measure CoC across primary care (PC) and behavioral health (BH) providers separately and estimate the care density among the providers seen by each patient. We hypothesize that greater CoC within each specialty and care density would be associated with fewer ED visits.

4.2 METHODS

4.2.1 Data

We obtained enrollment and health care claims data for fee-for-service Medicare beneficiaries enrolled in a Part D plan in Pennsylvania from 2011 to 2012. The enrollment file contains information on the beneficiaries, including demographics (e.g., age, race/ethnicity, gender) and eligibility category (Elderly, Disability). We used inpatient, outpatient, and professional (carrier) claims for BH and physical health services (e.g. service date, type of service and diagnosis at service).

4.2.2 Study Sample

We identified our study sample in 2011 and measured their CoC and ED visits simultaneously for one year in 2012. Our sample included individuals 18 years and older who had a diagnosis of SMI and type II diabetes in 2011. We identified beneficiaries with SMI based on the presence of ICD-9 diagnoses indicating schizophrenia (295.0–295.9), bipolar disorder I

(296.0, 296.1, and 296.4–296.7), or major depressive disorder (MDD) (296.2x and 296.3x, with the fifth digit indicating the severe subtype with or without psychosis) in 1 inpatient or 2 outpatient/professional claims. We focused our analysis on individuals with type II diabetes because individuals with SMI are more than highly likely to have metabolic abnormalities characteristic of type II diabetes including insulin resistance and dyslipidemias due to medication side-effects and high rates of obesity in this population. (Fagiolini & Goracci, 2008) We identified individuals with type 2 diabetes if they met the CCW criteria for diabetes diagnosis as well as if they 1) were on any oral medication (regardless of proportion of type 1/type 2 codes) or 2) were on insulin only but had >= 50% of their claims with a diagnosis of type 2 diabetes.

4.2.3 Dependent Variable: ED visits

Our dependent variable is the number of ED visits made in 2012 by our cohort. We identified ED visits using the methodology outlined by Henessy et al. (Hennessy et al., 2010) This method combines the use of revenue codes and procedure codes. ED visits were identified in the claims files using the inpatient file (using revenue codes 0450, 0451, 0452, 0456, 459, or 0981 in any position), outpatient file (using the same revenue codes or using procedure codes 99281 through 99285, G0380 through G0385 or G8354) and carrier files (using the same procedure codes or place of service code = 23).

4.2.4 Main Independent Variables: Care coordination

We measured care coordination using two related measures– CoC index and care density.

4.2.4.1 Continuity of care index

There are a number of tools for measuring the CoC in administrative data that capture the dispersion of visits across various providers. (Magill & Senf, 1987) Commonly used continuity of care indices include the Usual Provider Continuity (UPC), the Continuity of Care Score, and the Modified Modified CoC Index (MMCCI).(Jee & Cabana, 2006) The UPC measures the density of provider visits through a ratio of the number of visits to the predominant provider divided by the total visits that the patient made to any provider. While it allows the identification of the primary provider for the patient, it does not capture continuity of care for patients who may visit multiple providers. The CoC Score and the MMCCI both measure the degree of dispersion of providers for each patient; however, the MMCCI index has been tested to show more reliable values for CoC.(Magill & Senf, 1987) Therefore we used the MMCCI to calculate CoC in our study. The formula for MMCI is as follows:

$$\textbf{Continuity score} = \frac{\textbf{1 – (No. of ambulatory providers/[No. of Visits +0.1])}}{\textbf{1 – (1/No. of Ambulatory Visits +0.1])}}$$

This score ranges from 0 (if each visit is to a different provider) to 1 (if all visit are to the same provider). As shown in Figure 5, the MMCCI varies based on the number of visits and the number of providers involve in the individual's care.

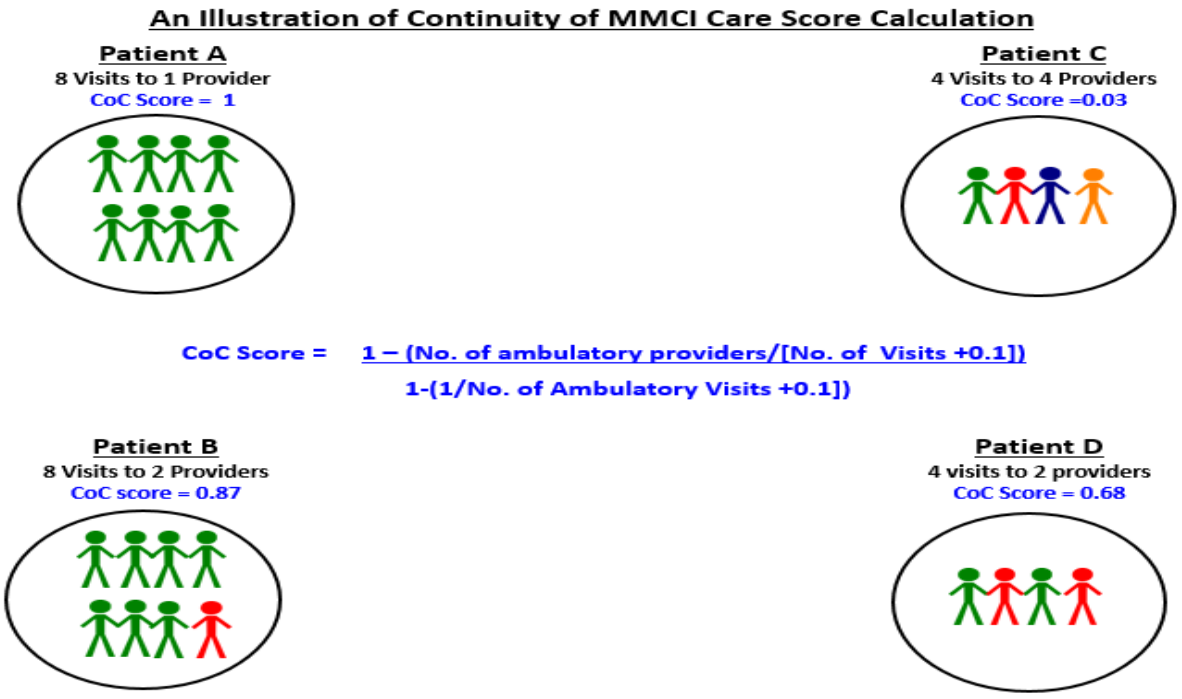


Figure 5. An Illustration of MMCI Continuity of Care Score

We calculated the MMCCI for BH and PC providers separately using professional and outpatient non-institutional claims. We chose to use non-institutional claims to narrow our analysis to ambulatory providers only and not include inpatient or emergency room providers in our calculation of CoC. We used the CMS Provider Specialty Codes ‘Psychiatry, ‘General Psychiatry’, ‘Psychologist’, ‘Clinical psychologist’, and ‘Addiction medicine’ to identify BH providers, and 'General practice', 'Family practice', 'Pediatric medicine', 'Geriatric medicine', 'Certified clinical nurse specialist’, and 'Nurse practitioner' to identify PCP visits. If there was more than one visit to a provider in a single day, we counted each visit separately if they had a unique claim number.

4.2.4.2 Care Density Variable

We used the care density variable developed by Pollock et al(Pollack, Weissman, Lemke, Hussey, & Weiner, 2013) as a proxy for communication between providers. This variable measures the extent of 'patient-sharing' among an enrollee's ambulatory providers, and quantifies the total number of shared patients between two providers. It is calculated as a fraction of the sum of shared patients among each pair of a patient's outpatient providers over the total number of pairs of outpatient doctors that a patient visits. An example of a care density calculation is shown in Figure 6. The three providers (A, B and C) seen by a single patient X is shown. The number of patients they share is represented by the lines that connect them. Providers A and B share 3 patients, providers B and C share 2 patients and providers A and C share one patient. In this example, the care density for patient X will be calculated as the total number of patients shared by the three providers (3+2+1) divided by the number of provider pairs that patient X sees (3). This patient's care density index would be 3 (6/2). Conversely, if another patient visited 6 different providers who shared a total of 300 patients between themselves, the care density variable would equal 20. We constructed care density variables separately for BH and PC providers. The higher the care density variable, the greater the patient sharing among providers seen by the patient.

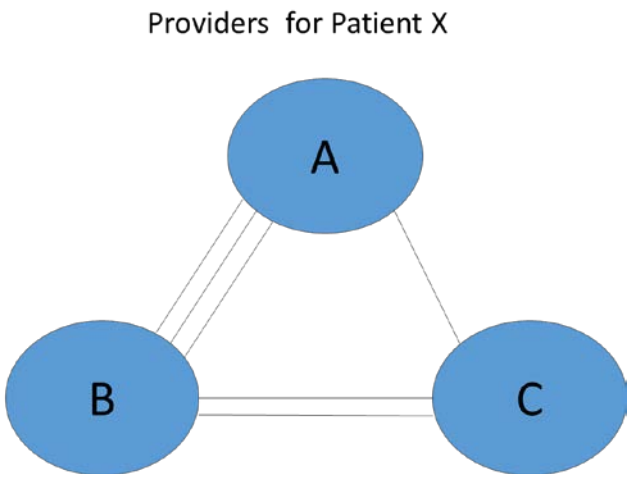


Figure 6. Care Density Index

Figure shows calculation of care density index from administrative data. It has been adapted from study by Pollack, C. E., Weissman, G. E., Lemke, K. W., Hussey, P. S., & Weiner, J. P. (2013). Patient sharing among physicians and costs of care: a network analytic approach to care coordination using claims data. *Journal of general internal medicine*, *28*(3), 459-465.

4.2.5 Covariates

Covariates in our analyses consisted of demographic variables (e.g., age, sex or race), and several clinical variables (SMI diagnosis type, SUD comorbidity (Y/N), physical health comorbidities). Individuals with more than 1 SMI diagnosis during the study period were assigned a diagnosis based on the following hierarchy: schizophrenia, then bipolar, and last MDD. For example, if enrollees had both schizophrenia and MDD diagnosis, they would be included in the schizophrenia category but not MDD. We also included the Elixhauser comorbidity index (excluding MH diagnoses) to identify physical health comorbidities.(Elixhauser et al., 1998)

We also added two indicators of socioeconomic status: beneficiary dual eligibility status and participation in the low-income subsidy (LIS) program under Medicare Part D. The LIS is a sliding scale of enrollment eligibility starts from automatic enrollment for beneficiaries who are at 135% federal poverty level (FPL) to a manual application process if the beneficiary is less than 150% FPL. Since these variables are correlated, we created dummy variables that captured whether the individual was dually eligible, have LIS, or both.

To control for regional variation in health care use patterns, we constructed a geographic variable that groups the Pennsylvania zip codes into seventeen Dartmouth defined Hospital Referral Regions (HRRs).(Wennberg, Fisher, Goodman, & Skinner, 2008) These regions represent regional health care markets for tertiary medical care.

4.2.6 Statistical Analysis

We conducted descriptive analyses of individuals with SMI and type II diabetes using chi square test for categorical variables (gender, race, dual eligibility, diagnosis) and t-tests for continuous variables (CoC index, care density, age, number of comorbidities). Since, our dependent variable was a count of ED visits, we conducted a likelihood ratio test to determine whether to pursue a Poisson or negative binomial regression. Since we had a large number of individuals with zero ED visits, we also used the Vuong's test to see if zero-inflated Poisson regression was applicable. Since the LR test was significant and the Vuong's test was not significant, we employed a negative binomial regression to measure the association between the number of ED visits and CoC. Since individuals who are eligible to receive Medicare through disability, compared to the elderly, may have different risks for ED visits, we conducted the analysis first combined and then separately for each eligibility category.

4.3 RESULTS

Our final sample consisted of 10,703 individuals who had SMI and type II diabetes in 2011 of whom 52% were disabled.(Table **7**) The elderly population was predominantly white (87.1%) and female (70.9%) with a mean age of 76 (standard deviation (SD) 7.6). The disabled population was also predominantly white (77.0%) with a mean age of 51.8 (SD 8.3) and about half (52.2%) were female. The most common SMI diagnosis was major depressive disorder (MDD) in the elderly population (59.0%) and schizophrenia in the disabled population (42.9%). The mean number of physical health comorbidities was 8.7 (SD 3.2) in the elderly population and 6.8 (SD 3.1) in the disabled population.

Table 7. Characteristics of Medicare Enrollees with Serious Mental Illness and Type II Diabetes in 2011

Characteristic	Total	Elderly	Disabled	P value
N (%)	10,703 (100)	5,112 (47.7)	5,591 (52.2)	
Female (%)	61.2	70.9	52.2	<.0001
Age [mean(SD)]	63.3 (14.5)	76.0 (7.6)	51.8 (8.3)	<.0001
Race (%)				
Black	11.7	8.1	15.1	<.0001
White	81.8	87.1	77	<.0001
Other	6.4	4.9	7.9	<.0001
Disabled (%)	52.2	-	-	
Dually enrolled (%)	72.0	61.2	81.8	<.0001
Low Income Subsidy (%)	78.0	65.3	89.7	<.0001
ESRD (%)	2.3	2.1	2.4	0.2391
Diagnosis				
Schizophrenia (%)	33.9	24.1	42.9	<.0001
Bipolar disorder (%)	22.5	16.9	27.6	
MDD (%)	43.6	59	29.5	
Number of physical health comorbidities [mean(SD)][a]	7.7 (3.3)	8.73 (3.2)	6.8 (3.1)	<.0001
ED Visits [mean(SD)]	2.2 (4.3)	1.7 (2.6)	2.6 (5.3)	<.0001
Number of ED Visits (%)[b]				
O	42.5	41.0	44.1	<.0001
1	18.8	17.8	20.0	
$\geq$ 2	38.7	41.2	35.9	
Care density	19.1 (27.7)	18.6 (25.5)	19.5 (29.6)	

NOTE: The table shows characteristics of Medicare enrollees with serious mental illness and type II diabetes in 2011 who were continuously enrolled in Medicare in 2011 and 2012. We defined serious mental illness using a case-ascertainment method and one inpatient and two outpatient primary diagnoses of schizophrenia (295.0–295.9), bipolar disorder I (296.0, 296.1, and 296.4–296.7), or severe or psychotic MDD (296.2x and 296.3x).

[a] Physical health comorbidities is the count according to the Elixhauser comorbidity index excluding MH diagnoses.

[b] ED visit identified in the inpatient file (using revenue codes 0450, 0451, 0452, 0456, 459, or 0981 in any position), in the outpatient file (using the same revenue codes or using procedure codes 99281 through 99285,G0380 through G0385 or G8354) and in the carrier file (using the same procedure codes or place of service code = 23.

4.3.1 ED visits

The mean number of ED visits was 2.61 (SD 5.31) in the elderly and 1.69 (SD 2.58) in the disabled populations. During 2012, 41% of the elderly and 44% of the disabled did not have any ED visits. (**Table 7**).

4.3.2 Continuity of Care

The elderly enrollees made fewer BH visits (average of 4.4 BH visits (SD 7.4)) compared to the disabled (average was 7.7 (SD 11.8)) (Table 8). There were also fewer BH providers seen by the elderly (average of 0.8 (SD 0.9)) providers than the disabled who saw an average of 1 provider (SD 0.9). The elderly population made more PC visits than the disabled population 12.3 (SD 11.9) vs. 9.5 (SD 11.5). The elderly and disabled enrollees visited an average of 2.0 (SD 1.6) and 1.9 (SD 1.6) PC providers during the year, respectively.

The average BH CoC score was lower in the elderly population - 0.57 (SD 0.47) than in the disabled population - 0.7 (SD 0.4). Conversely, PC CoC score was higher in the elderly population 0.82 (SD 0.28) than the disabled 0.77 (SD 0.32). CoC was higher for both groups in the PC setting than in the BH setting.

Table 8. Continuity of Care in Ambulatory Behavioral health and Primary Care Services in 2012 for Medicare Enrollees with Serious Mental Illness and Type II Diabetes in 2011

	Total			Elderly			Disabled		
Type of Provider	Number of Providers	Number of Visits	COC	Number of Providers	Number of Visits	COC	Number of Providers	Number of Visits	COC
Behavioral Health, Mean (SD)[a]	0.9 (0.9)	6.2 (10.1)	0.6 (0.3)	0.8 (0.9)	4.4 (7.4)	0.6 (0.5)	1.0 (0.9)	7.7 (11.8)	0.7 (0.4)
Primary Care, Mean (SD)[b]	1.9 (1.6)	10.8 (11.7)	0.8 (0.3)	2.0 (1.6)	12.3 (11.9)	0.8 (0.3)	1.9 (1.6)	9.5 (11.5)	0.8 (0.3)

Note: We measured continuity of care in ambulatory behavioral health and primary care services using the Modified Modified Continuity of Care Index (MMCCI). Behavioral health and PCP provider and visits identified through professional (bcarrier) claims in 2012. If there was more than one visit to a provider in a single day, each visit was counted separately.

4.3.3 Care Density

Care density for the total sample was 19.1(SD 27.7). The elderly population had a slightly lower care density (18.6 SD 25.5) than the disabled population (19.5 SD 29.6). This implies that the providers that the disabled patients saw shared more patients between them than the providers seen by elderly patients.

4.3.4 Negative Binomial Regression

The results of the negative binomial regression were not significantly different for the elderly and disabled populations (Table 9). For every increase in CoC score for PC providers, there is a 35% decrease in rate of ED visits. (IRR 0.65, CI 0.57-0.73, P<0.001). CoC in BH care was not significantly associated with number of ED visits. The care density variable was also

significantly associated with ED visits. For every one point increase in care density, there was a 1% decrease in the rate of ED visits. (IRR 0.99, CI 0.99-0.99, P<0.001)

Table 9. Negative Binomial Analysis Comparing Number of ED Visits and Continuity of Care in 2012 by Medicare Enrollees with SMI and Type II Diabetes

	Total				Elderly				Disabled			
	IRR	95% CI		P value	IRR	95% CI		P value	IRR	95% CI		P value
COC BH	1.06	0.99	1.13	0.10	1.10	1.01	1.2	0.03	1.03	0.94	1.13	0.54
COC Primary Care	0.65	0.57	0.73	P<0.001	0.66	0.53	0.82	P<0.001	0.62	0.52	0.73	P<0.001
Care density	0.99	0.99	0.99	P<0.001	0.99	0.99	0.99	P<0.001	0.99	0.99	0.99	P<0.001
Diagnosis (Reference = MDD)												
Schizophrenia	0.97	0.90	1.04	0.43	0.91	0.81	1.03	0.14	0.99	0.9	1.09	0.86
Bipolar D/O	0.90	0.84	0.96	P<0.001	0.94	0.86	1.04	0.26	0.83	0.75	0.91	P<0.001
Age	0.97	0.97	0.98	P<0.001	0.98	0.98	0.99	P<0.001	0.98	0.97	0.98	P<0.001
Female	1.01	0.96	1.07	0.62	0.94	0.87	1.03	0.18	1.05	0.97	1.13	0.26
Disabled (Y/N)	0.99	0.89	1.08	0.70								
Dual/ LIS (reference = Dual = 0 LIS = 0)												
Dual and LIS	1.04	0.97	1.12	0.27	1.01	0.91	1.09	0.94	1.19	1.04	1.37	0.01
Dual = 1 LIS = 0	0.96	0.84	1.09	0.52	0.99	0.80	1.21	0.89	1.08	0.89	1.3	0.45
Elixhauser Total	1.17	1.16	1.19	P<0.001	1.14	1.12	1.15	P<0.001	1.21	1.19	1.23	P<0.001
Race (Reference = White)												
Black	1.01	0.92	1.11	0.83	1.06	0.91	1.22	0.47	1.00	0.89	1.12	0.96
Other	1.08	0.97	1.22	0.15	1.17	0.98	1.40	0.09	1.07	0.92	1.24	0.39
HRR (Reference = Philadelphia)												
Allentown	1.06	0.97	1.16	0.23	1.08	0.96	1.22	0.18	1.04	0.91	1.19	0.54
Altoona	1.06	0.90	1.26	0.49	0.99	0.76	1.28	0.91	1.14	0.91	1.43	0.25
Binghamton	1.05	0.36	3.00	0.94	0.01	0.0	0.1	0.99	1.47	0.4	5.35	0.56
Danville	1.17	1.03	1.34	0.02	1.07	0.88	1.31	0.48	1.21	1.01	1.44	0.03
Erie	0.91	0.81	1.03	0.12	0.96	0.81	1.14	0.64	0.89	0.76	1.05	0.16
Harrisburg	0.96	0.85	1.08	0.47	0.95	0.8	1.13	0.56	0.95	0.81	1.12	0.57
Johnstown	1.11	0.92	1.35	0.26	1.27	0.96	1.67	0.1	1.02	0.79	1.32	0.87
Lancaster	0.85	0.73	0.99	0.04	0.9	0.74	1.09	0.28	0.82	0.65	1.03	0.08
Table 9 Continued	09	0.72	1.66	0.69	0.96	0.53	1.73	0.88	1.26	0.7	2.26	0.45
	97	0.88	1.07	0.58	1.09	0.96	1.24	0.19	0.88	0.76	1.01	0.06
Reading	0.98	0.86	1.12	0. 77	1.02	0.85	1.22	0.84	0.95	0.8	1.14	0.6
Sayre	1.08	0.82	1.43	0.57	1.33	0.83	2.12	0.23	0.97	0.69	1.37	0.87
Scranton	1.01	0.87	1.16	0.92	1.18	0.95	1.47	0.13	0.9	0.75	1.09	0.3
Wilkes-Barre	0.87	0.73	1.05	0.14	0.81	0.61	1.06	0.12	0.9	0.71	1.14	0.39
York	0.96	0.79	1.17	0.72	0.74	0.56	0.97	0.03	1.17	0.89	1.54	0.27
Youngstown	1.11	0.86	1.44	0.41	1.03	0.7	1.52	0.87	1.1	0.78	1.55	0.58

4.4 DISCUSSION

Our study shows that individuals with SMI visit the primary care offices almost twice as much as they visit the behavioral health provider (6.2 visits to the BH provider vs. 10.8 to the PC). Continuity of care is also much higher in the PC specialty than in BH. This is not unlike other studies that that show that these visits are often repeat consultations for their PH comorbidities.(Daumit, Pratt, Crum, Powe, & Ford, 2002) This underscores the high priority of PC with respect to regular preventive or maintenance visits specifically for diabetes and related physical health conditions. However significant barriers such as cognitive impairment and stigma associated with their behavioral health illness may prevent them from developing a trusting relationship with one single point of contact.(Viron & Stern, 2010) This could be due to their own reluctance to discuss with their provider or due to provider discomfort in communicating freely with patients that they generally consider challenging.(Phelan, Stradins, & Morrison, 2001) Thus individuals with SMI go to multiple primary care providers with a high likelihood of poor outcomes.

If individuals do visit multiple PC providers, an ideal scenario would be sharing of information or treatment strategies such as changes in medication, test results or referrals to specialists to ensure coordination of care. The addition of the care density variable in our study allows us to measure CoC in tandem with a quantified score of patient sharing among these providers. Thus, if a patient sees multiple providers who share many patients among them, even if the CoC score is low, a care density that is high picks up potential collaborative care among multiple providers. This network of providers may form a cohesive approach to treatment than those who see patients independently. We did see that in our analysis, the average care density among the provider networks was higher than that of other studies that have used commercial

insurance plan data. Further study may be necessary to understand the difference in provider networks for Medicare and commercial insurance plans.

We also see that CoC in PC is positively associated with a lower rate of ED visits. Current payment models for PCs favor short consultations based reactively on symptom aggravation in primary care practices that do not share treatment plans or prescribing information with other facilities(Lawrence & Kisely, 2010). Payors have responded to this challenge through delivery system and payment reforms. One such plan is the development of behavioral health homes that integrate primary care practices within behavioral health facilities ensuring that the patient only needs to visit one facility for their routine visits. This single point of contact has been shown to benefit individuals with SMI get adequate physical health care for their comorbidities.(Crompton, Groves, & McGrath, 2010) One more model is the addition of social workers or service coordinators who are affiliated with the primary care and behavioral health practices could serve as communication liaisons between the PC provider and patient. These social workers form a trust relationship with the patient and ensure that preventive and maintenance visits are completed on time.

Despite these findings, our study has a number of limitations. First, we measure the CoC and ED visits simultaneously. This does not allow us to measure the directional impact of CoC on ED visits. While we show that having higher CoC could lead to better symptom management and lower risks of complications resulting in ED visits, it is entirely possible that individuals with a lot of complications visit many PC providers.(Cheng et al., 2010) However, we do know for certain that having an ongoing relationship with a provider allows the patient to communicate their medical problems as well as their preferences and dislikes. This alliance between a provider

and a patient is likely to mean that the patient is more likely to consult with the provider in case of a perceived urgent issue instead of presenting at the emergency room.

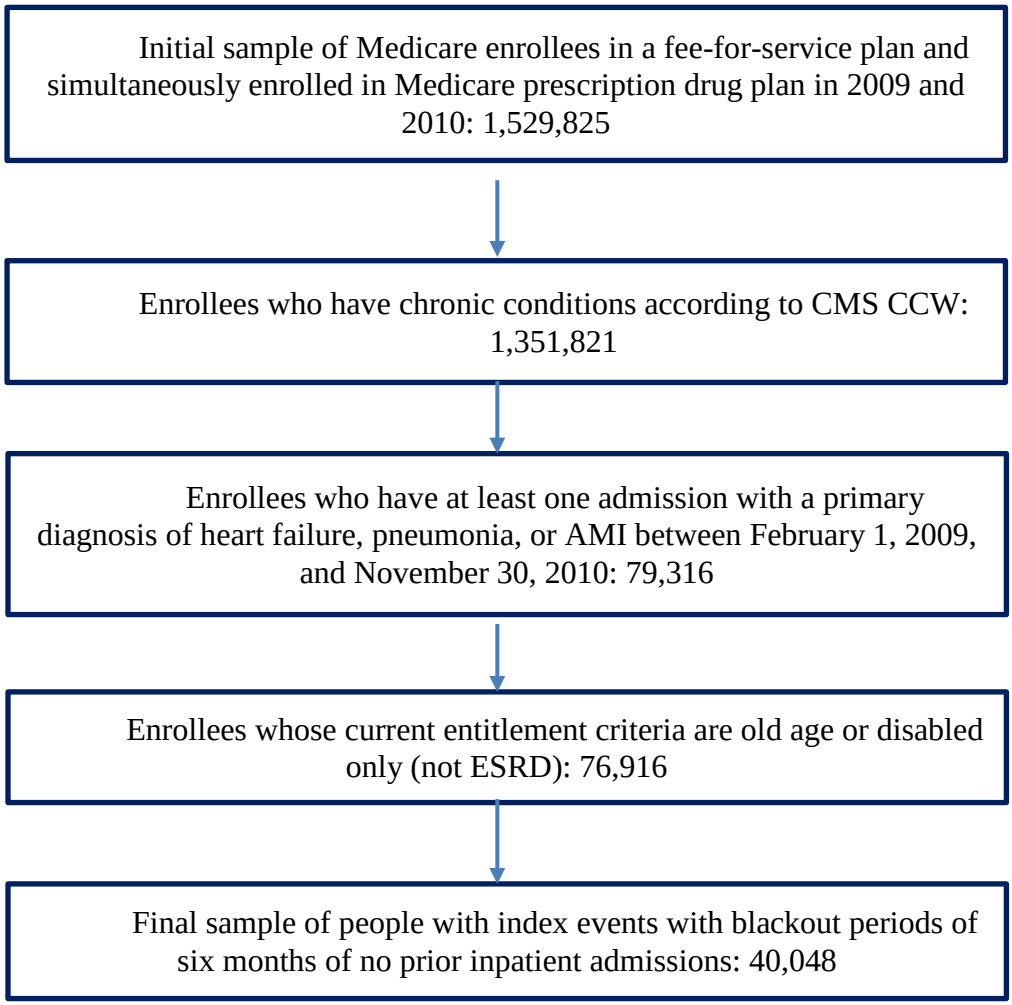
It is difficult to get one measure that comprehensively assesses care continuity. In the absence of that, we have used a CoC index in addition to the care density measure to measure care coordination. While we have learned that measurement of CoC along with a care density variable may be one method, further methodological work needs to be done to enhance the measurement of CoC among providers.

Also, from administrative claims data, we do not have information on patient preferences about their primary care provider that may be key to understanding CoC. We also do not analyze the cause of the ED visits. Further study may elucidate more clearly whether visits for conditions that may have been treated at an ambulatory setting or if all ED visits are were specifically associated with CoC.

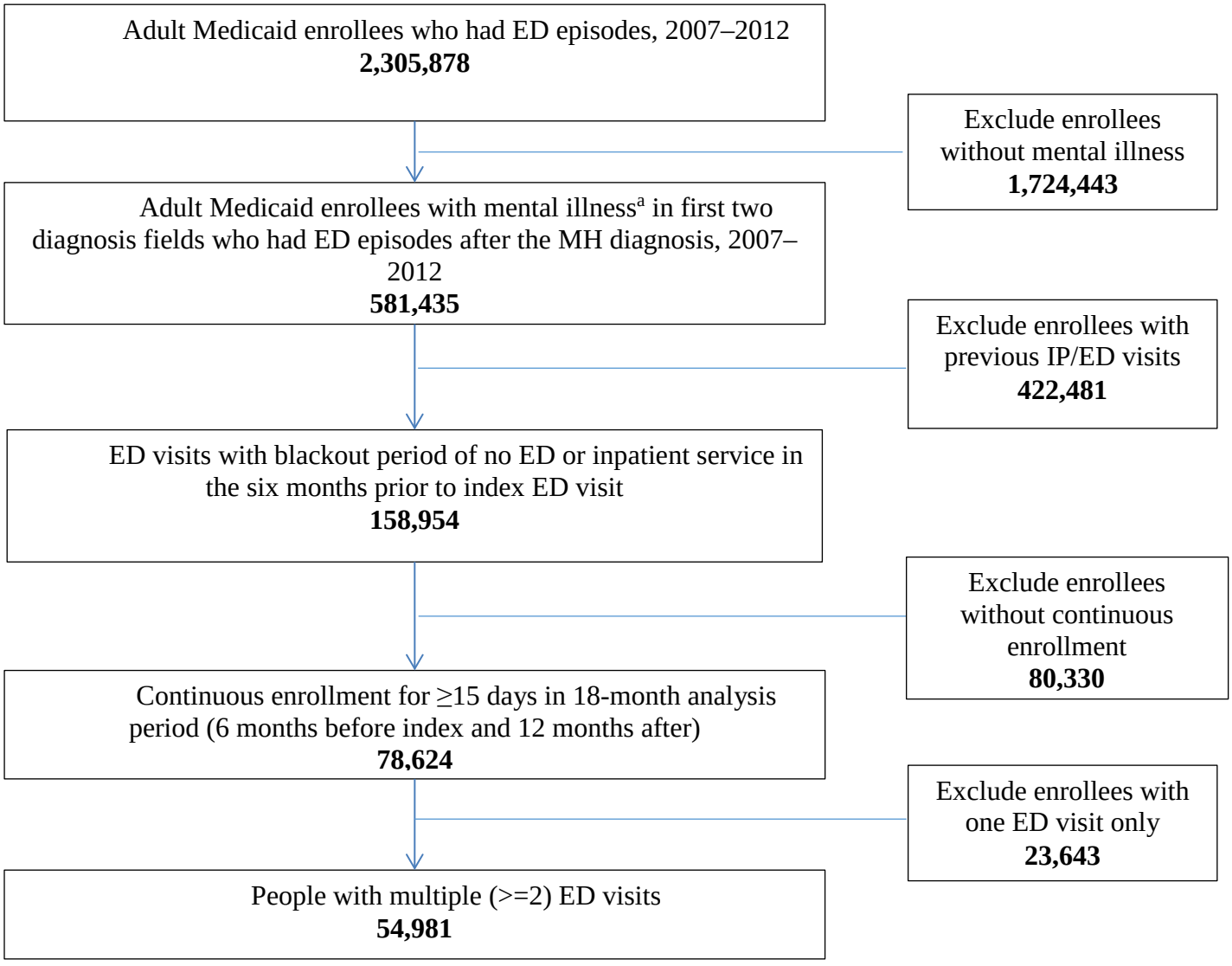
4.5 CONCLUSION

Our study shows that having a high level of CoC was associated with decreased emergency department use for individuals with SMI and type II diabetes. This finding underlines the importance of alternative payment models that encourage CoC.

APPENDIX A: FLOW CHART SHOWING BUILDING A STUDY SAMPLE OF MEDICARE ENROLLEES WITH CHRONIC ILLNESSESS WHO ARE ADMITTED FOR AMI, PNEUMONIA OR HEART FAILURE IN 2009 AND 2010



APPENDIX B: FLOW CHART SHOWING SAMPLE BUILDING FOR MEDICAID ENROLLEES WHO USE THE EMERGENCY DEPARTMENT IN 2007 TO 2012



NOTE: ED visits could be for MH, substance-use, or physical health issues. We included only nondual enrollees ages 18 to 54 who resided in Pennsylvania.

[a] We identified mental illness using a case-ascertainment method with one inpatient and two outpatient diagnoses in any diagnosis field. We used mental illness ICD-9-CM diagnosis codes 290, 293–302.x, and 306.x–319. recorded as primary diagnoses at either one inpatient or two separate outpatient encounters.

APPENDIX C: TABLE SHOWING DIFFERENCE FOR TWO METHODS OF ESTIMATING OF ODDS THIRTY DAY READMISSION FOR MEDICARE INDIVIVUALS WITH CHRONIC ILLNESS ADMITTED TO AN ACUTE FACILITY FOR ACUTE MYOCARDIAL INFACTION, HEART FAILURE OR PNEUMONIA

Characteristic	Original Model	Propensity score matched	Difference in Odds Ratio
Mental illness	1.46	1.46	0.00
Female	0.91	0.80	-0.11
Entitlement	1.06	0.87	-0.19
Age	1.00	1.01	0.01
Race: *Reference category is white*			
Black	1.15	1.31	0.16
Other	0.94	0.97	0.03
LIS	1.33	1.34	0.01
Dually eligible	1.07	1.12	0.05
Substance-use disorder	1.26	1.28	0.02
Number of chronic illnesses	1.05	1.05	0.00
Index event–level variables			
Length of stay	0.99	0.99	0.00
Outpatient follow-up	1.40	1.38	-0.02
Difference in TCM: *Reference category is no difference in therapeutic categories count*			
Therapeutic categories dropped	0.95	0.97	0.02
Therapeutic categories added	1.16	1.15	-0.01
Discharge destination: *Reference category is home*			
Home health	1.10	0.97	-0.13
SNF	0.62	0.38	-0.24
Other	0.18	0.13	-0.05
Mental illness * Outpatient follow-up	0.96	0.97	0.01
Difference in TCM*: Reference category is no difference in therapeutic categories count*			
Mental illness * Therapeutic categories dropped	1.30	1.28	-0.02
Mental illness * Therapeutic categories added	1.14	1.14	0.00

BIBLIOGRAPHY

Aagaard, J., Aagaard, A., & Buus, N. (2014). Predictors of frequent visits to a psychiatric emergency room: A large-scale register study combined with a small-scale interview study. *International journal of nursing studies, 51*(7), 1003-1013.

Abuse, C. o. S. (2011). Substance use screening, brief intervention, and referral to treatment for pediatricians: Am Acad Pediatrics.

Abuse, S. (2016). Mental Health Services Administration. Behavioral health trends in the United States: results from the 2014 National Survey on Drug Use and Health, 2015. HHS Publication No. SMA 15-4927, NSDUH Series H-50.

Agresti, A., & Kateri, M. (2011). *Categorical data analysis*: Springer.

Alexander, L., & Druss, B. (2012). Behavioral health homes for people with mental health and substance use conditions: The core clinical features. *Washington, DC, SAMHSA-HRSA Center for Integrated Health Solutions, US Department of Health and Human Services*.

Alper, E., O'Malley, T. A., Greenwald, J., Aronson, M. D., & Park, L. (2014). Hospital discharge and readmission. *Retrieved February, 1*, 2015.

Arfken, C. L., Zeman, L. L., Yeager, L., White, A., Mischel, E., & Amirsadri, A. (2004). Case-control study of frequent visitors to an urban psychiatric emergency service. *Psychiatric Services, 55*(3), 295-301.

Axon, R. N., & Williams, M. V. (2011). Hospital readmission as an accountability measure. *Jama, 305*(5), 504-505.

Balla, U., Malnick, S., & Schattner, A. (2008). Early readmissions to the department of medicine as a screening tool for monitoring quality of care problems. *Medicine, 87*(5), 294-300.

Barefoot, J. C., & Schroll, M. (1996). Symptoms of depression, acute myocardial infarction, and total mortality in a community sample. *Circulation, 93*(11), 1976-1980.

Barnett, M. L., Landon, B. E., O'malley, A. J., Keating, N. L., & Christakis, N. A. (2011). Mapping physician networks with self-reported and administrative data. *Health services research, 46*(5), 1592-1609.

Bechtel, C., & Ness, D. L. (2010). If you build it, will they come? Designing truly patient-centered health care. *Health affairs, 29*(5), 914-920.

Begley, C., Courtney, P., & Burau, K. (2006). Houston hospitals emergency department use study. *Gateway to Care*, 1-46.

Bell, C. M., Brener, S. S., Gunraj, N., Huo, C., Bierman, A. S., Scales, D. C., . . . Urbach, D. R. (2011). Association of ICU or hospital admission with unintentional discontinuation of medications for chronic diseases. *Jama, 306*(8), 840-847.

Bell, C. M., Rahimi-Darabad, P., & Orner, A. I. (2006). Discontinuity of chronic medications in patients discharged from the intensive care unit. *Journal of general internal medicine, 21*(9), 937-941.

Berenson, J., & Shih, A. (2012). Higher readmissions at safety-net hospitals and potential policy solutions. *Issue Brief (Commonw Fund), 34*, 1-16.

Billings, J., Parikh, N., & Mijanovich, T. (2000). Emergency department use in New York City: a substitute for primary care? *Issue brief (Commonwealth Fund)*(433), 1-5.

Blumenthal, D., Abrams, M., & Nuzum, R. (2015). The affordable care act at 5 years: Mass Medical Soc.

Boccuti, C., & Casillas, G. (2015). Aiming for fewer hospital U-turns: the Medicare hospital readmission reduction program. *The Henry J. Kaiser Family Foundation*, 1-10.

Bond, G. R., Drake, R. E., Mueser, K. T., & Latimer, E. (2001). Assertive community treatment for people with severe mental illness. *Disease Management and Health Outcomes, 9*(3), 141-159.

Brown, M. T., & Bussell, J. K. (2011). *Medication adherence: WHO cares?* Paper presented at the Mayo Clinic Proceedings.

Bruffaerts, R., Sabbe, M., & Demyttenaere, K. (2004). Effects of patient and health-system characteristics on community tenure of discharged psychiatric inpatients. *Psychiatric Services, 55*(6), 685-690.

Buck, J., Miller, K., & Bae, J. (2000). Mental Health and Substance Abuse Services in Medicaid, 1986-1992. DHHS Pub. No.(SMA) 99-3366. Rockville, MD: Center for Mental Health Services. *Substance Abuse and Mental Health Services Administration*.

Campbell, N. L., Boustani, M. A., Skopelja, E. N., Gao, S., Unverzagt, F. W., & Murray, M. D. (2012). Medication adherence in older adults with cognitive impairment: a systematic evidence-based review. *The American journal of geriatric pharmacotherapy, 10*(3), 165-177.

Catalano, R., McConnell, W., Forster, P., McFarland, B., & Thornton, D. (2003). Psychiatric emergency services and the system of care. *Psychiatric Services, 54*(3), 351-355.

Chang, G., Weiss, A. P., Orav, E. J., & Rauch, S. L. (2014). Predictors of frequent emergency department use among patients with psychiatric illness. *General hospital psychiatry, 36*(6), 716-720.

Chaput, Y. J., & Lebel, M.-J. (2007). Demographic and clinical profiles of patients who make multiple visits to psychiatric emergency services. *Psychiatric Services, 58*(3), 335-341.

Chen, J., Zhai, Y., O'Loughlin, J., Volckmann, E., Mackenzie, J., & Ibele, A. (2016). Higher BMI and Weight Related Public Distress May Predict Unnecessary Returns to the Emergency Department Following Bariatric Surgery. *Surgery for Obesity and Related Diseases, 12*(7), S131-S132.

Cheng, S.-H., Chen, C.-C., & Hou, Y.-F. (2010). A longitudinal examination of continuity of care and avoidable hospitalization: evidence from a universal coverage health care system. *Archives of Internal Medicine, 170*(18), 1671-1677.

Chow, J. C.-C., Jaffee, K., & Snowden, L. (2003). Racial/ethnic disparities in the use of mental health services in poverty areas. *American Journal of Public Health, 93*(5), 792-797.

Coleman, E. A., Parry, C., Chalmers, S., & Min, S.-j. (2006). The care transitions intervention: results of a randomized controlled trial. *Archives of Internal Medicine, 166*(17), 1822-1828.

Coleman, E. A., & Williams, M. V. (2007). Executing high-quality c are transitions: A call to do it right. *Journal of Hospital Medicine, 2*(5), 287-290.

Commission, M. P. A. (2007). *Report to the Congress: promoting greater efficiency in Medicare*: Medicare Payment Advisory Commission (MedPAC).

Cornish, P. L., Knowles, S. R., Marchesano, R., Tam, V., Shadowitz, S., Juurlink, D. N., & Etchells, E. E. (2005). Unintended medication discrepancies at the time of hospital admission. *Archives of Internal Medicine, 165*(4), 424-429.

Corrigan, J. M. (2005). Crossing the quality chasm. *Building a better delivery system*.

Crompton, D., Groves, A., & McGrath, J. (2010). What can we do to reduce the burden of avoidable deaths in those with serious mental illness? *Epidemiologia e Psichiatria Sociale, 19*(01), 4-7.

Daumit, G. L., Pratt, L. A., Crum, R. M., Powe, N. R., & Ford, D. E. (2002). Characteristics of primary care visits for individuals with severe mental illness in a national sample. *General hospital psychiatry, 24*(6), 391-395.

Dhossche, D. M., & Ghani, S. O. (1998). A study on recidivism in the psychiatric emergency room. *Annals of Clinical Psychiatry, 10*(2), 59-67.

Dixon, L., Goldberg, R., Iannone, V., Lucksted, A., Brown, C., Kreyenbuhl, J., . . . Potts, W. (2009). Use of a critical time intervention to promote continuity of care after psychiatric inpatient hospitalization. *Psychiatric Services, 60*(4), 451-458.

Donohue, J. M., Huskamp, H. A., & Zuvekas, S. H. (2009). Dual eligibles with mental disorders and Medicare part D: how are they faring? *Health affairs, 28*(3), 746-759.

Doran, K. M., Raven, M. C., & Rosenheck, R. A. (2013). What drives frequent emergency department use in an integrated health system? National data from the Veterans Health Administration. *Annals of Emergency Medicine, 62*(2), 151-159.

Druss, B. G., Rosenheck, R. A., Desai, M. M., & Perlin, J. B. (2002). Quality of preventive medical care for patients with mental disorders. *Medical care, 40*(2), 129-136.

Elixhauser, A., Steiner, C., Harris, D. R., & Coffey, R. M. (1998). Comorbidity measures for use with administrative data. *Medical care, 36*(1), 8-27.

Ellison, J. M., Blum, N., & Barsky, A. J. (1986). Repeat visitors in the psychiatric emergency service: a critical review of the data. *Psychiatric Services, 37*(1), 37-41.

Fagiolini, A., & Goracci, A. (2008). The effects of undertreated chronic medical illnesses in patients with severe mental disorders. *The Journal of clinical psychiatry, 70*, 22-29.

Forster, A. J., Murff, H. J., Peterson, J. F., Gandhi, T. K., & Bates, D. W. (2003). The incidence and severity of adverse events affecting patients after discharge from the hospital. *Annals of internal medicine, 138*(3), 161-167.

Garfield, R. L., Zuvekas, S. H., Lave, J. R., & Donohue, J. M. (2011). The impact of national health care reform on adults with severe mental disorders. *American Journal of Psychiatry, 168*(5), 486-494.

Gentilello, L. M., Ebel, B. E., Wickizer, T. M., Salkever, D. S., & Rivara, F. P. (2005). Alcohol interventions for trauma patients treated in emergency departments and hospitals: a cost benefit analysis. *Annals of surgery, 241*(4), 541-550.

Gentilello, L. M., Rivara, F. P., Donovan, D. M., Jurkovich, G. J., Daranciang, E., Dunn, C. W., . . . Ries, R. R. (1999). Alcohol interventions in a trauma center as a means of reducing the risk of injury recurrence. *Annals of surgery, 230*(4), 473.

Gheorghiade, M., Vaduganathan, M., Fonarow, G. C., & Bonow, R. O. (2013). Rehospitalization for heart failure: problems and perspectives. *Journal of the American College of Cardiology, 61*(4), 391-403.

Gill, J. M., Mainous III, A. G., & Nsereko, M. (2000). The effect of continuity of care on emergency department use. *Archives of family medicine, 9*(4), 333.

Harrington, R. A., Becker, R. C., Ezekowitz, M., Meade, T. W., O'Connor, C. M., Vorchheimer, D. A., & Guyatt, G. H. (2004). Antithrombotic therapy for coronary artery disease: the Seventh ACCP Conference on Antithrombotic and Thrombolytic Therapy. *CHEST Journal, 126*(3_suppl), 513S-548S.

Hennessy, S., Leonard, C. E., Freeman, C. P., Deo, R., Newcomb, C., Kimmel, S. E., . . . Bilker, W. B. (2010). Validation of diagnostic codes for outpatient-originating sudden cardiac death and ventricular arrhythmia in Medicaid and Medicare claims data. *Pharmacoepidemiology and drug safety, 19*(6), 555-562.

HERT, M., Correll, C. U., Bobes, J., CETKOVICH-BAKMAS, M., Cohen, D., Asai, I., . . . Ndetei, D. M. (2011). Physical illness in patients with severe mental disorders. I. Prevalence, impact of medications and disparities in health care. *World psychiatry, 10*(1), 52-77.

Horvitz-Lennon, M., Kilbourne, A. M., & Pincus, H. A. (2006). From silos to bridges: meeting the general health care needs of adults with severe mental illnesses. *Health affairs, 25*(3), 659-669.

Ionescu-Ittu, R., McCusker, J., Ciampi, A., Vadeboncoeur, A.-M., Roberge, D., Larouche, D., . . . Pineault, R. (2007). Continuity of primary care and emergency department utilization among elderly people. *Canadian Medical Association Journal, 177*(11), 1362-1368.

James, J. (2013). Medicare hospital readmissions reduction program. *Health affairs, 34*(2), 1-5.

Jee, S. H., & Cabana, M. D. (2006). Indices for continuity of care: a systematic review of the literature. *Medical Care Research and Review, 63*(2), 158-188.

Jiang, H. J., Boutwell, A. E., Maxwell, J., Bourgoin, A., Regenstein, M., & Andres, E. (2016). Understanding patient, provider, and system factors related to Medicaid readmissions. *The Joint Commission Journal on Quality and Patient Safety, 42*(3), 115-121.

Kalucy, R., Thomas, L., & King, D. (2005). Changing demand for mental health services in the emergency department of a public hospital. *Australian and New Zealand Journal of Psychiatry, 39*(1-2), 74-80.

Kasper, E. K., Gerstenblith, G., Hefter, G., Van Anden, E., Brinker, J. A., Thiemann, D. R., . . . Gottlieb, S. H. (2002). A randomized trial of the efficacy of multidisciplinary care in heart failure outpatients at high risk of hospital readmission. *Journal of the American College of Cardiology, 39*(3), 471-480.

Kawachi, I., Colditz, G. A., Ascherio, A., Rimm, E. B., Giovannucci, E., Stampfer, M. J., & Willett, W. C. (1994). Prospective study of phobic anxiety and risk of coronary heart disease in men. *Circulation, 89*(5), 1992-1997.

Kilcup, M., Schultz, D., Carlson, J., & Wilson, B. (2013). Postdischarge pharmacist medication reconciliation: impact on readmission rates and financial savings. *Journal of the American Pharmacists Association, 53*(1), 78-84.

Kumar, G. S., & Klein, R. (2013). Effectiveness of case management strategies in reducing emergency department visits in frequent user patient populations: a systematic review. *The Journal of emergency medicine, 44*(3), 717-729.

Kushel, M. B., Perry, S., Bangsberg, D., Clark, R., & Moss, A. R. (2002). Emergency department use among the homeless and marginally housed: results from a community-based study. *American Journal of Public Health, 92*(5), 778-784.

Lang, P. O., Hasso, Y., Dramé, M., Vogt-Ferrier, N., Prudent, M., Gold, G., & Michel, J. P. (2010). Potentially inappropriate prescribing including under-use amongst older patients with cognitive or psychiatric co-morbidities. *Age and ageing, 39*(3), 373-381.

Larkin, G. L., Claassen, C. A., Emond, J. A., & Camargo Jr, C. A. (2004). Trends in US Emergency Department Visits for Mental Health, 1992-2001. *Academic Emergency Medicine, 11*(5), 486.

Larkin, G. L., Claassen, C. A., Emond, J. A., Pelletier, A. J., & Camargo, C. A. (2005). Trends in US emergency department visits for mental health conditions, 1992 to 2001. *Psychiatric Services, 56*(6), 671-677.

Law, P. (2015). Law 111-148, Patient Protection and Affordable Care Act, March 23, 2010. *As of February, 13*.

Lawrence, D., & Kisely, S. (2010). Review: Inequalities in healthcare provision for people with severe mental illness. *Journal of psychopharmacology, 24*(4_suppl), 61-68.

Leslie, D. L., & Rosenheck, R. A. (2000). Comparing quality of mental health care for public-sector and privately insured populations. *Psychiatric Services, 51*(5), 650-655.

Li, Y., Cai, X., Du, H., Glance, L. G., Lyness, J. M., Cram, P., & Mukamel, D. B. (2011). Mentally ill Medicare patients less likely than others to receive certain types of surgery. *Health affairs, 30*(7), 1307-1315.

Lindamer, L. A., Liu, L., Sommerfeld, D. H., Folsom, D. P., Hawthorne, W., Garcia, P., . . . Jeste, D. V. (2012). Predisposing, enabling, and need factors associated with high service use in a public mental health system. *Administration and Policy in Mental Health and Mental Health Services Research, 39*(3), 200-209.

Lurie, N., Popkin, M., Dysken, M., Moscovice, I., & Finch, M. (1992). Accuracy of diagnoses of schizophrenia in Medicaid claims. *Psychiatric Services, 43*(1), 69-71.

Magill, M. K., & Senf, J. (1987). A new method for measuring continuity of care in family practice residencies. *The Journal of family practice, 24*(2), 165-168.

McCarthy, D. (2012). University of California, San Francisco Medical Center: reducing readmissions through heart failure care management. *The Commonwealth Fund, 7*, 1-18.

McCarthy, D., Cohen, A., & Johnson, M. B. (2013). Gaining Ground: care management programs to reduce hospital admissions and readmissions among chronically ill and vulnerable patients. *The Commonwealth Fund: New York*.

Mechanic, D., & Aiken, L. H. (1987). Improving the care of patients with chronic mental illness. *New England Journal of Medicine, 317*(26), 1634-1638.

Medicare, C. f., & Services, M. (2009). Medicare provider analysis and review (MEDPAR) file. *Retrieved f rom* https://www. *cms. gov/IdentifiableDataFiles/05_MedicareProvider AnalysisandReviewFile. asp*.

Medicare, C. f., & Services, M. (2014a). Medicare Hospital Quality Chartbook: Performance Report on Outcome Measures: September.

Medicare, C. f., & Services, M. (2014b). Readmissions reduction program.

Misky, G. J., Wald, H. L., & Coleman, E. A. (2010). Post-hospitalization transitions: Examining the effects of timing of primary care provider follow-up. *Journal of Hospital Medicine, 5*(7), 392-397.

Mitchell, A. J., & Selmes, T. (2007). Why don't patients attend their appointments? Maintaining engagement with psychiatric services. *Advances in psychiatric treatment, 13*(6), 423-434.

Nagin, D. (2005). *Group-based modeling of development*: Harvard University Press.

Nagin, D. S., & Odgers, C. L. (2010). Group-based trajectory modeling in clinical research. *Annual review of clinical psychology, 6*, 109-138.

Neighbors, C. J., Sun, Y., Yerneni, R., Tesiny, E., Burke, C., Bardsley, L., . . . Morgenstern, J. (2013). Medicaid care management: Description of high-cost addictions treatment clients. *Journal of substance abuse treatment, 45*(3), 280-286.

Nelson, E. A., Maruish, M. E., & Axler, J. L. (2000). Effects of discharge planning and compliance with outpatient appointments on readmission rates. *Psychiatric Services, 51*(7), 885-889.

Nieminen, M. S., Böhm, M., Cowie, M. R., Drexler, H., Filippatos, G. S., Jondeau, G., . . . Metra, M. (2005). Executive summary of the guidelines on the diagnosis and treatment of acute heart failure. *European heart journal, 26*(4), 384-416.

Niska, R., Bhuiya, F., & Xu, J. (2010). National hospital ambulatory medical care survey: 2007 emergency department summary. *Natl Health Stat Report, 26*(26), 1-31.

Owens, P. L., Mutter, R., & Stocks, C. (2006). Mental health and substance abuse-related emergency department visits among adults, 2007: Statistical Brief# 92: Agency for Health Care Policy and Research (US), Rockville (MD).

Parks, J., Svendsen, D., Singer, P., Foti, M. E., & Mauer, B. (2006). Morbidity and mortality in people with serious mental illness. *Alexandria, VA: National Association of State Mental Health Program Directors (NASMHPD) Medical Directors Council, 25*.

Pennsylvania Department of Human Services. Statewide managed care map. Pennsylvania Department of Human Services. Retrieved from http://www.dhs.pa.gov/provider/healthcaremedicalassistance/managedcareinformation/statewidemanagedcaremap/#.vnlaulyridu.

Phelan, M., Stradins, L., & Morrison, S. (2001). Physical health of people with severe mental illness: can be improved if primary care and mental health professionals pay attention to it. *British Medical Journal, 322*(7284), 443-443.

Pollack, C. E., Frick, K. D., Herbert, R. J., Blackford, A. L., Neville, B. A., Wolff, A. C., . . . Snyder, C. F. (2014). It's who you know: patient-sharing, quality, and costs of cancer survivorship care. *Journal of Cancer Survivorship, 8*(2), 156-166.

Pollack, C. E., Weissman, G. E., Lemke, K. W., Hussey, P. S., & Weiner, J. P. (2013). Patient sharing among physicians and costs of care: a network analytic approach to care coordination using claims data. *Journal of general internal medicine, 28*(3), 459-465.

Pope, D., Fernandes, C. M., Bouthillette, F., & Etherington, J. (2000). Frequent users of the emergency department: a program to improve care and reduce visits. *Canadian Medical Association Journal, 162*(7), 1017-1020.

Pronovost, P., Weast, B., Schwarz, M., Wyskiel, R. M., Prow, D., Milanovich, S. N., . . . Lipsett, P. (2003). Medication reconciliation: a practical tool to reduce the risk of medication errors. *Journal of critical care, 18*(4), 201-205.

Quality, A. f. H. R. a. Care Management: Implications for Medical Practice, Health Policy, and Health Services Research. Retrieved from http://www.ahrq.gov/professionals/prevention-chronic-care/improve/coordination/caremanagement/index.html

Richard-Lepouriel, H., Weber, K., Baertschi, M., DiGiorgio, S., Sarasin, F., & Canuto, A. (2015). Predictors of recurrent use of psychiatric emergency services. *Psychiatric Services, 66*(5), 521-526.

Shortell, S. M. (1976). Continuity of medical care: conceptualization and measurement. *Medical care*, 377-391.

Smith, R. P., Larkin, G. L., & Southwick, S. M. (2008). Trends in US emergency department visits for anxiety-related mental health conditions, 1992-2001. *The Journal of clinical psychiatry, 69*(2), 286-294.

Solberg, L. I., Asplin, B. R., Weinick, R. M., & Magid, D. J. Emergency department crowding. *Annals of Emergency Medicine, 42*(6), 824-834. doi:10.1016/S0196-0644(03)00816-3
Spettell, C. M., Wall, T. C., Allison, J., Calhoun, J., Kobylinski, R., Fargason, R., & Kiefe, C. I. (2003). Identifying Physician-Recognized Depression from Administrative Data: Consequences for Quality Measurement. *Health services research, 38*(4), 1081-1102.
Statistics, N. C. f. H. (2013). Health, United States, 2012: With special feature on emergency care.
Stone, J., & Hoffman, G. J. (2010). Medicare hospital readmissions: issues, policy options and PPACA. *Congressional research service*, 1-37.
Unützer, J., Schoenbaum, M., Druss, B. G., & Katon, W. J. (2006). Transforming mental health care at the interface with general medicine: report for the presidents commission. *Psychiatric Services, 57*(1), 37-47.
Van Walraven, C., Bennett, C., Jennings, A., Austin, P. C., & Forster, A. J. (2011). Proportion of hospital readmissions deemed avoidable: a systematic review. *Canadian Medical Association Journal*, cmaj. 101860.
van Walraven, C., Jennings, A., Taljaard, M., Dhalla, I., English, S., Mulpuru, S., . . . Forster, A. J. (2011). Incidence of potentially avoidable urgent readmissions and their relation to all-cause urgent readmissions. *Canadian Medical Association Journal, 183*(14), E1067-E1072.
Viggiano, T., Pincus, H. A., & Crystal, S. (2012). Care transition interventions in mental health. *Current opinion in psychiatry, 25*(6), 551-558.
Viron, M. J., & Stern, T. A. (2010). The impact of serious mental illness on health and healthcare. *Psychosomatics, 51*(6), 458-465.
Wan, T. T., & Ozcan, Y. A. (1991). Determinants of psychiatric rehospitalization: a social area analysis. *Community Mental Health Journal, 27*(1), 3-16.
Warehouse, C. C. D. (2012). Chronic condition algorithms. 2014.
Wellstone, P. (2008). Pete Domenici Mental Health Parity and Addiction Equity Act of 2008. *HR, 1424*(110), 511-512.
Wennberg, J. E., Fisher, E. S., Goodman, D. C., & Skinner, J. S. (2008). Tracking the Care of Patients with Severe Chronic Illness-The Dartmouth Atlas of Health Care 2008.
Woltz, P. C., Chapa, D. W., Friedmann, E., Son, H., Akintade, B., & Thomas, S. A. (2012). Effects of interventions on depression in heart failure: a systematic review. *Heart & Lung: The Journal of Acute and Critical Care, 41*(5), 469-483.
Yasaitis, L. C., Bynum, J. P., & Skinner, J. S. (2013). Association between physician supply, local practice norms, and outpatient visit rates. *Medical care, 51*(6).
Yoon, J., & Bernell, S. L. (2013). The role of adverse physical health events on the utilization of mental health services. *Health services research, 48*(1), 175-194.
Young, A. S., Chinman, M. J., Cradock-O'Leary, J. A., Sullivan, G., Murata, D., Mintz, J., & Koegel, P. (2005). Characteristics of individuals with severe mental illness who use emergency services. *Community Mental Health Journal, 41*(2), 159-168.
Ziegelstein, R. C., Fauerbach, J. A., Stevens, S. S., Romanelli, J., Richter, D. P., & Bush, D. E. (2000). Patients with depression are less likely to follow recommendations to reduce cardiac risk during recovery from a myocardial infarction. *Archives of Internal Medicine, 160*(12), 1818-1823.