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Do coverage expansion and patient-centeredness care delivery improve patient health outcomes and care quality?

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List of Abbreviations

ACO	Accountable Care Organization	MEPS-HC	Medical Expenditure Panel Survey-Household Component
ACSC	ambulatory care sensitive condition	MICE	multiple imputations by chained equations
AHRQ	Agency for Healthcare Research and Quality	MOS	Medical Organization Survey
AMI	Any Mental Illness	NC	North Carolina
ARTS	Addiction and Recovery Treatment Services	NCQA	National Committee for Quality Assurance
ASAM	American Society of Addiction Medicine	NP	Nurse Practitioner
BMI	Body Mass Index	OBOT	Office-Based Opioid Treatment
BP	Blood Pressure	OECD	Organization for Economic Co-operation and Development
CHD	Coronary Heart Diseases	OLS	Ordinary Least Squares
CVD	Cardiovascular Disease	OUD	Opioid Use Disorder
COVID-19	Corona Virus Disease of 2019	PA	Physician Assistant
ED	Emergency Department	PCMH	Patient Centered Medical Home
EHR	Electronic Health Record	PCP	Primary Care Physician
EMR	Electronic Medical Record	PQI	Prevention Quality Indicator
FIPS	Federal Information Processing System	SAHIE	Small Area Health Insurance Estimates
FPL	Federal Poverty Level	SAPIE	Small Area Income and Poverty Estimates
GDP	Gross Domestic Product	SES	Socio Economic Status
GED	General Educational Development	SID	State Inpatient Database
HCUP	Healthcare Cost and Utilization Project	SUD	Substance Use Disorder
HC	Household Component	VA	Virginia
ICD-10-CM	International Classification of Diseases, tenth Revision, Clinical Modification		

Abstract

Chapter 1: Although correlated, improvement of patient health outcomes and quality of care is a result of health care delivery, performance, and healthcare policies that intend to impact health outcomes (Porter, 2010; AHRQ, 2015). This dissertation focuses on a special model of care delivery (Patient-Centered Medical Homes (PCMH)) and two programs (Addiction and Recovery Treatment Services (ARTS) and Medicaid expansion) to examine the correlation and impact of these programs on cardiovascular-related preventive care, healthcare expenditures, and health behavior hospitalizations as patient outcomes.

Chapter 2: We examined the impact of ARTS and Medicaid expansion implemented in Virginia in the first quarter of 2017 and the first quarter of 2019, respectively, on the number of acute hospitalizations for mental illnesses, SUD, and OUD in Virginia relative to North Carolina (which did not implement similar programs) between 2016-2019. We used quarterly county-level Virginia inpatient claims data and North Carolina HCUP data for this purpose. We found the effect of ARTS implementation did not present immediately after the policy was adopted, instead, it took approximately a year to see a significant reduction in behavioral hospitalizations in Virginia compared to North Carolina. Additionally, Virginia expanded Medicaid, which altered the impact of the ARTS program. The ARTS effect is explained by increased access to treatment services for Medicaid members, while the Medicaid expansion effect is explained by pent-up demand for newly enrolled members who were previously uninsured.

Chapter 3: We examined the association between patient-centeredness practices which have any number of Patient-Centered Medical Homes (PCMH) attributes and the probability of cardiovascular preventive services and recommendations among adults who are medically high-risk for cardiovascular diseases (CVD) and by race/ethnicity subpopulations who have a usual source of care. For this purpose, we used the Medical Expenditure Panel Survey-Household Component (MEPS-HC) full-year consolidated data and the Medical Organization Survey (MOS) years 2015 and 2016. Patient-centeredness practices are defined as three categories of low, medium, and high patient-centered attributes. Our finding confirmed no statistically significant difference between adults who are medically high risk for CVD and among race/ethnicity subpopulations who received care from different patient-centered categories and the probability of cardiovascular preventive services. Our findings are consistent with the other studies that examined the association between PCMH practices and the probability of receiving preventive care among different populations.

Chapter 4: We used the Medical Expenditure Panel Survey-Household Component (MEPS-HC) full-year consolidated data and Medical Organization Survey (MOS) to examine the association between the patient-centered categories (defined the same as chapter 2: low, medium, and high patient-centered attributes) and the total payments for all healthcare services used, including payments by third-party payers and out-of-pocket payments, among adults who had the usual source of care in 2015 and 2016. We found that individuals receiving care from practices with high patient-centered attributes spent more on healthcare than individuals who received care from practices with low patient-centered attributes. However, when we moderate our model with the number of chronic diseases, there is a downward trend of healthcare expenditures among individuals with three to nine chronic diseases, who spend on average $11,633, $10,739, and

$10,423 annually when they receive care from practices with low, medium, and high patient-centered attributes, respectively. These results show that individuals with three to nine chronic diseases spend almost $1210 less on average when they receive care from practices with high relative to low patient-centered attributes. More comprehensive and integrated care through patient-centered practices may explain less waste in healthcare and lower expenditure.

Chapter 1

Introduction

A healthcare system is efficient when inputs are transferred to valued outcomes, such as health improvement (Cylus, 2016). Health outcomes in the last decade indicate the inefficiency of the United States health care system; examples of poor outcomes include the high prevalence of mental illnesses, substance use disorders (SUD) and opioid use disorders (OUD); the high mortality rate from cardiovascular disease; and high healthcare expenditures (Peterson-KFF, 2021; NAMI, 2022; OECD data, 2021a).

Health policies and programs tend to improve health outcomes through different mechanisms. The healthcare environment, e.g., demand, socioeconomic resources, and delivery system influence healthcare access (Ryvicker, 2018). A recent program, implemented in Virginia during the second quarter of 2017, is Addiction Recovery and Treatment Services (ARTS), which enhances behavioral health services to keep Virginians well and thriving in their communities. Two of the principal goals of the ARTS program are early intervention for mental health and substance use disorder (SUD) comorbidities and support for a comprehensive alignment of services across the systems serving Medicaid members.

In 2010, the Affordable Care Act (ACA) made several changes to Medicaid, including the expansion of eligibility to adults with incomes up to 138% of the federal poverty level (FPL). Virginia adopted Medicaid expansion in 2019 to increase access to critical services such as inpatient treatment for low-income population with behavioral conditions. Before the ACA, many people with mental health conditions did not qualify for Medicaid unless they were pregnant, elderly, or qualified for disability benefits. Medicaid expansion removes barriers to coverage for many people with mental illnesses, SUD, and OUD (NAMI, 2020b). We compared counties with low and high median household incomes, which also have different socioeconomic

resources, to see whether counties with low median household incomes benefit more from these policies.

Chapter 2 of this dissertation examines the impact of ARTS and Medicaid expansion on the number of hospitalizations for mental illness, SUD, and OUD. Some literature shows that an increase in delivery of and access to outpatient mental health services decreases inpatient services. However, increasing access to mental health services through Medicaid expansion had mixed results in patients' outcomes, including use of inpatient services. Available medical resources could explain the differences in health outcomes, even when access to healthcare services increases with policy changes. Our study first examines the impact of the ARTS program and Medicaid expansion between 2016-2019 in Virginia compared to North Carolina which did not have a program similar to ARTS and did not expand Medicaid.

The National Committee for Quality Assurance (NCQA) released its Patient-Centered Medical Homes (PCMH) Recognition program in 2008 to provide high-quality, affordable, and accessible patient-centered care by promoting stronger relationships with patients, addressing care needs more comprehensively, and providing time to coordinate care across all sectors of the healthcare system (Moran, 2014). In chapter 3 of this dissertation, we examine the correlation between patient-centered practices as an integral and comprehensive model of care and cardiovascular preventive care as a quality of care that affects the health outcome of medically high-risk patients. Although patient-centered practices correlated with a better health outcome, there is little evidence that confirms the correlation between this model of care and better preventive care. In contrast to previous studies, we constructed the variable patient-centered practices differently to allow us to predict the direct correlation between patient-centered practices and higher preventive care services for medically high-risk patients.

Previously, expenditure in the healthcare system was assumed to be an accomplishment. The more money spent on a patient, the better we expect outcomes. However, substantial evidence suggested that our healthcare system delivers many unnecessary and costly services (Kaplan, 1989). In chapter 4 of this dissertation, we examine whether getting care from a comprehensive and integral healthcare setting, as defined in chapter 3, correlates with fewer healthcare expenditures. Further, we test if the number of chronic diseases changes the trend of healthcare expenditures. Patients with more chronic diseases tend to be more costly; however, comprehensive care from patient-centered practices can reduce redundant and unnecessary care that non-centered patient practices might otherwise request.

Answering these questions will give policymakers better insight into current programs on patient health outcomes and quality care. With this additional information, policymakers could implement reforms for policies that do not have the expected impact on or correlation with defined health outcomes.

Chapter 2

Do Addiction and Recovery Treatment Services (ARTS) and Medicaid Expansion Affect the Number of Inpatient Admissions for Mental Illness, Substance Use Disorder (SUD), and Opioid Use Disorder (OUD)?

2.1. Introduction

Behavioral Health in the United States

Mental illness, substance use disorder (SUD), and opioid use disorder (OUD) affect tens of millions of people each year in the United States (Lipari, 2019). Mental illness is defined as a mental, behavioral, or emotional disorder, ranging from no impairment to mild, moderate, or severe impairment (NIH,2020). SUD includes dependence on or misuse of alcohol and other legal and illegal drugs. OUD is physical and psychological reliance on opioids, a substance found in certain prescription pain medications and illegal drugs like heroin.

An estimated 50% of Americans are diagnosed with a mental illness at some point in their lifetime (CDC, 2018). In 2016, approximately 61.4 million adults were diagnosed with any mental illness in the United States, representing almost 19% of all U.S. adults (NSDUH, 2021). In 2017, 15.1 million people reported an alcohol use disorder, and 7.4 million people reported an illegal SUD (SAMHSA, 2017). Individuals with mental health illnesses are more likely to have some type of SUD/OUD and vice versa. Statistics from the 2019 National Survey on Drug Use and Health indicate that 9.5 million adults in the United States have both a mental illness and SUD (SAMHDA, 2021). Also, another study showed that 50% of adults who had SUD also had some type of mental illness (Ross, 2012; Regier,1990).

Behavioral Health in the Commonwealth of Virginia

Almost a quarter million adults in Virginia live with co-occurring mental illness and SUD. During 2013–2017, the average annual prevalence of severe mental illness in Virginia was

4.2% of the total population (or 265,000 individuals). This rate climbs when all mental illness and SUD/OUD are combined. In Virginia, almost 167 per 100,000 population were hospitalized with an opioid-related condition in 2014 (Weiss, 2017). Also, the number of fatal drug overdoses more than doubled in Virginia between 2007 and 2017, from 721 fatalities in 2007 to 1,526 in 2017 (VDH, 2019).

The Burden of Behavioral Conditions

Mental illnesses, SUD, and OUD can affect an individual, their family, and the community due to the individual's mood changes, distorted thinking, altered behavior, and physical changes. Effects on an individual include a higher risk of cardiovascular and metabolic disorders, cancer, gastrointestinal disorders, and memory loss (which also affects medication adherence). Effects on families include the high number of caregivers, with their own mental or emotional health issues, who spend an average of 32 hours per week providing unpaid care to people with mental illnesses (NAMI, 2020a). Individuals with mental illness, SUD, and OUD are more likely to have trouble maintaining healthy relationships with their family members. Also, mental illness, SUD, and OUD burden the community, as individuals with these conditions are more likely to be unemployed, commit criminal offenses, and experience financial difficulties (Babor, 2017; National Institute on Drug Abuse, 2020).

Across the United States economy, severe mental illness causes $193.2 billion in lost earnings annually (NAMI, 2020a). Twenty percent of people experiencing homelessness in the United States have a severe mental health condition (NAMI, 2020a). Thirty-seven percent of adults incarcerated in the state and federal prison system have a diagnosed mental illness (NAMI, 2020a). The societal costs (i.e., healthcare, criminal justice, and workplace costs)

associated with just OUD are 6.5 times higher in 2016 than in 2001 (Birnbaum, 2006; Florence, 2016).

The healthcare system faces the cost of preventable emergency department visits and hospitalizations due to mental illness, SUD, and OUD. One out of every eight adult emergency department visits is related to a type of mental disorder (CDC, 2018). Moreover, more than 40% of avoidable hospitalizations are linked to behavioral problems (CDC, 2018), and mood disorders are the third most common cause of hospitalization for adults under age 45 in the United States (CDC, 2018). One-third of the most common and costly medical conditions were more prevalent among patients with SUD than among patients who did not have SUD (Mertens, 2003). The hospitalization rate related to opioids and stimulant substances increased 26.6% from 2012 to 2018 among adults 18 and older (Fingar, 2021). Hospital stays for a mental illness and/or SUD accounted for 6.1% of all adult hospital stays and 3.6% of total hospital costs ($15.3 billion). On average, a hospital stay for mental illness and/or SUD costs $7,100, with an average hospital length of stay of 6.4 days (Owens, 2019).

Evidence indicates that access to outpatient mental health care can prevent hospitalizations for mental illnesses (Chen, 2018). However, many patients still face significant barriers to consistent mental care (Walker, 2015), including outpatient care (Trude, 2003), and estimates suggest that only half of the people with mental illnesses receive treatment (NIH, 2018). More than 20 million people in the U.S. needed treatment for SUD in 2018, but only 3.7 million received treatment (Lipari, 2019). More than 51% of individuals with co-occurring mental illness and SUD received neither substance use treatment nor mental health services, and only 7.8% received treatment for both (Lipari, 2019). Indeed, only 7.9% of adults who had alcohol use disorder in the past year received treatment (Lipari, 2019).

While there are many reasons why people with behavioral health problems do not get treatment, many people lack insurance coverage for behavioral health care, either because they are uninsured or because their insurance does not include coverage of behavioral health care services.

Recent Policy Actions to Increase Access to Behavioral Health Services in the Commonwealth of Virginia

Addiction and Recovery Treatment Services (ARTS)

To increase access to and quality of treatment and recovery services for Medicaid members with SUD—which may include co-occurrence of mental illnesses—Virginia implemented the Addiction and Recovery Treatment Services (ARTS) program in April 2017. ARTS expanded coverage of many addiction treatment services for Medicaid members, including community-based services and short-term residential treatment, which covered individual, group, and family therapy; psychiatric services; and continuing care services to assist with transitions back into the community. ARTS also increased provider reimbursement rates for many existing services and introduced a new care delivery model, the Preferred Office-Based Opioid Treatment (OBOT) provider, which integrated treatment of OUD with behavioral and physical health services by incentivizing increased use of care coordination. To further integrate behavioral health services, including addiction treatment and mental health services, with other health services, behavioral health services were “carved in” to the benefits covered by Medicaid. These benefits are administered by the six managed care organizations that oversee the majority of medical and health benefits for Medicaid members in Virginia, with the goal of offering a more comprehensive and fully integrated care delivery system (Cunningham, 2020).

Medicaid Expansion

As allowed for by the Patient Protection and Affordable Care Act, on January 1, 2019, Virginia expanded Medicaid eligibility for adults with family incomes up to 138% of the federal poverty level (FPL). Medicaid expansion removed barriers to health insurance coverage for many additional people with mental illnesses and SUD who were previously uninsured. With more people covered by Medicaid, many adults with behavioral health problems will be able to access services earlier, thereby preventing the need for hospitalization for mental illnesses and SUD/OUD (NAMI, 2020b). Expanded eligibility for Medicaid coverage also allows more low-income Virginians to access ARTS for the treatment of SUD.

Previous studies showed mixed results on the effect of Medicaid expansion on the utilization of healthcare services generally and for behavioral health specifically. Some studies showed increased access to healthcare services after Medicaid expansion (e.g., increased use of outpatient behavioral services in states among the Hispanic population) (Rosales, 2021), a decrease in cost-related delays in care among people with a depression diagnosis (Fry, 2018), and an increase in SUD treatment in outpatient settings (Maclean, 2019). An analysis of survey data indicated an association between the expansion of Medicaid and a substantial improvement in mental health and access to care among low-income adults with chronic conditions (Winkelman, 2018). Mojtabai et al. found that Medicaid enrollment among individuals with SUD was significantly associated with the use of SUD treatment services, including outpatient clinics and general inpatient hospitals (2018). However, in Massachusetts, Medicaid enrollees who were mental health and substance abuse care users experienced increased access to all other outpatient services and decreased mental health inpatient admissions, while less costly types of twenty-four-hour care were substituted with inpatient services (Callahan, 1995). Health insurance reduces barriers to care and increases access to

providers; however, some other factors might change the direction of utilization, e.g., the availability of the resources such as living in a county with no outpatient clinic, patients' demands, and health literacy (Deck, 2006).

Hospitalizations for Behavioral Health Conditions as an Indicator of Healthcare Quality

According to Prevention Quality Indicators (PQIs) defined by the Agency for Healthcare Research and Quality (AHRQ), hospitalizations due to ambulatory care sensitive conditions (ACSCs), including chronic diseases such as diabetes, ischemic heart disease, hypertension, and pneumonia, could be largely prevented if ambulatory care is provided in a timely and effective manner. Evidence suggests that effective primary care that is well-coordinated with specialists is associated with lower ACSC hospitalizations (AHRQ, 2021; Gao, 2014; Kao, 2019; Feachem, 2002). Although behavioral health conditions were not defined as ACSCs, Samartzis et al. evaluated avoidable hospitalizations due to mental illness as an indicator of healthcare quality (2019). Avoidable hospitalization due to behavioral health problems reflects a lack of access to corresponding outpatient services (Samartzis, 2019). Some studies evaluated the general effect of Medicaid expansion on healthcare accessibility, and one study explicitly showed a reduction in opioid-related hospital admissions after Medicaid expansion (Wen, 2020). Additionally, ARTS implementation in Virginia showed a reduction in all emergency department and inpatient use among Medicaid beneficiaries with OUD (Barnes, 2020). Virginia is unique in that a major expansion of Medicaid benefits for SUD (the establishment of the ARTS program) in 2017 was followed by a major expansion in people eligible for these benefits (Medicaid expansion) in 2019. In other words, increased access to SUD treatment that was initially provided only to Medicaid beneficiaries in 2017 was extended to a larger population of low-income people in 2019. This study measures the effect of the ARTS program and further Medicaid expansion on

the number of hospitalizations due to mental illness, SUD, and OUD in Virginia. Implementation of ARTS and Medicaid expansion in Virginia is expected to increase the delivery and accessibility of mental health outpatient services and decrease preventable hospitalizations for mental illness.

Research Question

Did ARTS and Medicaid expansion reduce the number of acute hospitalizations of mental illnesses, SUD, and OUD in Virginia relative to states that did not expand Medicaid?

Hypotheses 1

The number of hospitalizations due to mental illness, SUD, and OUD decreased following implementation of the Virginia ARTS program in 2017 relative to comparable state that did not implement such a program.

Hypotheses 2

The average number of hospitalizations due to mental illness, SUD, and OUD decreased following Medicaid expansion in Virginia in 2019, relative to comparable states that did not expand Medicaid.

2.2. Conceptual Framework

We use Anderson and Newman's conceptual framework to describe how the ARTS program and Medicaid expansion would change the number of hospitalizations for mental illness, SUD, and OUD (Figure 1). Anderson and Newman’s model defines the factors that affect health care utilization. Environmental factors that influence health care utilization include any federal or state policies and programs that facilitate access to more convenient healthcare services. In Virginia, the ARTS program covers pharmacotherapy (Methadone and buprenorphine) and increases access to SUD and OUD treatment for Medicaid beneficiaries by

reimbursing Office-Based Opioid Treatment programs. Among the patients who receive pharmacotherapy, the rate of counseling or psychotherapy also increases (Cunningham, 2020). Since many with SUD have co-occurring mental illnesses and the ARTS model of care emphasizes integration of treatment for SUD and mental illness, Medicaid beneficiaries with co-occurring mental illness and SUD/OUD are more likely to receive mental health as well as SUD/OUD treatment. Increased access to outpatient services decreases the acute inpatient admission among Medicaid beneficiaries with SUD/OUD (Cunningham, 2020).

Another environmental factor known to facilitate health care access is the expansion of Medicaid beginning in 2019. Medicaid coverage for low-income populations under 138% of FPL provides ARTS benefits, alongside other outpatient and mental health services, for new enrollees. Since low-income individuals are more likely to have a mental illness and SUD/OUD, the increased access to health care is expected to increase outpatient health care utilization and decrease hospitalization for mental illnesses and SUD/OUD (Sommers, 2016).

Utilization of health services is also influenced by the following factors:

1. Predisposing factor: a high rate of low-income individuals in a community can affect the number of new Medicaid beneficiaries and the demand for health care services.
2. Enabling factor: having affordable health insurance increases the likelihood of using health care services; other studies show Medicaid expansion increases outpatient services (Wen, 2019).
3. Needs factor: the type and severity of the mental illnesses and SUD/OUD determine the need for outpatient services or inpatient admission. More severe cases need to be admitted, however, potentially preventable hospitalizations are expected to decrease after the ARTS program and Medicaid expansion (Wen, 2019).

2.3. Methods

Criteria for Selecting a Comparison State

As a comparison state, North Carolina has not expanded Medicaid and has not implemented a major expansion of SUD/OUD benefits like the ARTS program in our interested time period. ARTS included a SUD demonstration waiver in 2017, while North Carolina implemented a SUD demonstration waiver in 2019. However, the North Carolina waiver was limited primarily to allowing Medicaid payment for residential treatment services, while ARTS involved an expansion of services across all American Society of Addiction Medicine (ASAM) levels of care (Sandoe, 2021). The demographic and geographic location of North Carolina is also comparable with Virginia (Table 1).

Additionally, North Carolina has a similar "Mental Health America" adult ranking as Virginia, based on the prevalence of mental health and access to care measures before ARTS implementation in Virginia. "Mental Health America" adult ranking used seven measures, including a prevalence of adults with Any Mental Illness (AMI), adults with SUD in the past year, adults with serious thoughts of suicide, adults with AMI who are uninsured, adults with AMI who did not receive treatment, adults with AMI reporting unmet need, and adults with a disability who could not see a doctor due to costs.

Data Source

Our analysis compares Virginia inpatient claim data to North Carolina Healthcare Cost and Utilization Project (HCUP) data by quarter year over the years 2016 to 2019. Virginia inpatient claims data are comparable to HCUP inpatient claims data in terms of availability of information on the *International Classification of Diseases, Tenth Revision*, Clinical Modification (ICD-10-CM) codes of mental illness, SUD, and OUD. This information makes

these data sets suitable to answer our research question. HCUP is based on data from community hospitals, defined as short-term, non-Federal, general, and other hospitals, excluding hospital units of other institutions (e.g., prisons), long-term care, rehabilitation, psychiatric, and alcoholism and chemical dependency hospitals. Therefore, the data for both states are restricted to admissions to general, acute, short-term hospitals for problems related to mental health and SUD/OUD (Saba, 2008). Further, we identified the county of residence for each individual by county-level Federal Information Processing System (FIPS) codes available in the claim datasets and used Small Area Health Insurance Estimates (SAHIE) and Small Area Income and Poverty Estimates (SAPIE) databases to merge the information on percentage of uninsured and median household income of counties as a proxy variable for individual household income and federal poverty level in Virginia and North Carolina. The United States Census Bureau's SAHIE and SAPIE program produces the only source of data for single-year estimates of health insurance coverage status, income, and poverty for all counties in the United States (Bureau, 2021).

Inclusion Criteria

We included inpatient admissions for all adults between 18 and 64 years admitted to the hospital with the diagnosis of mental illnesses, SUD, and OUD. Admissions are restricted to ages 18-64 years old, because they are the age groups eligible for Medicaid expansion. To assess the impact of ARTS and Medicaid expansion on the population, we included individuals with all types of insurance coverage, including those who were uninsured (that is, whose admissions were self-paid or paid through hospital charity care programs). This is especially important for assessing the effects of Medicaid expansion, since Medicaid admissions alone are likely to increase due to the increase in Medicaid eligibility, but overall admissions may decrease due to increased access to services for people who were previously uninsured. While it would have

been optimal to further target the sample to admissions for people who were lower income, information on patient income was not available in the admissions data.

Exclusion Criteria

We excluded psychiatric hospitals since they provide longer-term specialized care while acute care hospitals provide treatment to mentally ill patients, usually for less than 30 days (North Texas Help, 2021).

Description of Measures

The original data was admission-level, however, we aggregated the number of mental illnesses or/and SUD and OUD admissions for each county (and independent cities in Virginia) for county-level analysis. Admissions for each county were aggregated by quarter, so that the unit of analysis is the county/quarter. For Virginia, there are 2128 observations—133 (95 counties and 38 independent cities) by 16 quarters (January 2016 through December 2019). For North Carolina, there are 1600 observations—100 counties by 16 quarters.

Independent Variable

The main independent variables are time periods corresponding to the implementation of the ARTS program in Virginia in the second quarter of 2017 and Medicaid expansion in the first quarter of 2019.

Dependent Variable

The main dependent variables are the number of mental illness, SUD, and OUD admissions for each county by quarter. Admissions for mental illness, SUD, and OUD are defined based on ICD-10-CM codes (Appendix A Table1). The mental illness and/or SUD and OUD diagnosis could occur in any position in the claim from primary diagnosis, secondary, or beyond.

Analytical Method

We performed descriptive analyses of the average number of mental illnesses and/or SUD and OUD hospitalization by county (and independent city) from the first quarter of 2016 until the last quarter of 2019 in Virginia and North Carolina.

We used a Poisson fixed-effect event study regression to examine differences in the number of mental illness and/or SUD and OUD hospitalizations in the quarters before and after ARTS in Virginia and North Carolina. This analysis expands the difference-in-difference analyses by creating a separate parameter for each quarter of interest.

To control for time-invariant characteristics of counties and independent cities, we include county-level fixed effects in all multivariate analyses. While we do not explicitly control for the predisposing, enabling, and need factors described in the conceptual framework, many of these factors are implicitly accounted for in the county-level fixed effects. We also include time dummies and a quarter-specific measure of the uninsured percentage under 65 years old as a time varying measure that might have an impact on our dependent variable in each quarter (Wen, 2020).

By estimating the number of admissions through a Poisson model, we avoid the potential estimation bias that could result from estimating rates of admissions for behavioral health conditions. For example, the total hospitalizations might change (higher or lower) concurrent with the behavioral admissions, making the mental illness and/or SUD/OUD rate biased. In addition, the Poisson model is appropriate for some counties where there is a low count of hospitalizations.

We estimate the effect of the ARTS program on the number of mental illnesses and/or SUD and OUD hospitalizations after implementation in April 2017 (11 quarters). Parameters for

the interactions between the Virginia dummy variable and each quarterly time dummy variable estimates the proportional difference in admissions for Virginia relative to North Carolina. We then average these estimates over different periods to assess the impact of ARTS and then the impact of ARTS combined with Medicaid expansion compared to the pre-ARTS period. We obtained linear combinations of parameters using the command "lincom" in Stata 13 (Stata, 2022a) to compute the average estimate in the seven quarters after ARTS but before Medicaid expansion and then the last four quarters after Medicaid expansion. Thus, we estimate the average proportional difference in hospitalizations in Virginia in these two periods relative to the time period preceding ARTS. We computed standard errors that are robust to heteroskedasticity for all multivariate models. The parameters of interest are the differences in the percentage change in Virginia hospitalizations for mental illness and/or SUD and OUD relative to their level of hospitalizations prior to implementation of ARTS minus the same difference for these type of hospitalizations in North Carolina.

All models were estimated using Stata 13, and $p<0.05$ was considered statistically significant.

Statistical Model

$$hospitalization_{it}=\beta_0+ \Psi_t + \beta_j (state_t*\Psi_t) + x_{it} + \alpha_i + u_{it}$$

Ψ_t represents a full set of quarterly dummy variables (1 quarter is a reference + 15 dummy variables). $State_t*\Psi_t$ represents the set of interactions between a dummy variable for Virginia and the quarterly dummies starting with the first quarter of 2016 to the fourth quarter of 2019 with indication of second quarter of 2017 as a reference when ARTS came into effect. x_{it} is the percentage of uninsured. αi is the county fixed effect. u_{it} notates the error term.

Sensitivity Analysis

Individuals with income lower than 138% FPL are the target population for Medicaid programs, like ARTS and Medicaid expansion. So, we expect more access to behavioral health services after adopting these policies in this population. However, we were not able to refine the population based on their income due to the lack of information on individual household income and FPL in the claim data. As a proxy, we estimated the model above by stratifying counties of Virginia and North Carolina into two groups using median household income. Then, we compared the estimates of the difference in quarterly health behavior hospitalizations in Virginia and North Carolina of the below median income counties model relative to above median income counties model using "suest" command in Stata13 (Stata, 2022c).

2.4. Results

There were a total of 3,728 county/quarter observations from 2016 to 2019. The average age of patients who were hospitalized for mental illness or SUD/OUD was 44 years for both Virginia and North Carolina. The mean county average length of hospital stays for mental illness and/or SUD/OUD was four days in Virginia and five days in North Carolina (Table 2).

The total hospitalizations for mental illness and SUD/OUD were 713,513 in Virginia and 1,092,067 in North Carolina between 2016-2019 (Table 2). Among the total number of hospitalizations for mental illness and SUD/OUD, 624,832 were for mental illness and 254,514 were for SUD/OUD in Virginia compared to the total hospitalizations for mental illness and SUD/OUD that was 955,590 for mental illness, and 385,166 for SUD/OUD in North Carolina. The average number of county hospitalizations per quarter for all hospitalizations and mental illness and SUD/OUD hospitalizations before and after ARTS implementation and after Medicaid expansion in Virginia and North Carolina is shown in Table 3, as well as Figures 2 and 3. Admissions for behavioral health increased in North Carolina but held steady in Virginia.

Notably, total average hospitalizations (behavioral and non-behavioral) were largely unchanged in both states. The unadjusted difference in behavioral hospitalizations between Virginia and North Carolina is an upward trend that provides an initial indication of divergent trends in Virginia and North Carolina (Figure 4).

Table 4 shows results of the Poisson fixed-effect event study regression for three dependent variables: (a) all behavioral health hospitalization, (b) hospitalizations for mental illness only, and (c) hospitalizations for SUD/OUD only. The difference in predicted number of mental illness and SUD/OUD hospitalizations between Virginia and North Carolina remained unchanged in all quarters before ARTS implementation, but after ARTS, the number of mental illness and SUD/OUD hospitalizations decreased in Virginia relative to North Carolina. The number of mental illness and SUD/OUD hospitalizations in the first quarter of 2018 decreased by 2.6% (95% CI [-5.1-(-0.2)]) compared to the second quarter of 2017 (the beginning of the ARTS program). The reduction in mental illness and SUD/OUD hospitalizations remained statistically significant by 2.8% (95% CI [-5.3-(-0.2)]) in the second quarter of 2018, 4.2% (95% CI [-5.3-(-0.2)]) in the third quarter of 2018, and 4.9% (95% CI [-7.5-(-2.4)]) in the fourth quarter of 2018 compared to beginning of the ARTS program in Virginia relative to North Carolina.

The slope of the change in mental illness and SUD/OUD hospitalizations was interrupted in the first quarter of 2019 when Medicaid expansion was implemented in Virginia (Figure 5).

Further, our estimations of mental illness hospitalizations showed that the implementation of the ARTS program did not have an immediate effect on mental illness hospitalizations in 2017. Significant effects on the reduction of mental illness hospitalizations in Virginia compared to North Carolina started in the last quarter of 2017 and continued through the end of 2018. Then, this smooth decline was interrupted when Medicaid expansion occurred

(Figure 6). Compared with the implementation of ARTS, the reduction in the mental illness hospitalizations was 2.3% (95% CI [-4.4-(-0.2)] in the last quarter of 2017, 3.0% (95% CI [-5.4-(-0.4)]) in the first quarter of 2018, 3.5% (95% CI [-6.3-(-0.8)]) in the second quarter of 2018, 4.7% (95% CI [-7.5-(-1.9)]) in the third quarter of 2018, and 5.3% (95% CI [-8.2-(-2.4)]) in the last quarter of 2018 in Virginia compared to North Carolina. The trend of reduction in mental illness hospitalizations was interrupted after Medicaid expansion in Virginia compared to North Carolina (Table 4).

The proportional change in SUD/OUD only hospitalizations after ARTS implementation showed no significant difference in Virginia compared to North Carolina (Table 4). Figure 7 shows the same trend of reduction in hospitalizations in Virginia compared to North Carolina after ARTS implementation and before Medicaid expansion. This trend changed after Medicaid expansion in Virginia (Figure 7).

Average Proportional Change in the Number of Hospitalizations

To estimate the impact of ARTS alone and in combination with Medicaid expansion, we calculated the average of the parameters for the interaction of the Virginia dummy variable and the quarterly time dummies in the respective time periods. These averages estimate the proportional difference in hospitalizations in Virginia compared to North Carolina relative to the time period preceding ARTS (Table 5). In the seven quarters after ARTS but before Medicaid expansion, mental illness and/or SUD/OUD hospitalizations showed a significant decrease of approximately 2.7% (p-value 0.026). For mental illness hospitalizations alone, there was an approximate 2.9% decrease (p-value 0.022), but the change in SUD/OUD hospitalizations was not statistically significant.

Table 5 also shows parallel estimates for the period after Medicaid expansion. The estimates of the average proportional difference in hospitalizations are negative for mental illness hospitalizations but positive for SUD/OUD hospitalizations, but these are not statistically significant. The last row of Table 5 also provides the difference in the estimates in the two periods, but none of these estimates are statistically significant.

Sensitivity Analysis

The results of the sensitivity analysis looking at the difference in behavioral health hospitalizations in Virginia and North Carolina showed a reduction after ARTS implementation in both groups of the high and low median household income groups (Appendix A, Table 1). However, the reduction in mental illness and SUD/OUD hospitalizations together, and mental illness hospitalizations alone, were not significant in the low median household income group in both states. The reduction in these behavioral health hospitalizations was significant in the last quarter of 2018 in Virginia's high median household income group compared to the high median household income group in North Carolina. Table 6 shows the results of testing the differences between the proportional change of each quarter by "suest" in the low median household income groups (in Virginia compared to North Carolina) and in the high median household income groups (in Virginia compared to North Carolina) with significant differences between these two county groups in behavioral health hospitalizations (Stata, 2022b). Comparing the counties of high and low median household income groups suggested that the high median household income group may had more access to outpatient mental health services and that caused the reduction in hospitalizations after the ARTS policy in this group in Virginia compared to North Carolina.

2.5. Discussion

In this study, we examined the effect of ARTS on the total number of mental illness and SUD/OUD hospitalizations in Virginia compared to North Carolina. We further tested the difference in the average "parameter estimates" of mental illness and/or SUD/OUD hospitalizations after Medicaid expansion and after ARTS compared to North Carolina, which has not yet expanded Medicaid. The Poisson fixed-effect event study regression showed no significant difference in behavioral health hospitalizations in Virginia compared to North Carolina before ARTS implementation, however, after ARTS implementation the difference between the two was significant. This effect did not appear immediately after the adoption of the policy. Instead, it took about a year to see a significant reduction in the behavioral hospitalization in Virginia compared to North Carolina. Then, with the expansion of Medicaid, the ARTS effect was interrupted.

The results of our study are consistent with the first hypothesis of a reduction in the number of hospitalizations due to mental illness, SUD, and OUD following the implementation of the Virginia ARTS program in 2017 relative to North Carolina. Healthcare delivery by the ARTS program is more efficient with outpatient addiction treatments, mental health services, and OBOT which decreases the need for more costly inpatient services. The results of the subsequent analyses were inconsistent with our second hypothesis, which indicated that the number of hospitalizations due to mental illness, SUD, and OUD decreased following Medicaid expansion in Virginia in 2019, relative to North Carolina, which did not expand Medicaid. After Medicaid expansion there were a lot of new patients being brought into the system with pre-existing problems that were not being treated, and therefore required higher level acute inpatient care when they first enrolled in Medicaid. This result is consistent with prior research showing that

expanding health insurance coverage increases utilization of all healthcare service types, including inpatient services (Farrell,2020; Mojtabai, 2018).

In sum, the ARTS effect is explained by increased access to treatment services for Medicaid members, while the Medicaid expansion effect is explained by pent-up demand for newly enrolled members who were previously uninsured. Although implementing this policy and program increased access to healthcare, policymakers should consider other factors that might affect the utilization, including the need for services, health literacy, or availability of resources such as behavioral health outpatient clinics. Accessing care—whether it is available, timely, convenient, or affordable—affects health care utilization. The need for services affects differential use of health utilization for specific populations. Besides, the need for specific healthcare services is the primary determinant of healthcare utilization (National Academies, 2018). Analyses of the impact of these programs in low and high median household income counties clearly showed the contribution of health care resources in the high median income counties on the effect of the ARTS program.

2.6. Limitations

The findings in this paper are subject to some limitations. First, admissions data do not have information on patient characteristics that might be most affected by Medicaid expansion, e.g., household income or FPL. We used the median household income by county level as a proxy variable to address this issue. As a sensitivity test, we stratified the analysis by county income level to examine whether the ARTS and Medicaid expansion effects would be greater in lower income counties, but the results failed to show this, likely because these variables were confounded with other county level population and health system factors. Second, ARTS and Medicaid expansion policies were not randomly assigned. Although our difference-in-differences

methods control for some sources of bias, we cannot rule out the possibility that some other change occurred differentially in Virginia compared to North Carolina at the same time as these policies were adopted, potentially biasing our difference-in-differences estimates. However, we estimated event study regressions comparing changes between Virginia and North Carolina to assess parallel trends in the pre-policy period, which showed that Virginia and North Carolina had similar trends prior to the ARTS policy. Third, we used a single state to compare the effect of ARTS and Medicaid expansion in Virginia on behavioral health hospitalizations, and therefore it is possible that the results would differ if other states were included as comparisons. However, North Carolina is a reasonable comparison state with Virginia in terms of the population characteristics and the lack of similar changes in Medicaid policies in North Carolina that address behavioral health issues. Finally, we analyzed the effect of Medicaid expansion in one year. To see the impact of behavioral health hospitalization through the year, we use the quarters as a unit of time. However, with the COVID-19 pandemic starting in 2020, we expected a reduction of all admissions that could potentially bias the effect of the Medicaid expansion policy.

2.7. Conclusion

The ARTS implementation reduced the number of hospitalizations for mental illness and SUD/OUD in Virginia compared to North Carolina, which did not implement any similar policies to address mental health and SUD/OUD issues. The reduction in the number of behavioral health hospitalizations after ARTS was offset by increases in the number of hospitalizations after Medicaid expansion, perhaps due to pent-up demand for behavioral health services among newly enrolled members who were previously uninsured. The significant effect

of the ARTS program in high median household income counties shows the contribution of the availability of health behavior services in the effect of the ARTS program.

Figures and Tables

Figure 1

The Anderson and Newman's Conceptual Framework to Describe the Number of Hospitalizations after ARTS and Medicaid Expansion

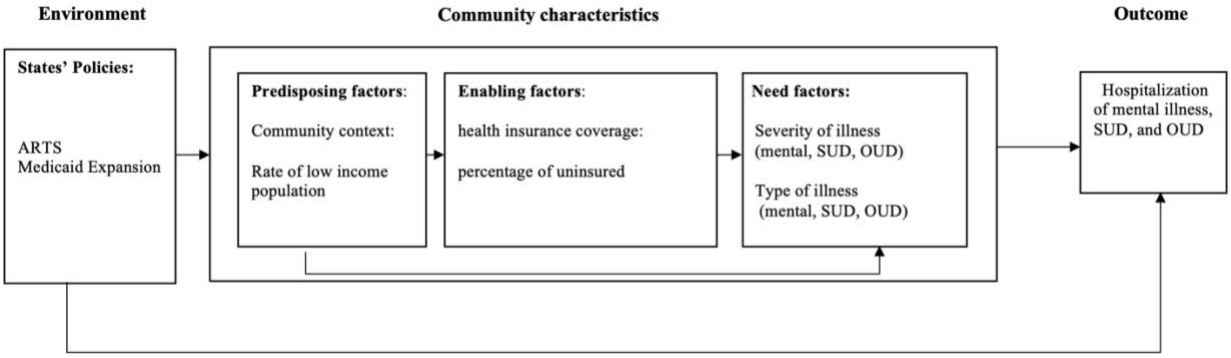
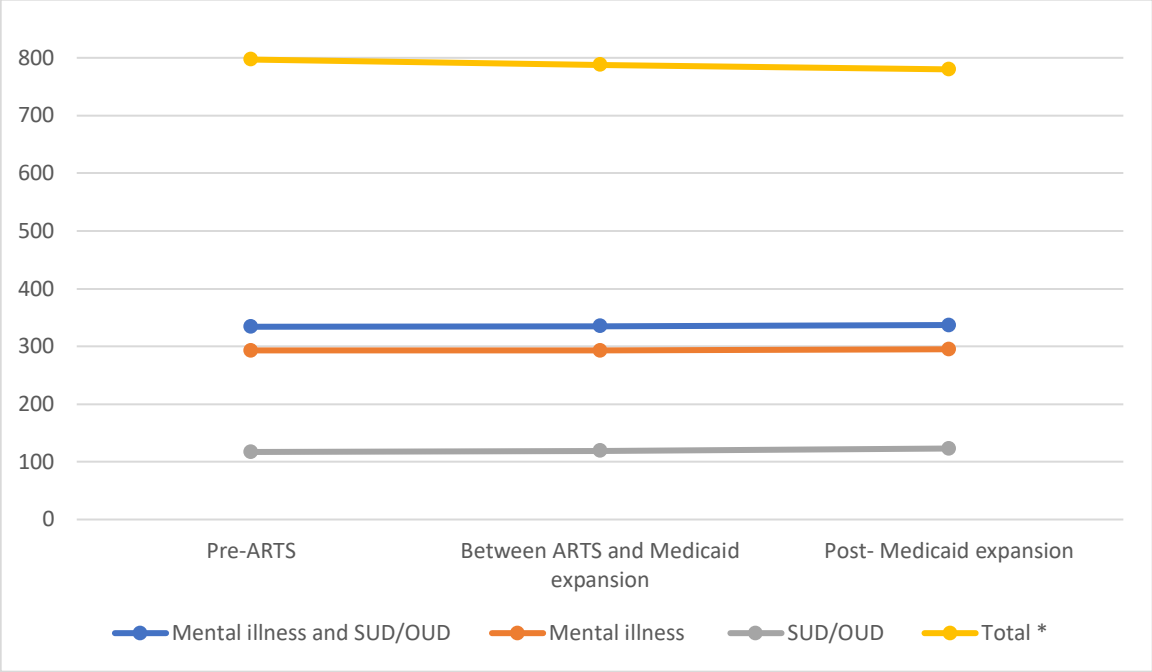


Figure 2

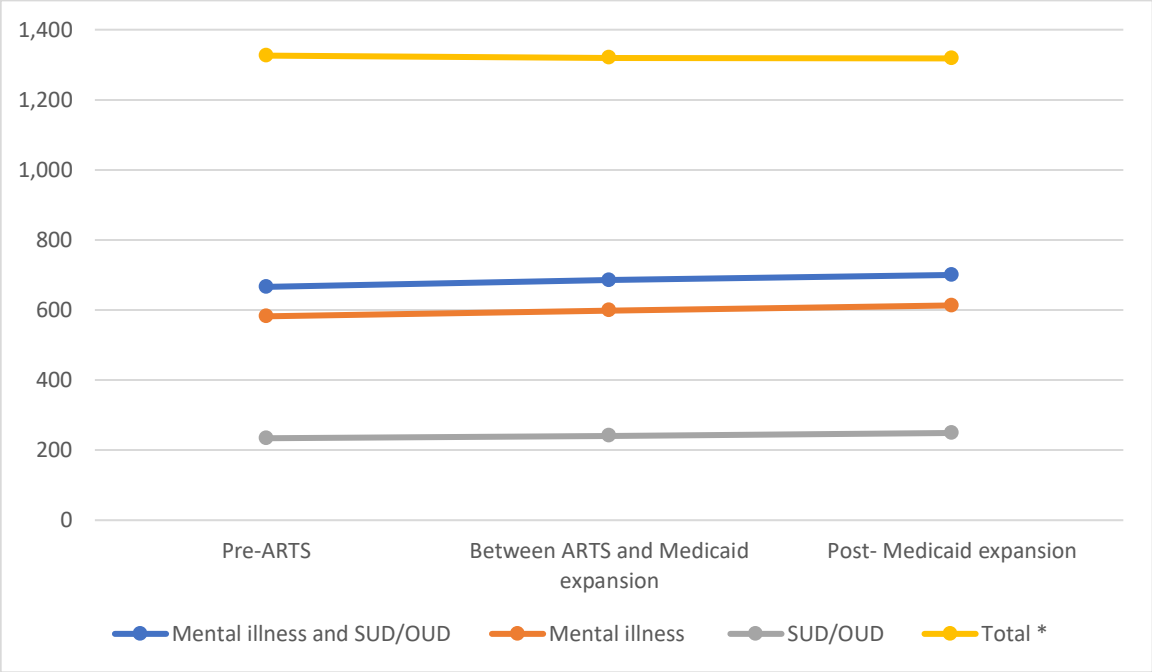
Mean Number of Hospitalizations by VA County Quarterly Before ARTS, Between ARTS and Medicaid Expansion, and After Medicaid Expansion.



*Total referred to all behavioral and non-behavioral hospitalizations

Figure 3

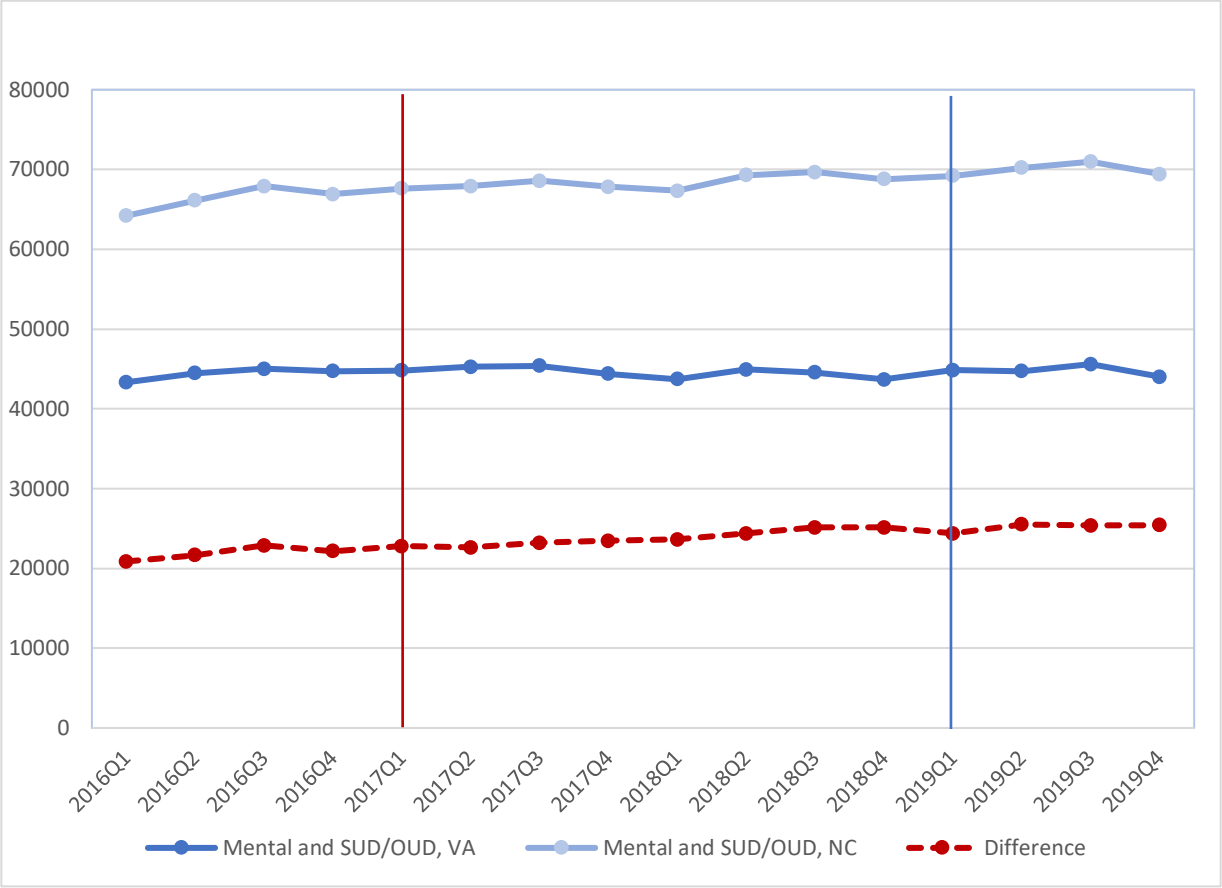
Mean Number of Hospitalizations by NC County Quarterly Before ARTS, Between ARTS and Medicaid Expansion, and After Medicaid Expansion in VA.



*Total referred to all behavioral and non-behavioral hospitalizations

Figure 4

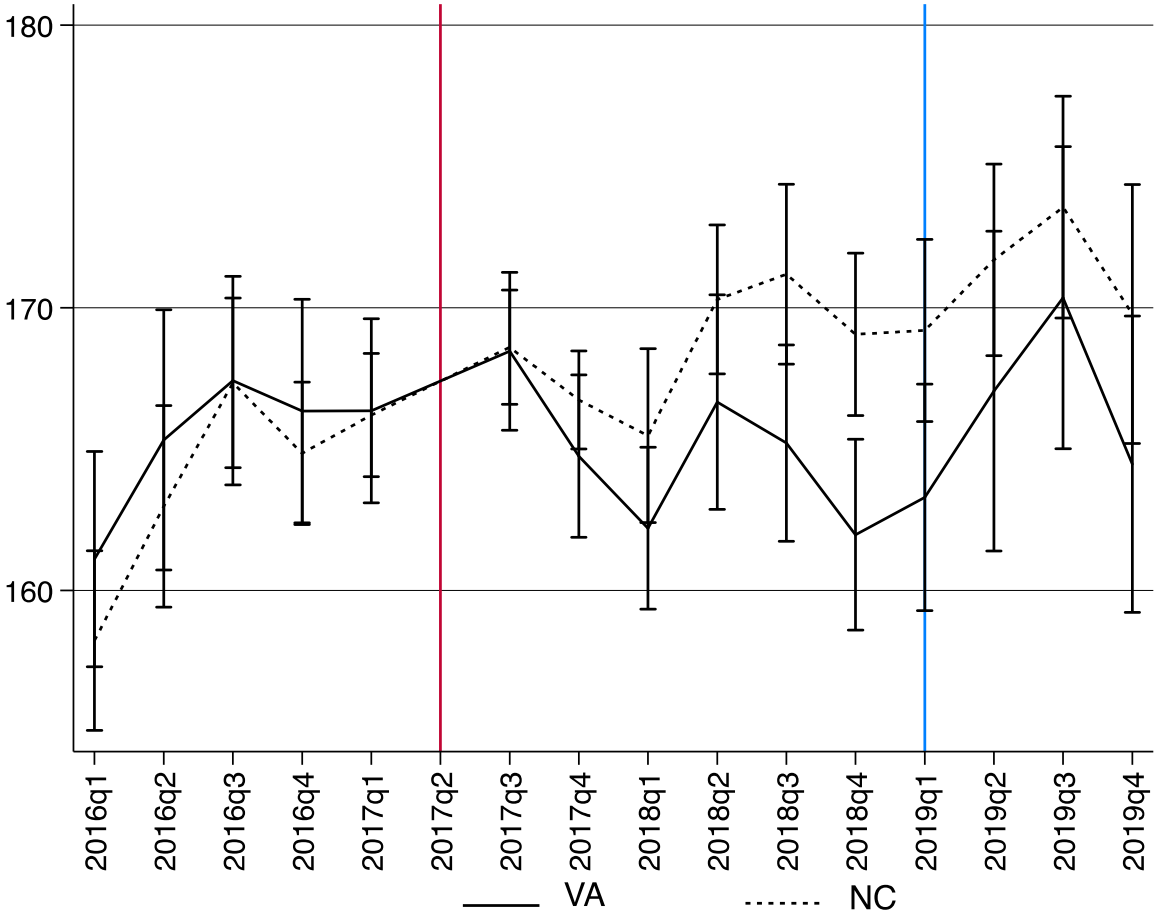
Difference in Mental Illness, SUD, and OUD Hospitalizations Between VA and NC



The red vertical line indicates the first quarter of the ARTS program, and the blue vertical line indicates the first quarter of Medicaid expansion in Virginia

Figure 5

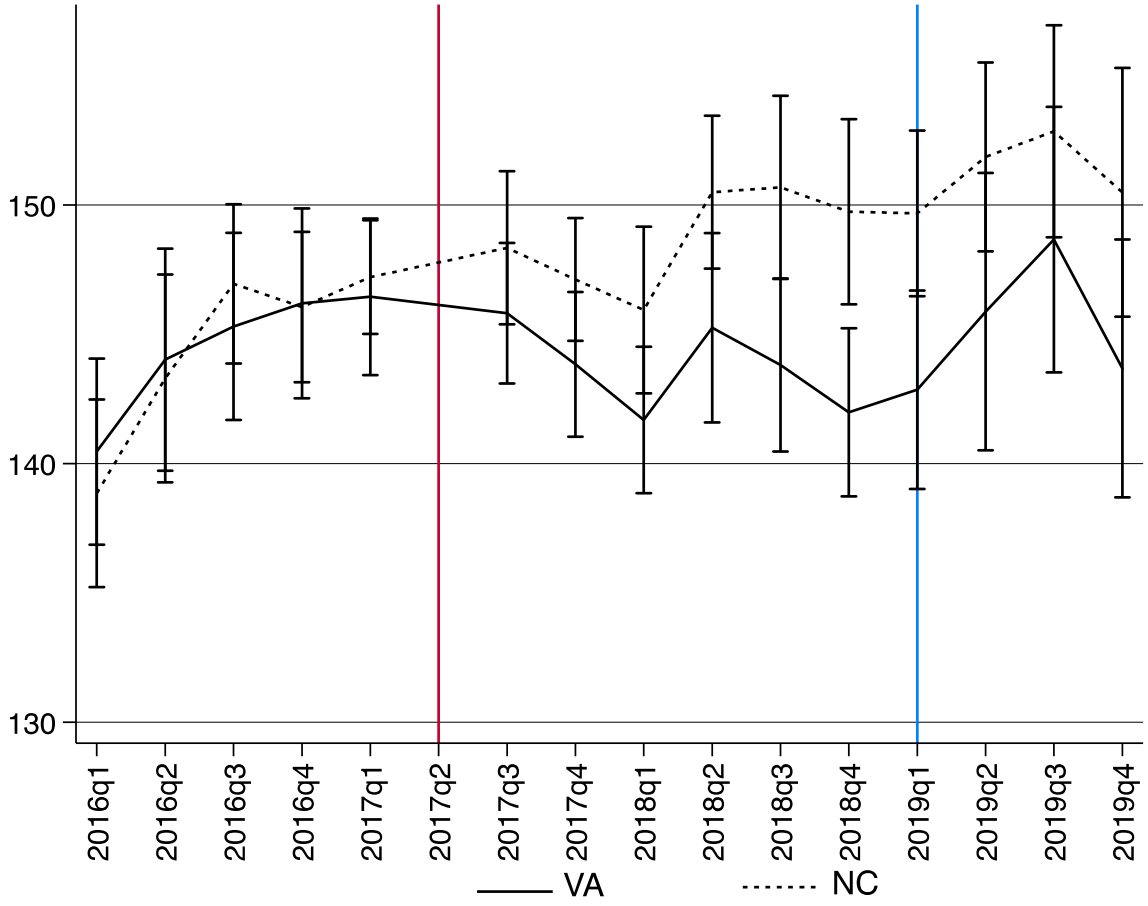
Impact of the Adoption of ARTS and Medicaid Expansion
Predicted Number of Mental Illness and SUD/OUD Hospitalizations by County/Quarter



The red vertical line indicates the first quarter of the ARTS program, and the blue vertical line indicates the first quarter of Medicaid expansion in Virginia

Figure 6

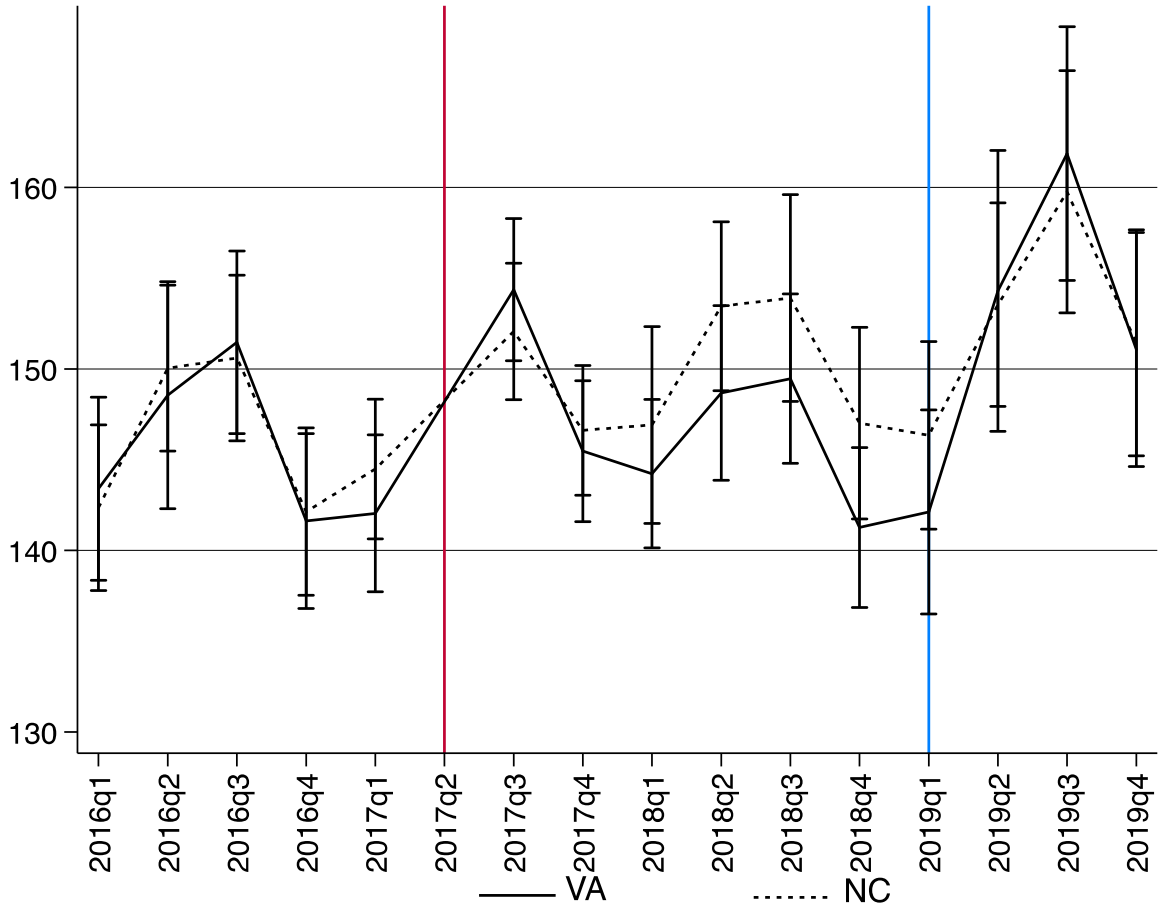
Impact of the Adoption of ARTS and Medicaid Expansion
Predicted Number of Mental Illness Hospitalizations by County/Quarter



The red vertical line indicates the first quarter of the ARTS program, and the blue vertical line indicates the first quarter of Medicaid expansion in Virginia

Figure 7

Impact of the Adoption of ARTS and Medicaid Expansion
Predicted Number of SUD/OUD Hospitalizations by County/Quarter



The red vertical line indicates the first quarter of the ARTS program, and the blue vertical line indicates the first quarter of Medicaid expansion in Virginia

Table 1

Comparison of Virginia and North Carolina

Behavioral Health Status	**Virginia**	**North Carolina**
Prevalence of mental illness	17.38%	18.77%
SUD disorders in the past year	7.32%	6.95%
Thoughts of suicide	4.16%	4.57%
Healthcare Access	**Virginia**	**North Carolina**
Uninsured	13.50%	13.80%
AMI not received treatment	54.50%	56.50%
AMI reporting unmet need	28.60%	26.50%
Disability who cannot see a doctor due to cost	34.24%	35.23%
Demographics	**Virginia**	**North Carolina**
Population census April, 2010	8,631,393	10,439,388
Female	50.8%	51.4%
White	69.4%	70.6%
Black or African American	19.9%	22.2%
High school graduate or higher (>25 years old)	89.7%	87.8%
Median household income (2019 dollars)	$74,222	$54,602

Table 2

Mean Patients' Characteristics Who Were Hospitalized for Mental Illness and/or SUD/OUD

	Virginia	**North Carolina**	**p-value**
Total number of hospitalizations for mental illness and SUD/OUD	713,513	1,092,067	<0.000
Total number of hospitalizations for mental illness	624,832	955,590	<0.000
Total number of hospitalizations for SUD/OUD	254,514	385,166	<0.000
Average age of admissions (years) (Min-Max)	44 (39-47.5)	44 (41-48)	0.554
Average length of hospital stays (days) (Min-Max)	4 (2.4-6)	5 (3.7-6)	<0.000
Average percentage of uninsured younger than 65 years old (95% CI) (Min-Max)	10.2 (3.4-17.0) (10.1-10.3)	13.1 (8.5-21.3) (13.0-13.2)	<0.000

Table 3

Mean Number of County Hospitalizations Quarterly Before ARTS, Between ARTS and Medicaid Expansion, and After Medicaid Expansion

Virginia	**Pre-ARTS (5 quarters)**	**Between ARTS and Medicaid expansion (7 quarters)**	**Post-Medicaid expansion (4 quarters)**
Total admission	797	788	780
All mental illness, SUD and OUD	334	335	337
Mental illness hospitalizations	293	293	295
SUD and OUD	117	119	123
North Carolina	**Pre-ARTS (5 quarters) in VA**	**Between ARTS and Medicaid expansion (7 quarters) in VA**	**Post-Medicaid expansion (4 quarters) in VA**
Total admission	1326	1320	1318
All mental illness, SUD and OUD	666	685	700
Mental illness	582	599	613
SUD and OUD	234	241	249

Table 4

The Poisson Regression Percentage Change (%) of Total and Behavioral Health Hospitalizations in VA Compared to NC After and Before ARTS

	Total admission 95% (CI)	**Mental illness and SUD/OUD 95% (CI)**	**Mental illness 95% (CI)**	**SUD/OUD 95% (CI)**
VA/year-quarter				
2016Q1	-0.2 (-2.0-1.5)	1.2 (-1.7-4.0)	1.2 (-1.8-4.2)	0.7 (-3.5-4.9)
2016Q2	0.6 (-1.2-2.4)	0.7 (-2.6-4.1)	0.5 (-3.1-4.1)	-1.0 (-5.8-3.8)
2016Q3	-0.5 (-2.0-0.9)	-0.6 (-3.4-2.2)	-1.1 (-4.1-1.8)	0.6 (-3.3-4.5)
2016Q4	-2.1 *(-3.8-(-0.3))	0.3 (-2.4-2.9)	1.0 (-2.6-2.8)	-0.4 (-4.5-3.8)
2017Q1	-1.7 *(-3.1-(-0.2))	-0.6 (-2.7-1.7)	-0.5 (-2.8-1.8)	-1.7 (-5.4-2.0)
2017Q2	**Reference**	**Reference**	**Reference**	**Reference**
2017Q3	-0.2 (-1.5-1.0)	-0.7 (-2.6-1.1)	-1.7 (-3.7-0.3)	1.5 (-1.5-4.5)
2017Q4	-1.5 *(-2.9-(-0.0))	-1.8 (-3.7-0)	-2.3 *(-4.4-(-0.2))	-0.8 (-4.0-2.4)
2018 Q1	-1.4 (-3.0-0.3)	-2.6 *(-5.1-(-0.2))	-3.0 *(-5.4-(-0.4)	-1.8 (-6.2-2.5)
2018Q2	-1.8 *(-3.6-9-0.0))	-2.8 *(-5.3-(-0.2))	-3.5 *(-6.3-(-0.8))	-3.2 (-7.2-0.8)
2018Q3	-2.0 (-4.0-0.1)	-4.2 **(-5.3-(-0.2))	-4.7 **(-7.5-(-1.9))	-2.9 (-7.4-1.6)
2018Q4	-3.4 ***(-5.3-(-1.5))	-4.9 ***(-7.5-(-2.4))	-5.3 ***(-8.2-(-2.4))	-4.0 (-8.5-0.6)
2019Q1	-2.6 **(-4.5-(-0.6))	-1.7 (-5.1-1.7)	-1.9 (-5.4-1.6)	1.3 (-4.5-7.2)
2019Q2	-3.3 **(-5.5-(-1.2))	-3.4 (-6.9-0.2)	-4.0 (-7.7-(-0.3))	0.5 (-5.6-6.5)
2019Q3	-1.5 (-3.9-1.0)	-2.5 (-6.0-1.0)	-2.8 (-6.4-0.9)	1.3 (-4.5-7.1)
2019Q4	-1.9 (-4.9-1.1)	-3.8 *(-7.6-(-0.0)	-4.6 *(-8.5-(-0.7)	-0.2 (-5.8-5.3)

Table 5

Average of Quarterly Parameter Estimates in Different Periods Estimating the Proportional Change in the Number of Hospitalizations in Virginia Relative to North Carolina

	Mental illness/SUD/OUD Hospitalizations	**P-Value**	**Mental illness Hospitalizations**	**P-Value**	**SUD/OUD Hospitalizations**	**P-Value**
After ARTS, before Medicaid expansion (7 quarters)	**- 0.027**	**0.026**	**-0.029**	**0.022**	- 0.012	0.423
After Medicaid expansion (4 quarters)	- 0.004	0.735	-0.004	0.735	0.023	0.195
Difference	-0.031	0.088	-0.034	0.079	0.011	0.683

Table 6

The Poisson Regression Percentage Change of Behavioral Health Hospitalization in VA Compared to NC After and Before ARTS by County's Median Income

	Metal illness and OUD/SUD		**Mental illness**		**SUD/OUD**	
	Low median household income group percentage change (%) 95% (CI)	**High median household income group percentage change (%) 95% (CI)**	**Low median household income group percentage change (%) 95% (CI)**	**High median household income group percentage change (%) 95% (CI)**	**Low median household income group percentage change (%) 95% (CI)**	**High median household income group percentage change (%) 95% (CI)**
VA/year-quarter						
2016Q1	-2.1 (-6.1-1.8)	2.6 (-1.1-6.4)	-2.3 (-6.5-1.9)	2.5 (-1.6-6.6)	-1.8 (-8.7-5.1)	3.1 (-2.1-10.2)
2016Q2	-0.8 (-6.3-4.7)	1.4 (-2.4-5.2)	-1.7 (-7.7-4.3)	1.3 (-2.7-5.4)	-1.7 (-9.6-6.3)	1.3 (-4.1-6.7)
2016Q3	0.2 (-4.1-4.4)	-1.0 (-4.4-2.5)	-0.8 (-5.4-3.7)	-1.5 (-5.3-2.4)	3.2 (-3.0-9.3)	0.3 (-4.8-5.3)
2016Q4	2.6 (-2.4-7.6)	-0.3 (-3.1-2.5)	1.8 (-3.4-7.0)	-0.4 (-3.4-2.5)	4.2 (-2.4-10.7)	-1.3 (-5.9-3.4)
2017Q1	-0.6 (-4.4-3.1)	-0.5 (-3.4-2.3)	-1.0 (-4.9-3.0)	-0.4 (-3.3-2.6)	0.5 (-5.1-6.2)	-2.4 (-7.3-2.5)
2017Q2	**Reference**	**Reference**	**Reference**	**Reference**	**Reference**	**Reference**
2017Q3	-0.9 (-3.9-1.9)	-0.4 (-2.7-2.0)	-2.0 (-5.3-1.3)	-1.5 (-4.0-1.1)	3.5 (-1.4-8.5)	1.6 (-2.3-5.5)
2017Q4	-2.2 (-5.5-1.3)	-1.2 (-3.6-1.1)	-3.6 (-7.5-0.3)	-1.1 (-3.7-1.5)	5.4 (-0.2-11.0)	-3.0 (-6.9-0.8)
2018 Q1	-1.2 (-5.2-2.8)	-2.8 (-5.6-1.1)	-2.3 (-6.3-1.6)	-2.9 (-6.0-0.3)	4.9 (-2.4-12.4)	-3.8 (-6.1-3.4)
2018Q2	-1.2 (-5.2-2.8)	-3.3 *(-6.5-(-0.2))	-2.7 (-7.2-1.9)	-3.9 *(-7.4-(-0.4))	3.9 (-3.7-11.4)	-5.5 (-10.2-(-0.7))
2018Q3	-3.1 (-7.7-1.7)	-3.8 *(-7.1-(-0.6))	-4.2 (-9.7-1.2)	-4.2 *(-7.7-(-0.7))	3.6 (-3.9-11.2)	-3.1 (-8.0-1.7)
2018Q4	-3.1 (-7.5-2.6)	-4.3 **(-7.2-(-1.3)	-3.8 (-8.8-1.2)	-4.5 *(-8.0- (-1.0))	5.4 (-2.4-13.3)	-6.1 (-11.1-(-1.0))
2019Q1	-1.2 (-6.0-3.6)	-1.3 (-6.0-3.2)	-3.2 (-8.4-2.1)	-0.9 (-5.7-3.7)	8.7 (1.5-15.8)	0.2 (-7.1-7.6)
2019Q2	-3.6 (-8.4-1.3)	-2.7 (-7.5-2.0)	-5.6 *(-1.1-(-0.3))	-3.0 (-8.0-2.0)	7.2 (-1.3-15.6)	-0.5 ((-7.7-6.7)
2019Q3	-1.3 (-6.2-3.7)	-2.2 (-6.7-2.4)	-2.3 (-7.9-3.2)	-2.3 (-7.1-2.6)	4.7 (-3.5-13.0)	2.3 (-4.6-9.2)
2019Q4	-4.7 (-9.9-0.6)	-2.2 (-7.0-2.6)	-6.3 (-11.8-(-0.8))	-2.7 (-7.9-2.5)	2.7 (-5.8-11.1)	1.0 (-5.6-7.6)
Difference between high and low median household income groups	**Prob > chi2 = 0.0076 ****		**Prob > chi2 = 0.0034 ****		**Prob > chi2 = 0.0048 ****	

Chapter 3

Association Between Patient-Centered Practices and the Use of Cardiovascular-Related Preventive Services Among High-Risk Patients

3.1. Introduction

Cardiovascular diseases are the leading cause of death for men, women, and people of most racial and ethnic groups in the United States (CDC, 2020). Cardiovascular diseases cost the United States about $219 billion annually in 2014 and 2015 (Fryar, 2012), including the cost of health care services, medicines, and lost productivity due to death (CDC, 2020). Simple recommendations, such as taking aspirin, eating healthy foods, exercising regularly, and regular blood pressure and cholesterol checks are secondary prevention measures that can prevent cardiovascular events and mortality, especially in medically high-risk populations (AHA, 2017; Ittaman, 2014; Meigs, 2000). However, as not all physician practices make these recommendations and not all patients adhere to these recommendations even when they are made, it is imperative to consider how practices can adopt processes and procedures that promote greater use of preventive services among patients.

Primary Care, Patient-Centered Medical Home (PCMH) and Preventive Services

The National Academy of Medicine defines primary care as "the provision of *integrated, accessible health care services* by clinicians who are *accountable* for addressing a large *majority of personal health care needs*, developing a *sustained partnership* with *patients*, and practicing in the *context of family and community*" (Donaldson, 1996). The primary care system, as a part of the healthcare system, provides the majority of health care in the United States. Preventive services, including preventive services for cardiovascular conditions, are routinely provided in primary care practices.

The patient-centered medical home (PCMH) is a series of components that were identified by the National Committee for Quality Assurance (NCQA) in 2008 to create industry standards (Arend, 2012). Under NCQA guidance, PCMH practices agree to adopt six key concepts: (a) emphasizing team-based care and practice organization, (b) knowing and managing patients through comprehensive data collection and sharing, (c) patient-centered access and continuity, (d) care management and support, (e) care coordination and care transitions, and (f) performance measurement and quality improvement (Farley, 2019). These key concepts emphasize provider roles and responsibilities under the team-based care model, focus on longitudinal relationships between patients and providers, highlight the delivery of evidence-based screening as performance measures, and provide data available to providers to identify gaps in preventive screening. All these components of PCMH are intended to improve population health outcomes, including mortality and morbidity of cardiovascular diseases, that might be due to greater utilization of health information technologies to provide preventive care services (Macinko, 2003; Healthy People, 2020; Hong, 2018). However, cost, not having a primary care provider, living too far from providers, lack of awareness about recommended preventive services, and greater racial and ethnic disparities are some of the barriers to access preventive services. A key objective of PCMH comprehensive care is to reduce these barriers (Healthy People, 2020).

Cancer screening has received more attention by health policy researchers, and some studies showed the effect of the PCMH model on screening for colorectal, breast, and cervical cancers. Findings suggested that cancer screening was not associated with the model of care, e.g., PCMH vs. non-PCMH (Hong, 2020; Farley, 2019; Bowdoin, 2016; Shi, 2017). Other chronic disease care, such as diabetes care, were also evaluated based on the model of care, and

the frequency of diabetes quality of care has not been changed by the PCMH model (Bowdoin, 2016; Farley, 2019). Finally, there were no differences in the recommendations for aspirin and statin use for coronary heart diseases (CHD) and annual cholesterol check among CHD patients between PCMH and non-PCMH models (Farley, 2019).

PCMH and Racial/Ethnic Disparities

Access and utilization of preventive health care differs across racial and ethnic groups (Hou, 2011; Johns, 2015). For example, blood sugar screening for diabetes patients is significantly different between minorities and the non-Hispanic White population (Tung, 2017), with the latter group achieving higher screening rates compared to racial/ethnic minorities. Many features of the PCMH directly address the special needs and challenges of disadvantaged populations through providing patient-centered care; using care management, population outreach, and evidence-based guidelines; and identifying high-needs populations using data (Reibling, 2016). Differences between minorities and White populations on healthcare access and care quality were attenuated, but not eliminated, by the PCMH model of care in Mitchell study, reflecting the National Academy of Medicine definition of disparities (2020). Evidence suggests that attributes of the PCMH model can reduce both health and healthcare disparities, including preventive care services in racial/ethnic minorities. Prior studies were limited by lack of a comparison group, non-PCMH practices, and the use of patient self-reporting of PCMH characteristics (Beal, 2009; Lee, 2011).

Promoting health by enhancing prevention services and adhering to recommendations are among the high-priority healthcare services in the United States, however, millions of people in the United States do not receive recommended preventive healthcare services (Healthy People, 2020). If the evidence shows that the PCMH increases the use of preventive and other

cardiovascular preventive services that are recommended to reduce cardiovascular disease, then policies that incentivize healthcare organizations to adopt the PCMH model could be considered.

Gaps in Preventive Care Knowledge in the PCMH Model of Care

Previous studies that examined the correlation between the PCMH model and preventive care considered the PCMH as a whole construct based on their PCMH certification status, but no studies have evaluated the effect of the combination of PCMH attributes on cardiovascular preventive care. PCMH attributes include the presence of a primary care provider, nurse practitioner or physician assistant, and case manager; multiple specialty practices; follow-up with patients discharged from a hospital within 48 hours; reserved time for same-day appointments; preventive care reminders; and the use of EHRs to communicate with patients, decision or population management support, and provider report cards (ARHQ, 2021). It is possible that most studies have not found large differences between PCMH and non-PCMH in part because they have not examined the PCMH attributes of practices, including those of practices that are not formally certified as PCMH. Practices may have all or some PCMH attributes, but not be PCMH certified for various reasons, such as its complicated recognition process (O'Neil, 2022). Furthermore, previous studies have not addressed how the association between the combination of PCMH attributes and preventive use differs by race/ethnicity.

Objectives and Research Questions

The purpose of this research is to examine the association between the PCMH model of care and the receipt of cardiovascular-related preventive care in medically high-risk individuals. In addition, this study assesses whether the association between the PCMH model of care and cardiovascular-related preventive care differs by race/ethnicity. Since we focus on the number of

attributes of the PCMH model of care, whether certified or not, throughout this paper we identify practices with any number of PCMH attributes as "patient-centered" practices.

Research Question 1

Do individuals who are medically at high-risk for cardiovascular disease receive more cardiovascular-related preventive care from practices with high and medium patient-centered attributes compared to medically high-risk individuals who receive care from practices with low patient-centered attributes?

Hypothesis. The probability of receiving cardiovascular-related preventive care is higher among medically high-risk individuals who receive care from patient-centered practices with high and medium patient-centered attributes relative to medically high-risk individuals who receive care from practices with low patient-centered attributes.

Research Question 2

Do practices with high and medium patient-centered attributes reduce racial/ethnic disparities in cardiovascular preventive care relative to practices with low patient-centered attributes?

Hypothesis 1. The probability of receiving cardiovascular-related preventive care in all race/ethnicity groups who receive care from practices with high and medium patient-centered attributes is higher than their counterparts who receive care from practices with low patient-centered attributes.

Hypothesis 2. There are fewer racial/ethnic disparities in cardiovascular-related preventive care use in practices with high and medium patient-centered attributes compared to practices with low patient-centered attributes.

3.2. Conceptual Framework

We used the mixed model of Donabedian and Anderson conceptual frameworks to describe healthcare quality in the patient-centered setting (Figure 8). Preventive services, such as cardiovascular related care, are the measure of healthcare quality outcomes in this research. The Donabedian framework, which examines health services and evaluates the quality of health care, is based on three dimensions: (a) structure, (b) process, and (c) outcome. Structure in this framework refers to the physical and organizational setting in which healthcare is delivered, such as different payment models (ACO, capitation).

The patient-centered practices implement a set of "processes" for the purpose of delivering efficient and effective care to the patients. One of the processes of the patient-centered practices that facilitates optimal outcomes is organized team-based care, which is the provision of health services to patients by at least two health providers, including primary-care provider, nurse practitioner, physician assistant, or specialist, who work collaboratively with patients (Schottenfeld, 2016). Patients of patient-centered practices are prompted by a routine reminder system for preventive services, immunizations, follow-ups for chronic or acute conditions, and missed visits (Smith, 2016). Another of the processes of the patient-centered practices that facilitates optimal outcomes is patient centeredness, which provides access to clinical and document advice 24/7, appointments outside normal business hours, and same-day appointments; helps patients choose a clinician; and patient assessments are facilitated by their designated clinician/care team and supported by access to their medical record (Palmer, 2021). Care management and patient support, as a component of patient-centered practices, is designed to assist patients and their support systems in managing medical conditions more effectively. To manage care, patient-centered practices incorporate patients' preferences and functional goals,

identify treatment goals, and assess and address potential barriers to meeting goals (SIPH, 2021; AmeriHealth, 2021). Finally, patient-centered practices establish a culture of data-driven performance improvement on clinical quality, efficiency, and patient experience and engage staff and patients/families/caregivers in quality improvement activities such as providing report cards on the performance of their health care providers for the betterment of the care quality (Foster, 2021).

The structure and process of the patient-centered practices are expected to increase cardiovascular-related preventive care by comprehensive care in the context of patient centeredness.

Anderson's framework aims to discover conditions that either facilitate or impede health service utilization. In this research, we include individuals' characteristics—as represented by the Anderson framework—that influence receipt of cardiovascular-related preventive services. For this purpose, we included predisposing and enabling factors of the Anderson framework in our conceptual framework. Predisposing factors contain social structures and demographic factors. Social structure (e.g., education, employment, and marital status) and population demographics (e.g., age, gender, and race/ethnicity) could affect the probability of receiving preventive care because of health and healthcare disparities (Lee, 2018). Mechanisms that produce health disparities are varied, ranging from differences in disease awareness, attitudes, and beliefs (e.g., mistrust, religious/cultural beliefs) to differences in access to the full continuum of care (e.g., primary as well as specialty care) and the quality of care received. These mechanisms are complex with numerous other contributing and confounding factors (e.g., SES) (Lin, 2021). Enabling factors, such as income and health insurance, impact the probability of receiving preventive care services due to inequity in access to healthcare services (Magge, 2013).

3.3. Methods

Data Source

We used the Medical Expenditure Panel Survey-Household Component (MEPS-HC) full-year consolidated data and Medical Organization Survey (MOS). MEPS is supported by the Agency for Healthcare Research and Quality (AHRQ). MEPS-HC consolidated data is a representative survey of the United States population conducted annually, including detailed information on health care utilization, expenditures, and health insurance coverage. The MOS was conducted as part of MEPS in 2015 and 2016 to obtain more detailed information on the organization of the practices of office-based care providers identified as the usual source of care in the MEPS-HC and seen by the HC respondent. The objective of the MOS "is to provide data that can be used for evaluating relationships between provider organization characteristics and individuals' health care use and expenditures. More specifically, these data support studies of the association between practice characteristics and consumer access, service use, expenditures, and quality of care. Analytic weights were developed for MEPS sample persons with linked MOS responses to enable nationally representative analyses of the MOS target population" (Stagnitti, 2018).

The survey obtained the name and location of the usual source of care from MEPS respondents with their permission (MEPS, 2022a; MEPS, 2022b). Then, a subsample of the providers, based on the usual sources of care, was selected and administered the MOS questionnaire. The information on the office-based health care providers on the MOS questionnaire includes patient-centered practices attributes and certification status. The cumulative response rate for the full-year household component and the MOS was 36.7% in 2015 and 35.0% in 2016 (ARHQ, 2020).

The data are structured at the patient level, with an average of 1.7 patients per provider surveyed in 2015, where a total of 4,216 practices were surveyed, corresponding to 7,161 individuals (MEPS, 2022a; MEPS, 2022b). For 2016, the final analytic sample size was 9,137 persons across 5,201 unique responding practices (average of 1.8 sample persons per practice). Data from the MOS is linked to MEPS household survey respondents, permitting person-level analysis for the subset of MEPS respondents included in the MOS.

Inclusion Criteria

All individuals aged 18 and older with a usual source of care who were diagnosed with any high-risk cardiovascular-related chronic diseases were included in our study. We chose a sample of medically high-risk individuals because cardiovascular preventive care is crucial to their health outcomes (Arnett, 2019). High-risk cardiovascular-related chronic diseases include high blood pressure or hypertension, coronary heart diseases, angina or angina pectoris, heart attack or myocardial infarction, other kinds of heart disease or condition, hypercholesterolemia, diabetes, stroke, and obesity (CDC, 2022). To identify high-risk cardiovascular-related chronic diseases, we used the series of questions in MEPS-HC asking respondents whether they had been diagnosed with these specific diseases. For obesity, we used the Body Mass Index (BMI) variable and defined “obesity” as a BMI of 30 and over (CDC, 2021). The sample selection is shown in Figure 9. After applying the inclusion criteria, the final sample for the study is 8,764 persons.

Variables

Independent Variables. The main independent variables are attributes of patient-centered practices. The MOS included questions that are relevant for the following patient-centered attributes (Rittenhouse, 2011): (a) presence of a primary care provider, (b)

presence of a nurse practitioner or physician assistant, (c) multiple specialty practice, (d) presence of case manager, (e) follow-up with patients discharged from a hospital within 48 hours, (f) reserved time for same-day appointments, (g) preventive care reminders, (h) use of EHRs to communicate with patients, (i) use of EHRs for decision support or population management support, and (j) provider report cards. The MOS questions related to each attribute are shown in Table 7.

In the next step, we created binary variables for each patient-centered attribute so that we gave a value of 1 to each item if the practice has that attribute. For example, if the practice has a case manager, we gave a value of 1 for this attribute. Then, we created an index that sums the values of the 10 patient-centered attributes, with values ranging from 0 to 10. Finally, we created the categorical variable based on modified tertiles representing practices displaying high, medium, or low patient-centered attributes, with 0-5 patient-centered attributes classified as low, 6-8 patient-centered attributes classified as medium, and 9-10 patient-centered attributes classified as high. In total, 838 individuals received care from practices classified as having low patient-centered attributes; 2,742 individuals received care from practices with medium patient-centered attributes; and 2,421 individuals received care from practices with high patient-centered attributes.

The patient-centered practice measure is designed primarily to test the hypothesis that a greater number of patient-centered attributes indicates more widespread adoption of PCMH practices and goals, which will have a greater effect on preventive care utilization. An alternative approach is to identify and test a smaller number of latent concepts—or factors—that are represented in the MOS survey data, of which each factor may be comprised of two or more attributes. As this study did not have a priori hypotheses about specific factors that would be

more important in affecting preventive care use, we conducted an exploratory factor analysis on the 10 attributes as an alternate way to measure adoption of patient-centered practices. Results using these measures are described in detail in Appendix B.

The other major independent variable is the race/ethnicity of individuals categorized into five groups: (a) Hispanic, (b) non-Hispanic White, (c) non-Hispanic Black, (d) non-Hispanic Asian, and (e) non-Hispanic other race or multiple races.

Dependent Variables. Cardiovascular-related preventive care measures were obtained from the MEPS-HC datafile and included the following binary variables shown in Table 7: (a) checking both blood pressure and blood cholesterol based on the recommended guidelines, (b) getting advice from a healthcare provider to eat fewer high fat or high cholesterol foods, (c) advice to exercise more, and (d) take aspirin frequently. Contraindication for taking aspirin was determined by another question that asked if taking aspirin was unsafe due to a medical condition. Since the recommendation for taking aspirin was for individuals 50 and older in 2015 and 2016, we restricted the sample to 50 years and older to find the association between the patient-centered practices and taking aspirin frequently in individuals who did not have a contraindication to take aspirin.

Covariates. We controlled for practice characteristics, including capitation, if the practice has any capitated contracts (per person, per month) with managed care plans, and ACO, if the practice participates in an ACO arrangement with either Medicare or private insurers. Capitation and ACO are categorized as “Yes,” “No,” and “Unknown.” The ownership (for-profit, non-profit, and government) information of practices is available only for 2015, so we could not control for this variable. We also controlled for individual characteristics, including age, gender, race/ethnicity, marital status, education, employment, family income, and health insurance status.

We included family income (in thousands of dollars) and age, but also considered an alternate specification containing the squares of these variables.

We categorized marital status into three groups: (a) married, (b) widowed/divorced/separated, and (c) never married. Education was categorized into six groups: (a) less than high school, (b) high school diploma or GED, (c) some college or associate degree, (d) Bachelor, and (e) Masters' or above. We also controlled for the health insurance status: (a) any private health insurance, (b) public health insurance, and (c) uninsured.

Missing Data

Preliminary descriptive analyses showed missing values up to 13% in patient-centered attributes; the highest missing rates were for "clinical quality of care individually provided to physicians" and "sending reminders for preventative care or follow-up care routinely" with 13% and 12% missing rates, respectively. The missing rates for our dependent variables varied from 2.3% in blood pressure and cholesterol preventive check, 1.5% in low-fat diet recommendation, 1.4% in exercise recommendation, and 1% in taking aspirin frequently. The covariates descriptive analysis showed that education had 22%, ACO had 31%, and capitation payment method had 29% missing values. In order to retain the greatest power and maximize the use of information, all these variables with missing values were imputed using multiple imputations by chained equations (MICE), including all covariates used in final models (Please see Appendix B for a description of the MICE method).

Statistical Analyses

After merging MEPS-HC and MOS data for 2015 and 2016, we appended 2015 and 2016 datasets. We described the individual characteristics in each year and in a pooled dataset. Using the logistic regression method, we reported the association between patient-centered

attributes/patient-centered categories and cardiovascular preventive care. We also reported the association of the patient-centered attributes/patient-centered categories on cardiovascular preventive care among different race/ethnicity groups, estimating separate models for Whites, Hispanics, and African Americans. Including the race/ethnicity as a categorical variable in a logistic model that constrained other parameter estimates to be equal for the race/ethnicity groups could bias estimates of the effect of patient-centered attributes/patient-centered categories on different race/ethnicity groups. Therefore, we tested the parameter estimates for the subpopulations to determine whether there was a significant difference in the probability that cardiovascular preventive services were provided.

The unit of analysis is individuals in all the statistical models. Because of the complex sampling design, we used survey weights in all the analyses. Standard errors used for tests of statistical significance account for the complex survey design. We defined all statistical significance as $p<0.05$ and used Stata version 13 for all the analyses.

Statistical Model for Research Question 1

$$(\text{blood pressure \& cholesterol check})_{it} = \beta_0 + \beta_1(\text{patient-centered categories})_{it} + \beta_2(\text{education})_{it} + \beta_3(\text{income})_{it} + \beta_4(\text{race/ethnicity})_{it} + \beta_5(\text{marital status})_{it} + B_6(\text{age})\,it + \beta_7(\text{age}^2)_{it} + \beta_8(\text{employment})_{it} + \beta_9(\text{health insurance})_{it} + \beta_{10}(\text{ACO})_{it} + \beta_{11}(\text{capitation})_{it} + \beta_{12}(\text{year})_{it} + u_{it}$$

$$(\text{low-fat diet rec})_{it} = \beta_0 + \beta_1(\text{patient-centered categories})_{it} + \beta_2(\text{education})_{it} + \beta_3(\text{income})_{it} + \beta_4(\text{race/ethnicity})_{it} + \beta_5(\text{marital status})_{it} + B_6(\text{age})_{it} + \beta_7(\text{age}^2)_{it} + \beta_8(\text{employment})_{it} + \beta_9(\text{health insurance})_{it} + \beta_{10}(\text{ACO})_{it} + \beta_{11}(\text{capitation})_{it} + \beta_{12}(\text{year})_{it} + u_{it}$$

$$(\text{exercise rec})_{it} = \beta_0 + \beta_1(\text{patient-centered categories})_{it} + \beta_2(\text{education})_{it} + \beta_3(\text{income})_{it} + \beta_4(\text{race/ethnicity})_{it} + \beta_5(\text{marital status})_{it} + B_6(\text{age})_{it} + \beta_7(\text{age}^2)_{it} + \beta_8(\text{employment})_{it} + \beta_9(\text{health insurance})_{it} + \beta_{10}(\text{ACO})_{it} + \beta_{11}(\text{capitation})_{it} + \beta_{12}(\text{year})_{it} + u_{it}$$

$$(\text{aspirin rec})_{it} = \beta_0 + \beta_1(\text{patient-centered categories})_{it} + \beta_2(\text{education})_{it} + \beta_3(\text{income})_{it} + \beta_4(\text{race/ethnicity})_{it} + \beta_5(\text{marital status})_{it} + B_6(\text{age})_{it} + \beta_7(\text{age}^2)_{it} + \beta_8(\text{employment})_{it} + \beta_9(\text{health insurance})_{it+} \beta_{10}(\text{ACO})_{it} + \beta_{11}(\text{capitation})_{it} + \beta_{12}(\text{year})_{it} + u_{it}$$

We used above logistic regression models for the pooled data of 2015 and 2016 to estimate the probability of receiving cardiovascular preventive care among individuals who receive care from practices with high and medium patient-centered attributes relative to individuals who received care from practices with low patient-centered attributes.

Statistical Model for Research Question 2

We also estimated each of the models below by race/ethnicity subpopulation (Whites, Hispanics, and African Americans).

$$\text{(blood pressure \& cholesterol check)}_{it} = \beta_0 + \beta_1(\text{patient-centered categories})_{it} + \beta_2(\text{education})_{it} + \beta_3(\text{income})_{it} + \beta_4(\text{marital status})_{it} + B_5(\text{age})_{it} + \beta_6(\text{age}^2)_{it} + \beta_7(\text{employment})_{it} + \beta_8(\text{health insurance})_{it} + \beta_9(\text{ACO})_{it} + \beta_{10}(\text{capitation})_{it} + \beta_{11}(\text{year})_{it} + u_{it}$$

$$\text{(low-fat diet rec)}_{it} = \beta_0 + \beta_1(\text{patient-centered categories})_{it} + \beta_2(\text{education})_{it} + \beta_3(\text{income})_{it} + \beta_4(\text{marital status})_{it} + B_5(\text{age})_{it} + \beta_6(\text{age}^2)_{it} + \beta_7(\text{employment})_{it} + \beta_8(\text{health insurance})_{it} + \beta_9(\text{ACO})_{it} + \beta_{10}(\text{capitation})_{it} + \beta_{11}(\text{year})_{it} + u_{it}$$

$$\text{(exercise rec)}_{it} = \beta_0 + \beta_1(\text{patient-centered categories})_{it} + \beta_2(\text{education})_{it} + \beta_3(\text{income})_{it} + \beta_4(\text{marital status})_{it} + B_5(\text{age})_{it} + \beta_6(\text{age}^2)_{it} + \beta_7(\text{employment})_{it} + \beta_8(\text{health insurance})_{it} + \beta_9(\text{ACO})_{it} + \beta_{10}(\text{capitation})_{it} + \beta_{11}(\text{year})_{it} + u_{it}$$

$$\text{(aspirin rec)}_{it} = \beta_0 + \beta_1(\text{patient-centered categories})_{it} + \beta_2(\text{education})_{it} + \beta_3(\text{income})_{it} + \beta_4(\text{marital status})_{it} + B_5(\text{age})_{it} + \beta_6(\text{age}^2)_{it} + \beta_7(\text{employment})_{it} + \beta_8(\text{health insurance})_{it} + \beta_9(\text{ACO})_{it} + \beta_{10}(\text{capitation})_{it} + \beta_{11}(\text{year})_{it} + u_{it}$$

To find the difference in cardiovascular preventive care among different racial/ethnic groups, we tested for significant differences in the logistic regression parameter estimates in the three subpopulations with "suest" command in Stata (Stata, 2022).

Sensitivity Analysis

We did several sensitivity analyses by first re-classifying patient-centered practices into 3 different sets of categories to change the number of attributes in each patient-centered practices and determine whether the number of attributes in each category changes the results of our analysis. These classifications are: (a) practices with low (0-3), medium (4-7), and high (8-10)

patient-centered attributes, (b) practices with low (0-4), medium (5-7), and high (8-10) patient-centered attributes, and (c) practices with low (0-6), medium (7-8), and high (9-10) patient-centered attributes.

In the second sensitivity analysis, we estimated the probability of getting cardiovascular preventive care with logistic regression models among individuals who received care from 10 individual patient-centered attributes in each model compared to individuals who received care from practices without these attributes in the total population and by race/ethnicity subpopulations (White, Hispanic, and African American subpopulations).

Model for the total population:

$$(\text{cardiovascular preventive care})_{it} = \beta_0 + \beta_1(\text{10 patient-centered attributes})_{it} + \beta_2(\text{education})_{it} + \beta_3(\text{income})_{it} + \beta_4(\text{race/ethnicity})_{it} + \beta_5(\text{marital status})_{it} + B_6(\text{age})\,it + \beta_7(\text{age}^2)_{it} + \beta_8(\text{employment})_{it} + \beta_9(\text{health insurance})_{it} + \beta_{10}(\text{ACO})_{it} + \beta_{11}(\text{capitation})_{it} + \beta_{12}(\text{year})_{it} + u_{it}$$

Model for race/ethnicity subpopulations:

$$(\text{cardiovascular preventive care})_{it} = \beta_0 + \beta_1(\text{10 patient-centered attributes})_{it} + \beta_2(\text{education})_{it} + \beta_3(\text{income})_{it} + \beta_4(\text{marital status})_{it} + B_5(\text{age})\,it + \beta_6(\text{age}^2)_{it} + \beta_7(\text{employment})_{it} + \beta_8(\text{health insurance})_{it} + \beta_9(\text{ACO})_{it} + \beta_{10}(\text{capitation})_{it} + \beta_{11}(\text{year})_{it} + u_{it}$$

3.4. Results

The sample size included 8,764 individuals (weighted: 81,459,769). Half of the study population was from 2015 and the other half was from 2016. The mean age of our sample size was 58. Most individuals were female (56.5%), White (70.0%), high school/GED level of education (52.3%), married (58.7%), employed/had job to return to (50.6%), and had some type of private insurance (67.4%). The mean family income was 73.4 thousand dollars (Table 8).

More than 95% of individuals had their blood pressure and cholesterol checked, based on the recommendation for patients with their risk of cardiovascular diseases. More than half of the sample size (54.3%) received a recommendation for a low-fat diet, 62.7% received a

recommendation exercise regularly, and 45% of individuals 50 years and older with the risk of cardiovascular diseases who did not have contraindication takes aspirin regularly (Table 8).

The logistic regression models to examine the association between cardiovascular-related preventive care and the patient-centered practices (research question 1) showed that among individuals who are at high risk for cardiovascular diseases, the odds of getting any of cardiovascular-related preventive care (blood pressure/cholesterol check, low-fat diet, and exercise recommendation, and aspirin taking) were not significantly different in practices with high and medium patient-centered attributes compared to practices with low patient-centered attributes (Table 9).

An analysis of the association between the probability of cardiovascular-related preventive care across patient-centered categories in different race/ethnicity sub populations (research question 2) showed no statistically significant differences in the probability of cardiovascular-related preventive care among individuals (in any race/ethnicity subpopulation) who receive care from practices with high and medium patient-centered attributes compared to individuals who received care from practices with low patient-centered attributes (Table 10). The result of predicted margins (%) and 95% CI of cardiovascular-related preventive care across different patient-centered categories is shown in the total population and in the different race/ethnicity subpopulations (Table 9 and 10).

Sensitivity Analysis

The results of sensitivity analyses, after reclassifying into different sets of categories with different numbers of attributes, did not show significant differences between the patient-centered practices and cardiovascular-related preventive care. To find out whether any individual patient-centered attributes was associated with the probability of cardiovascular-related preventive cares,

we examined the association between the 10 individual patient-centered attributes and the probability of cardiovascular-related preventive care. We estimated the same essential models (same control variables) but just included the individual attributes rather than patient-centered categories. We found that the odds of getting a recommendation for more exercise was 1.4 times higher (95% CI [1.0-1.9]; p-value<0.05) among medically high-risk individuals who received care from practices that had PCP than practices that did not have PCP. Among individuals who are at high risk for cardiovascular diseases, the odds of getting a recommendation for exercise from practices with a case manager and specialist is 10% (95% CI [0.7-1.0]; p-value<0.05) and 20% (95% CI [0.7-1.0]; p-value<0.05) lower, respectively, than those that did not have these patient-centered attributes. The odds of getting a recommendation for a low-fat diet was significantly higher by 1.3 times (95% CI [1.0-1.6]; p-value<0.05) among medically high-risk individuals who received care from practices that used an electronic records system to exchange secure messages with patients than those individuals who did not get care from these types of practices (Table 11 and Appendix B Tables 2 and 3).

We tested the correlation between cardiovascular preventive cares and each patient-centered attribute by race/ethnicity subpopulations. Although the presence of some patient-centered attributes showed significant differences in receiving cardiovascular preventive cares in the subpopulations, we did not find a discernable pattern (Appendix B Tables 4 and 5). Furthermore, the results of the analysis on the comparison of estimates in subpopulations by "suest" command is shown in Table 12, and it was not conclusive (Stata, 2022d).

Predicted probability of the correlation between patient-centered attributes and cardiovascular-related preventive cares in the total population and race/ethnic subpopulation is shown in Tables 2 and 4 of the Appendix.

3.5. Discussion

This study aimed to find the association between the patient-centered practices and the probability of cardiovascular preventive services and recommendations among adults who are medically high-risk for cardiovascular diseases (CVD) in 2015 and 2016. We first examined the correlation of patient-centered practices categorized as high, medium, or low with the probability of receiving cardiovascular preventive services, and that did not show a statistically significant difference between the patient-centered categories and the probability of receiving cardiovascular preventive services. Our results do not support our first hypothesis that the probability of receiving cardiovascular-related preventive care is higher among medically high-risk individuals who receive care from patient-centered practices with high and medium patient-centered attributes relative to medically high-risk individuals who receive care from practices with low patient-centered attributes. Then, we examined the association of each patient-centered attribute with these preventive services as a sensitivity analysis. We did not show meaningful differences in patients who receive care from practices that have any of patient-centered attributes compared to the practices without those attributes. The results of the model among different subpopulation did not support our second hypothesis that there are fewer racial/ethnic disparities in cardiovascular-related preventive care use in practices with high and medium patient-centered attributes compared to practices with low patient-centered attributes. Our results are consistent with previous studies that examined the correlation between the PCMH certification and preventive care indicators (Hong, 2020; Bowdoin, 2016; Farely, 2019). Hong et al. did not find a meaningful relationship in cancer screening uptake rates between those who received care from PCMH-certified practices and non-PCMH practices (2020). Bowdin et al. did not find a statistically significant difference in preventive care and healthcare quality measures

(cervical, breast, and colorectal cancer screening; current smoking; smoking cessation advice; flu shot; foot and eye exam for people with diabetes; and follow-up after emergency room visit for mental illness) and the PCMH model of care (2016).

Our patient study sample could have influenced our results showing that the patient-centered practice did not change the probability of receiving the cardiovascular related preventive care. Our sample study included individuals that are high-risk for cardiovascular-related chronic diseases, including blood pressure, coronary heart diseases, angina or angina pectoris, heart attack or myocardial infarction, other kinds of heart disease or condition, hypercholesterolemia, diabetes, stroke, and obesity. High-risk individuals with cardiovascular-related chronic diseases are more likely to visit specialty providers who spend more time adjusting their medications and performing a physical examination. These providers may not have time during their visits to recommend cardiovascular-related preventive measures and recommendations. This population might already be on medications, such as aspirin, which makes the recommendation for taking aspirin irrelevant. Also, patients at a high-risk for cardiovascular-related chronic diseases might have a comorbidity that limits their ability to follow some of the cardiovascular-related preventive care measures, such as regular physical activity. One other possible explanation for our findings related to getting BP/cholesterol checked is that an increase in BP/cholesterol check service would be harder to achieve above a certain level. Our study showed that the frequency of individuals who were high risk for CVD receiving both BP and cholesterol checked was 96%, which is higher than the national frequency for all adults (91%).

In addition, our results did not show any differences by race/ethnicity in the association of patient-centered practices with use of cardiovascular preventive services. However, among

individuals who are medically at high-risk for CVD and have the usual source of care, the probability of receiving cardiovascular-related preventive care and recommendations was higher among Black and Hispanic subpopulations than the White subpopulation. This result is consistent with another study, which found Black women were more likely than White women to report avoiding unhealthy foods and losing weight in the past year, because their healthcare providers encouraged them to do so (Mochari-Greenberger, 2010). Other studies showed that the probability of lifestyle modification recommendations was higher in non-White populations (Lobo, 2012; Grabovac, 2019). Although lifestyle modification recommendations are an essential factor in preventing cardiovascular diseases, they are effective concurrently with medical treatment. One explanation is that minorities with a usual source of care and medically high-risk for CVD might be discriminated against by healthcare providers from getting the medications, which is a more effective treatment (Bacon, 2020).

Although it was not part of the main aim of this study, our results showed that privately insured adults with CVD risk were more likely to receive a recommendation to check BP and cholesterol by guidelines than uninsured adults, which also aligned with a previous study by Grabovac (2019).

The reliability of the patient-centered practices should be examined to the extent to which they are consistent across different occasions of testing. Besides, additional research is needed to determine why each patient-centered attribute might be correlated with a higher probability of cardiovascular-related preventive care in the total population and each race/ethnicity subpopulation.

3.6. Limitations

First, using 2015−2016 survey data does not allow for an analysis of recent patient-centered efforts. For example, the National Committee for Quality Assurance—the nation's major PCMH accreditation provider—redesigned its PCMH recognition program in 2017, emphasizing performance and quality improvement under the Medicare Access and Children's Health Insurance Program Reauthorization Act. In particular, the National Committee for Quality Assurance reformed the program's 3-year recognition process to an annual check-in and reporting system (PCMH, 2021). These changes may result in different findings, therefore, an update of this work is warranted when the new MEPS-MOS data are released. Second, the information on cardiovascular-preventive services and recommendations were self-reported, and subject to misreporting due to social desirability and recall bias. Self-reported conditions are likely to be underreported (Edward, 1994); thus, our results may underestimate the likelihood of CVD preventive services and recommendations. Third, because of the cross-sectional nature of the data, there was a limited ability to make causal inferences. Finally, there is potential for selection bias, in that people with different propensities for preventive care use may be attracted to practices with different numbers of patient-centered attributes. This could overstate or understate the association between patient-centered practices and preventive care use. Also adding to the potential for selection bias is that data was only gathered for individuals from certain usual sources of care and from individuals with permission to contact their practices for the development of MOS data, although the whole sample of the MEPS data was drawn randomly.

3.7. Conclusion

None of the three categories (low, medium, and high) of levels of patient-centered practices were associated with the probability receiving cardiovascular preventive services or recommendations among medically high-risk adults for CVDs. Also, none of the three categories (low, medium, and high) of patient-centered practices were associated with the probability of cardiovascular preventive services and recommendations in race/ethnicity subpopulations. However, some patient-centered attributes were associated with the probability of services and recommendations among medically high-risk adults for CVDs and race/ethnic subpopulations, but they were not meaningful.

Figures and Tables

Figure 8

The Conceptual Framework of Cardiovascular-Related Preventive Care in Patient-Centered Practices

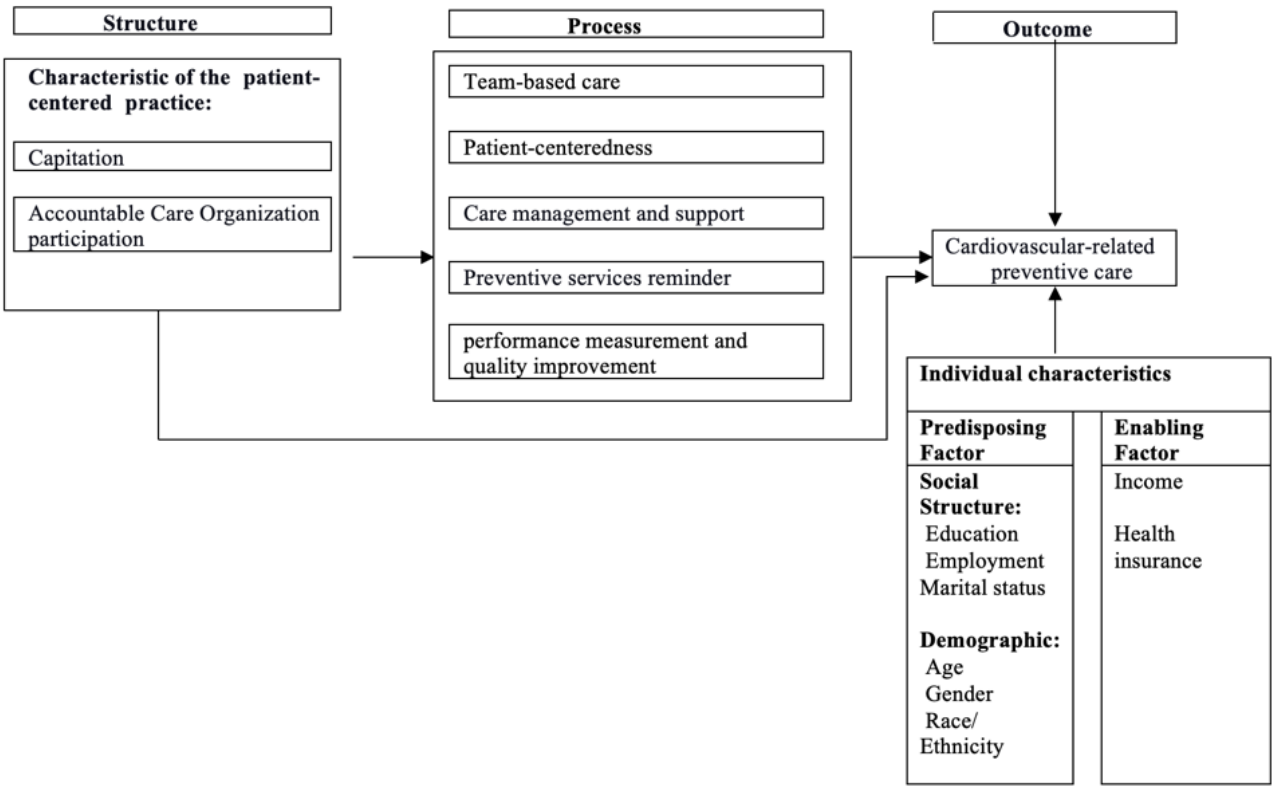


Figure 9

Sample Selection

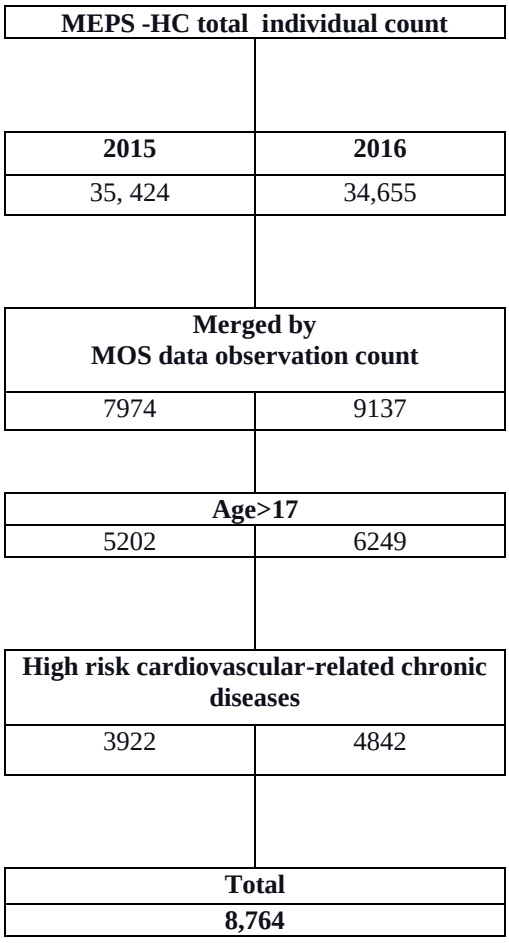


Table 7

Variables and Questions Used from MEPS-MOS

Independent Variables	**Questions**
Patient-centered attributes	
Presence of a primary care provider	Of the physicians working at the practice, how many are primary care physicians?
Presence of a nurse practitioner or physician assistant	Approximately how many nurse practitioners and physician assistants work at the practice?
Multiple specialty practice	Is this a multi-specialty group practice?
Presence of case manager	Does the practice use case managers whose primary job is to coordinate patient care?
Following up with patients discharged from a hospital within 48 hours	When patients are discharged from the hospital, does someone from the practice usually contact the patient within 48 hours?
Reserving time for same-day appointments	Does the practice routinely set time aside for same-day appointments?
Preventive care reminders	Does the practice routinely send patients reminders for preventative care or follow-up care?
Using EHRs to communicate with patients	If the practice uses an electronic records system, is it routinely used for exchanging secure messages with patients?
Using EHRs for decision support or population management support	If the practice uses an electronic records system, does it routinely provide reminders for either guideline-based interventions or screening tests?
Preparing provider report cards	Does the practice regularly give reports to physicians on the clinical quality of care they individually provide?
Dependent Variables	
Blood pressure check within a year AND/OR Cholesterol check within 5 years (Yes:1, No;0)	What was the time since last blood pressure check? What was the time since last blood cholesterol check by doctor or health professional?
Low-fat diet recommendation (Yes:1, No:0)	Do doctors or other health professionals ever advise you to eat fewer high-fat or high-cholesterol foods?
Exercise recommendation (Yes:1, No: 0)	Do you have a doctor advise to exercise more?
Take Aspirin frequently (Yes:1, No: 0)	Do you take aspirin frequently?

Table 8

Individual and Healthcare Organization Characteristics (N=8764, Weighted N= 81459769)

Individual characteristics		**Healthcare organization characteristics**	
	Total		**Total**
Age (Mean, 95% CI)	58.1 (57.3-58.8)	**Patient-centered Practices Categories**	
Sex		Low	12.8%
Female	56.5%	Medium	44.2%
Male	43.5%	High	43.0%
Race		**ACO**	
White	70.0%	Yes	67.7%
Hispanic	11.8%	No	32.3%
African American	11.3%	**Capitation**	
Asian	3.9%	Yes	48.1%
Other race or multiple races	3.0%	No	51.9%
Education		**Primary Care Physician (PCP)**	
Less than high school	45.3%	Has PCP	96.0%
High school or GED	7.0%	Not have PCP	4.0%
Some college or Associate degree	16.1%	**Physician Assistant/Nurse Practitioner (PA/NP)**	
Bachelor	17.0%	Has PA/NP	77.0%
Masters' and above	14.6%	Not have PA/NP	23.0%
Marital Status		**Case manager**	
Married	58.7%	Has case manager	55.0%
Widowed/ Divorced/Separated	27.3%	Not have case manager	45.0%
Never married	14.0%	**Specialty**	
Employment Status		Has specialty	40.8%
Employed/Has job to return	50.6%	Not have specialty	59.2%
Not employed	49.4%	**Check-in within hours after hospital discharge**	
Health insurance Status		Yes	73.8%
Uninsured	3.5%	No	26.2%
Any Private	67.4%	**Same day appointment**	
Public	29.0%	Yes	95.4%
Family Income in thousand (mean)	73.4	No	4.6%
Cardiovascular related preventive cares		**HER/EMR Exchange secure messages**	
Blood pressure and Cholesterol check recommended by guidelines		Yes	77.8%
No	4.3%	No	22.2%
Yes	95.7%	**EHRs for decision support**	
No fat diet recommendation		Yes	90.8%
No		45.7%	9.2%
Yes	54.3%	**Send preventive care reminder to patient**	
Exercise recommendation		Yes	81.9%
No	37.3%	No	18.1%
Yes	62.7%	**Reports to physician on clinical quality of care**	
Aspirin recommendation		Yes	91.2%
No	54.6%	No	8.8%
Yes	45.4%		

Table 9

Correlation Between Patient-Centered Categories and Cardiovascular-Related Preventive Cares (Odds Ratio and Predicted Margins)

Unweighted sample size=8764, Weighted=81459769

	BP and cholesterol check based on guideline recommendation	**No-fat diet Recommendation**	**Exercise Recommendation**	**Taking aspirin Among age>=50**
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Patient-centered Categories				
Low	Ref	Ref	Ref	Ref
Medium	1.1 (0.7-1.9)	1.1 (0.9-1.4)	1.1 (0.9-1.3)	1.1 (0.9-1.4)
High	1.1 (0.7-1.8)	1.0 (0.8-1.2)	0.9 (0.8-1.2)	1.0 (0.8-1.3)
ACO				
No	Ref	Ref	Ref	Ref
Yes	1.0 (0.6-1.5)	0.9 (0.8-1.2)	1.0 (0.8-1.2)	1.3 (1.0-1.6)
Capitation				
No	Ref	Ref	Ref	Ref
Yes	1.3 (0.9-1.8)	0.9 (0.8-1.1)	1.1 (0.9-1.3)	1.1 (0.9-1.3)
Age	1.1** (1.1-1.2)	1.1*** (1.1-1.2)	1.0*** (1.1-1.7)	1.3*** (1.2-1.5)
Age Square	1.0 (1.0-1.0)	1.0*** (1.0-1.0)	1.0*** (1.0-1.0)	1.0*** (1.0-1.0)
Sex				
Male	Ref	Ref	Ref	Ref
Female	1.2 (0.9-1.7)	0.8** (0.7-0.9)	1.0 (0.9-1.2)	0.6*** (0.5-0.7)
Race				
White	Ref	Ref	Ref	Ref
Hispanic	1.2 (0.8-1.8)	1.7*** (1.4-2.0)	1.5*** (1.2-1.7)	0.7* (0.6-1.3)
Black	2.5*** (1.7-3.7)	1.4** (1.1-1.7)	1.4** (1.2-1.7)	1.0 (0.8-1.2)
Asian	0.9 (0.4-2.0)	1.1 (0.8-1.5)	1.2 (0.9-1.6)	0.6* (0.4-0.9)
Other race or multiple race	0.8 (0.4-1.7)	0.8 (0.6-1.2)	0.8 (0.5-1.2)	1.1 (0.6-2.0)
Education				
Less than high school	Ref	Ref	Ref	Ref
High school or GED	0.9 (0.5-1.6)	0.9 (0.7-1.2)	1.0 (0.7-1.4)	0.9 (0.6-1.3)
Some college or associate degree	1.4 (0.8-2.6)	1.0 (0.8-1.2)	1.0 (0.8-1.3)	0.8 (0.6-1.1)
Bachelor	1.2 (0.7-2.0)	0.9 (0.7-1.1)	0.8 (0.6-1.1)	0.9 (0.7-1.2)
Masters' and above	2.4 (1.2-5.1)	1.0 (0.8-1.3)	0.7 (0.6-1.0)	0.7* (0.5-0.9)
Marital Status				
Married	Ref	Ref	Ref	Ref
Widowed/ Divorced/Separated	1.1 (0.7-1.7)	1.0 (0.8-1.2)	1.0 (0.8-1.1)	1.1 (0.9-1.4)
Never married	0.9 (0.6-1.3)	0.9 (0.7-1.1)	0.9 (0.8-1.2)	0.8 (0.6-1.1)
Employment Status				

Not employed	Ref	Ref	Ref	Ref
Employed	0.7* (0.5-0.9)	0.8** (0.7-1.0)	0.9 (0.8-1.1)	0.8* (0.7-1.0)
Health insurance Status				
Uninsured	Ref	Ref	Ref	Ref
Any private	2.5***(1.5-4.1)	1.3 (0.9-1.8)	1.3 (0.9-1.8)	1.0 (0.7-1.6)
Public	1.4 (0.8-2.3)	1.2 (0.8-1.6)	1.3 (0.9-1.8)	1.0 (0.7-1.7)
Family Income in thousand	1.0 (1.0-1.0)	1.0 (1.0-1.0)	1.0 (1.0-1.0)	1.0 (1.0-1.0)
Family income in thousand squared	1.0 (1.0-1.0)	1.0 (1.0-1.0)	1.0 (1.0-1.0)	1.0 (1.0-1.0)
Year				
2015	Ref	Ref	Ref	Ref
2016	1.0 (0.7-1.4)	1.0 (0.8-1.1)	1.0 (0.9-1.1)	0.9 (0.8-1.0)
Patient-centered Categories	**Predicted Margins (%) (95% CI)**	**Predicted Margins (%) (95% CI)**	**Predicted Margins (%) (95% CI)**	**Predicted Margins (%) (95% CI)**
Low	97.6 (96.6-98.7)	53.4 (48.8-58.0)	63.0 (58.8-67.1)	43.4 (38.4-48.4)
Medium	97.9 (97.3-98.4)	56.3 (53.9-58.7)	64.6 (62.4-66.9)	45.9 (42.8-48.9)
High	97.8 (97.2-98.5)	52.7 (49.8-55.5)	61.5 (58.8-64.3)	43.9 (40.8-47.0)

Table 10

Correlation Between Patient-Centered Categories and Cardiovascular-Related Preventive Cares in Each Race/Ethnicity Subpopulation (Odds Ratio and Predicted Margins)[1,2]

	BP and cholesterol check based on guideline recommendation			No-fat diet recommendation			Exercise recommendation			Taking aspirin among age>=50		
	White subpop[a]	Hispanic subpop[b]	African American subpop[c,3]	White Subpop	Hispanic subpop	African American subpop	White subpop	Hispanic subpop	African American subpop	White subpop[d]	Hispanic subpop[e]	African-American subpop[f]
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Patient-centered Categories												
Low	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Medium	1.3 (0.7-2.4)	1.2 (0.6-2.5)	0.9 (0.6-1.3)	1.2 (0.9-1.5)	1.2 (0.7-2.1)	1.1 (0.7-1.7)	1.1 (0.9-1.5)	1.0 (0.6-1.7)	1.1 (0.7-1.7)	1.3 (0.9-1.7)	1.2 (0.7-2.0)	0.7 (0.4-1.3)
High	1.1 (0.6-2.0)	1.9 0.8-3.9)	1.6*[4] (1.1-2.3)	0.9 (0.7-1.3)	1.2 (0.7-1.9)	1.1 (0.7-1.8)	0.9 (0.7-1.2)	1.2 (0.7-2.03)	1.2 (0.7-2.0)	1.1 (0.8-1.6)	1.3 (0.7-2.3)	0.8 (0.5-1.5)
Patient-centered Categories	**Predicted Margins (%) (95% CI)**	**Predicted Margins (%) (95% CI)**	**Predicted Margins (%) (95% CI)**	**Predicted Margins (%) (95% CI)**	**Predicted Margins (%) (95% CI)**	**Predicted Margins (%) (95% CI)**	**Predicted Margins (%) (95% CI)**	**Predicted Margins (%) (95% CI)**	**Predicted Margins (%) (95% CI)**	**Predicted Margins (%) (95% CI)**	**Predicted Margins (%) (95% CI)**	**Predicted Margins (%) (95% CI)**
Low	97.8 (96.5-99.1)	94.9 (91.8-98.0)	98.4 (97.9-99.0)	51.1 (45.1-57.1)	59.8 (49.5-70.1)	57.4 (48.3-66.5)	60.4 (54.9-65.8)	68.8 (59.4-78.2)	67.5 (58.0-77.0)	42.9 (36.6-49.1)	31.7 (21.4-42.0)	48.2 (37.1-59.3)
Medium	98.3 (97.6-98.9)	95.8 (93.8-97.7)	98.3 (97.9-98.6)	54.8 (51.7-58.0)	64.7 (59.5-70.0)	59.7 (55.0-64.4)	63.3 (60.3-66.3)	69.3 (64.5-74.1)	69.2 (64.5-73.9)	48.8 (44.9-52.7)	35.4 (29.6-41.1)	41.1 (34.9-47.2)
High	98.0 (97.2-98.7)	97.1 (95.7-98.5)	99.0 (98.7-99.2)	49.8 (46.0-53.6)	63.2 (58.6-67.9)	60.3 (55.2-65.5)	58.5 (54.9-62.1)	72.7 (68.1-77.2)	71.8 (67.6-75.9)	45.8 (41.8-49.8)	37.2 (30.0-44.3)	43.2 (36.0-50.4)

[a] sample size: 4296 Weighted: 57023260
[b] sample size: 2137 Weighted: 9641705
[c] sample size : 1649 Weighted: 9188899
[d] sample size: 3184 Weighted: 42510489
[e] sample size: 1274 Weighted: 5763090
[f] sample size: 1129 Weighted: 5960921

[1] -suest- tests has not been run because of the lack of differences in patient-centered effects across racial/ethnic groups.

[2] Coefficients of variables we controlled for are not included in this table.

[3] We estimated the probability of BP/cholesterol check with unimputed data in Black subpopulation, because the estimation of specified model that is fitted on Black subpopulation changed from one imputation to another which caused the estimation sample to be different between imputations. A varying estimation sample can lead to biased or less efficient estimates. As a result, -suest- cannot be done between estimation of imputed data (Hispanic and White subpopulations) and unimputed data (Black subpopulation).

[4] The significant difference between low and high patient-centered in BP/cholesterol check among the Black subpopulation could be biased because it was estimated with unimputed data.

Table 11

*Correlation Between Patient-Centered Attributes and Cardiovascular-Related Preventive Cares (Odds Ratio)**

Unweighted sample size=8764, Weighted=81459769

	BP and cholesterol check based on guideline recommendation	**No-fat diet recommendation**	**Exercise recommendation**	**Taking aspirin among age>=50**
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Primary Care Physician (PCP)				
Not have PCP	Ref	Ref	Ref	Ref
Has PCP	1.0 (0.4-2.2)	1.4 (1.0-2.0)	1.4* (1.0-1.9)	1.0 (0.7-1.6)
Physician Assistant (PA)				
Not have PA	Ref	Ref	Ref	Ref
Has PA	1.3 (0.9-1.9)	0.9 (0.8-1.1)	0.9 (0.8-1.1)	1.0 (0.8- 1.2)
Case manager				
Not have Case manager	Ref	Ref	Ref	Ref
Has case manager	1.0 (0.7-1.4)	1.0 (0.8-1.1)	0.9* (0.7-1.0)	1.1 (0.9- 1.3)
Specialty				
Not a multi-Specialty	Ref	Ref	Ref	Ref
Multi-Specialty	0.8 (0.6-1.1)	0.9* (0.8-1.0)	0.8* (0.7-1.0)	1.0 (0.8-1.2)
Check-in within hours after hospital discharge				
No	Ref	Ref	Ref	Ref
Yes	1.1 (0.7-1.7)	1.1 (0.9-1.2)	1.1 (0.9-1.3)	1.0 (0.7-1.3)
Same-day appointment				
No	Ref	Ref	Ref	Ref
Yes	1.7 (0.8-3.4)	0.9 (0.7-1.2)	0.9 (0.7-1.1)	0.9 (0.7-1.1)
HER/EMR Exchange secure messages				
No	Ref	Ref	Ref	Ref
Yes	1.2 (0.8-1.8)	1.0 (0.8-1.2)	1.2 (0.9-1.4)	0.9 (0.7-1.2)
EHRs for decision support and screening				
No	Ref	Ref	Ref	Ref
Yes	0.8 (0.5-1.3)	1.0 (0.8-1.2)	1.0 (0.7-1.2)	1.1 (0.9-1.5)
Sends preventive care reminder to patient				
No	Ref	Ref	Ref	Ref
Yes	1.1(0.6-2.0)	1.3* (1.0-1.6)	0.9 (0.7-1.1)	0.9 (0.7-1.3)
Reports to physician on clinical quality of care				
No	Ref	Ref	Ref	Ref
Yes	1.0 (0.5-1.8)	0.9 (0.6-1.2)	1.1 (0.8-1.2)	1.0 (0.7-1.5)

*Coefficients of variables we controlled for are included in the Appendix B Table 2

Table 12

Comparison of Coefficients of Patient-Centered Attributes in Different Race/Ethnicity Subpopulations

	No-fat diet Recommendation differences			
	White[a]-Hispanic[b] subpop	**White-African American[c] subpop**	**Black-White subpop**	**Black-Hispanics subpop**
PCP (95% CI)	-	-	0.42 (-0.3-1.1)	0.62 (-0.4-1.6)
Specialty (95% CI)	-0.34* (-0.68-(-0.01))	-0.10 (-0.41-0.21)	-	-
Send preventive care reminder to patient (95% CI)	0.03 (-0.53-0.60)	0.40 (-0.20-0.98)	-	-
	Exercise Recommendation differences			
	White-Hispanic subpop	**White-African American subpop**	-	-
Case manager (95% CI)	-0.44* (-0.85-(-0.02))	-0.54** (-0.92-(-0.15))	-	-
Specialty (95% CI)	-0.50* (-0.88-(-0.12))	-0.26 (-0.57-0.05)	-	-
	Taking Aspirin Among age>=50 differences			
	Hispanic-White subpop[d]	**Hispanic[e]-African American subpop[f]**	**African American-Whites subpop**	**African Americans-Hispanic subpop**
Send preventive care reminder to patient (95% CI)	-	-	-1.03** (-0.95-0.28)	-0.77 ((-1.71)-(-0.35))
Reports to physician on clinical quality of care (95% CI)	0.69 (-0.04-1.42)	0.84 (-0.14-1.82)	-	-

[a] sample size: 4296 Weighted: 57023260
[b] sample size: 2137 Weighted: 9641705
[c] sample size : 1649 Weighted: 918889
[d] sample size: 3184 Weighted: 42510489
[e] sample size: 1274 Weighted: 5763090
[f] sample size: 1129 Weighted: 596092

Chapter 4

Do Patients Receiving Care from Patient-Centered Practices Spend Less on Healthcare Services?

4.1. Introduction

In 2018, the United States healthcare expenditures were 17% of its Gross Domestic Product (GDP), which is twice the average of 36 Organization for Economic Co-operation and Development (OECD) member countries. Healthcare expenditures were estimated to be $11,072 U.S. dollars per capita in 2019 which is 1.4 times higher than the next highest per capita spender country, Switzerland, and three times higher than the average of all OECD member countries (OECD data, 2021a). Despite its high healthcare expenditures, the United States did not have the most optimal health outcomes. For example, in 2016, 71% of individuals aged 15 years or older in the United States were overweight or obese with a Body Mass Index (BMI) of more than 25 (OECD, 2021b). In 2018, life expectancy at birth in the United States was the lowest among other high-income countries at 78.7 years. Infant mortality was the highest at 5.8 deaths per 1,000 live births in the United States, while the mean was 3.6 deaths per 1,000 for the other high-income countries (Papanicolas, 2018).

Given that United States healthcare outcomes are no better than other high-income countries, much of the excess expenditures are likely spent on low-value services (Schoen, 2008). Low-value services are defined as services that provide little or no benefit to patients, have the potential to cause harm, and incur unnecessary costs to patients (Zadro, 2019). Low-value services that cause excessive healthcare expenditures include: (a) redundant and duplicate services (e.g., tests or procedures done more frequently than clinically necessary), (b) services with expensive equipment or personnel when less expensive inputs would suffice (e.g.,

unnecessary imaging or testing), and (c) quality defects that result in rework or scrapping (e.g., health and cost consequences of medical errors).

Some of this waste on low-value services can be prevented with greater integration and coordination of health care delivery (Bentley, 2008). Lack of health care coordination among multiple healthcare providers causes difficulties for patients to get timely and efficient care, especially for those who have multiple chronic diseases and need multiple health care specialists. Patients who are delayed in getting outpatient services due to a lack of coordination between providers are more likely to receive more costly services such as emergency department (ED) visits and hospitalization. Poor coordination can lead to unnecessary or even harmful services that ultimately increase costs and degrade the quality of care.

The patient-centered medical home (PCMH) model is intended to improve healthcare quality, reduce low-value care, and consequently lower healthcare expenditures by transforming primary care to a more organized setting. The PCMH model is a series of attributes that were identified by the National Committee for Quality Assurance (NCQA) in 2008 to create industry standards (Arend, 2012). Under NCQA guidance, PCMH practices agree to adopt six key concepts: (a) emphasizing team-based care and practice organization, (b) knowing and managing patients through comprehensive data collection and sharing, (c) patient-centered access and continuity, (d) care management and support, (e) care coordination and care transitions, and (f) performance measurement and quality improvement (Farley, 2019). These key concepts emphasize provider roles and responsibilities under the team-based care model, focus on longitudinal relationships between patients and providers, highlight the delivery of evidence-based medicine as measures of performance, and provide data available to providers to reduce redundant procedure, imaging, and testing. The PCMH is accountable for meeting the large

majority of each patient's physical and mental health care needs, including prevention and wellness, acute care, and chronic care. Providing comprehensive care requires a team of care providers. This team includes physicians, advanced practice nurses, physician assistants, nurses, pharmacists, nutritionists, social workers, educators, and care coordinators. Organized care reduces ED visits, preventable ED visits, inpatient admissions, redundant diagnostic tests, and procedures, consequently decreasing total healthcare expenditure (Cole, 2018; Van Hasselt, 2015).

Adults with multiple chronic conditions utilize health services at a higher rate than those with single chronic health conditions, particularly prescription drugs and inpatient health care services (Thorpe, 2006). So, the average healthcare expenditures for patients with more chronic conditions are higher than for patients with fewer chronic conditions (Lochner, 2013). Therefore, comprehensive and coordinated care of PCMH might have more benefits financially for patients who have more chronic conditions than patients who have fewer chronic conditions.

The effect of PCMH on healthcare costs was assessed in different studies from the payer, healthcare organizations, and providers' perspectives. The research from the patients' perspective showed a reduction in medical costs for adult patients who received care from practices with full implementation of the PCMH model (Paustian, 2014). Another study among hypertensive patients who received care from a PCMH showed less healthcare expenditures than those who received care from non-PCMH practices (Almalki, 2018). One limitation of these prior studies is that they are based on one or two organizations, and so it is unclear how generalizable these results are to PCMHs more broadly. Lin et al. did not find a difference in healthcare expenditures among children with special healthcare needs who received care from PCMH and non-PCMH practices; this study did not include the adult population (2018). The

study by Paustian et al. showed a significant reduction in the practice-level cost measure in PCMH practices, however, it did not consider patient healthcare expenditures (2014). Since we focus on the number of the attributions of the PCMH model of care, whether certified or not, throughout this paper, we will call the practices with any number of PCMH attributes "patient-centered" practices. To fill the knowledge gaps, we intend to examine the association of the patient-centered practices with total healthcare expenditures among adults in a nationally representative database. We also examine the effect of the patient-centered practices on expenditures among people with multiple chronic conditions to add more information about the effects of the patient-centered practices to the previous research.

Research Question 1

Are patient-centered practices associated with lower health care expenditures?

Hypothesis

Individuals 18 years and older who receive care from practices with high and medium patient-centered attributes are more likely to be low healthcare spenders relative to patients who seek care from practices with low patient-centered attributes.

Research Question 2

What is the association of the patient-centered practices with healthcare expenditures among people with multiple chronic conditions?

Hypothesis

The association of patient-centered practices with lower expenditures will be greater for adults with multiple chronic conditions relative to people with 0-2 chronic conditions.

Significance of the Policy

Information about healthcare costs in patient-centered practices is essential for practices to make an informed decision whether to adopt the PCMH. Policymakers might incentivize healthcare organizations to become PCMH certified if the evidence shows patient-centeredness reduces the healthcare expenditures.

4.2. Conceptual Framework

We use the hybrid model of Anderson and Donabedian conceptual framework to explain how the patient-centered practices lead to lower healthcare expenditure (Figure 10). The structural characteristics of patient-centered practices, such as participation in ACOs or capitation payment method, could affect an individuals' healthcare expenditure. The patient-centered practices that participate in ACOs tend to improve health care efficiency as an alternative payment model that places spending for all services under a global budget with incentives to stay under the budget and improve quality measures. This approach has been associated with lower overall healthcare spending (Modi, 2020). Another payment reform that aimed to reduce healthcare expenditures was capitation. Healthcare providers receive a fixed per person (or "capitated") payment that covers all health care services over a defined time period, adjusted for each patient's expected needs, and are also held accountable for high-quality outcomes. It is the only payment system that fully aligns with providers' financial incentives, intending to eliminate all major categories of waste (James, 2016).

The patient-centered practices implement a set of "processes" for the purpose of delivering efficient and effective care to the patients. One of the processes of the patient-centered practices that facilitate the optimal outcome is organized team-based care, which is the provision of health services to patients by at least two health providers including primary care provider, nurse practitioner, physician assistant, or specialist who work collaboratively with patients

(Schottenfeld, 2016). Patients of patient-centered practices are reminded by a routine reminder system for preventive services, immunization, chronic or acute conditions follow-ups, and missed visits (Smith, 2016). Patient centeredness provides access to clinical and document advice 24/7, appointments outside normal business hours, same-day appointments, helps patients choose a clinician, and patient assessments are facilitated by their designated clinician/care team and supported by access to their medical record (Palmer, 2021). Care management and patient support as a component of patient-centered practices is designed to assist patients and their support systems in managing medical conditions more effectively. To manage care, patient-centered practices incorporate patients' preferences and functional goals, identify treatment goals, and assess and address potential barriers to meeting goals (SIPH, 2021; Amerihealth, 2021). Finally, patient-centered practices establish a culture of data-driven performance improvement on clinical quality, efficiency, and patient experience and engage staff and patients/families/caregivers in quality improvement activities, such as providing report cards on the performance of their health care providers for the betterment of the care quality (Foster, 2021).

The Anderson framework describes how population characteristics (e.g., predisposing, enabling, and needs factors) affect healthcare expenditures. Predisposing factors include social structures (e.g., education and employment) and demographic factors (e.g., age, gender, and race/ethnicity) that could affect healthcare expenditures (Huang, 2019; Lee, 2018). Enabling factors, such as income and health insurance, might change an individuals' healthcare expenditures through the access to healthcare at the right time and in the right place (Magge, 2013). The needs factor indicator is the number of chronic diseases for the portion of our study

where we examine the correlation between receiving care from a patient-centered practice and the resulting healthcare expenditure, across the different number of chronic diseases.

4.3. Methods

Data source

We used the Medical Expenditure Panel Survey-Household Component (MEPS-HC) and Medical Organization Survey (MOS) supported by the Agency for Healthcare Research and Quality (AHRQ). MEPS-HC is a representative survey of the United States population conducted annually, including detailed information on health care utilization, expenditures, and health insurance coverage. The MOS was conducted as part of MEPS in 2015 and 2016 to obtain more detailed information on the organization of the practices of office-based care providers identified as the usual source of care in the MEPS-HC and seen by the HC respondent. The survey obtained the name and location of the usual source of care from MEPS respondents with their permission (MEPS, 2022a; MEPS, 2022b). Then, a subsample of the providers based on the usual sources of care was selected and administered the MOS questionnaire. The information on the office-based health care providers on the MOS questionnaire includes patient-centered attributes and certification status. The cumulative response rate for the full-year household component and the MOS was 36.7% in 2015 and 35.0% in 2016 (ARHQ, 2020).

The data are structured at the patient level, with an average of 1.7 patients per provider surveyed in 2015, where a total of 4,216 practices were surveyed, corresponding to 7,161 individuals (MEPS, 2022a; MEPS, 2022b). In 2016, the final analytic sample size was 9,137 persons across 5,201 unique responding practices (average of 1.8 sample persons per practice). Data from the MOS is linked to MEPS household survey respondents, permitting person-level

analysis for the subset of MEPS respondents included in the MOS. A special weight variable was developed for use with the linked MOS-household survey data.

Inclusion Criteria for Sample

Individuals 18 years and older who had a usual source of care were included in this study.

Exclusion Criteria for Sample

Individuals who had 10 and more chronic diseases excluded because the proportion of these individual in the sample was 0.01 percent and their health care expenditures were significantly different from individuals with 3-9 chronic diseases (Williams, 2016). See section "Analytical method to find the cutoff point for categorizing chronic diseases" for more on this below.

Variables

Independent Variables

The main independent variable is the measure of attributes for patient-centered practices. The definition of patient-centered practice used in this paper is the same as in chapter 2. The MOS questions related to each patient-centered attribute are shown in Table 1 of chapter 2. We created the same categorical variable as in chapter 2, based on modified tertiles representing practices displaying high, medium, or low patient-centered attributes, so that low patient-centered attributes had 0-5, medium patient-centered attributes had 6-8, and high patient-centered attributes had 9 or 10 attributes. In total, there were 838 individuals who received care from low patient-centered practices, which reported having 0-5 attributes; 2,742 individuals received care from practices with 6-8 patient-centered attributes; and 2,421 individuals received care from practices with 9 or 10 patient-centered attributes. We also identified groupings of attributes through a factor analysis, which is described in detail in the Appendix C. However, we

based our analysis on the direct measure of the number of patient-centered attributes since we hypothesized practices that have more widespread adoption of patient-centered attributes are more likely to be associated with less healthcare expenditures (details of the factor analysis method and results were described in the Appendix C).

Another independent variable is the number of chronic diseases per individual. In the MEPS-HC data set, participants were asked whether they were diagnosed with chronic diseases, including hypertension, coronary heart diseases, angina or angina pectoris, heart attack or myocardial infarction, other kinds of heart disease or condition, stroke, emphysema, chronic bronchitis, hypercholesterolemia, colon cancer, breast cancer, prostate cancer, diabetes, arthritis, and asthma (Higashi, 2007). We also included obesity, defined as BMI 30 and above, as a chronic condition. These chronic diseases reflect "high priority" conditions for the Agency for Healthcare Research and Quality (ARHQ), in part because of their impact on healthcare cost (Berkman, 2021). We summed these chronic conditions, which resulted in a range of values between 0-16. We created another binary variable equal to 1 for individuals with three to nine chronic diseases (excluding individuals with more than 9 chronic diseases) and equal to 0 for individuals with fewer than three chronic conditions (Nguyen, 2019).

Analytical Method to Find the Cutoff Point for Categorizing Chronic Diseases. To determine the cut point for categorizing chronic diseases in two groups of 0-2 chronic diseases and 3-9 chronic diseases, we first tested whether parameters of having 1 and 2 chronic diseases are equal to 0 (i.e., no different from 0 chronic diseases) with an F-statistic. The F-statistic failed to reject the null hypothesis, so we grouped individuals with 0, 1, and 2 chronic diseases into one category. Then, we estimated a restricted model (see statistical model blow) with a count variable for individuals with chronic diseases greater than 2, which showed the 0.2672 change in

ln(expenditure) per chronic disease exceeding 2. In the next step, we tested the restriction of the model imposed on the unrestricted model. For this purpose, we tested the difference between the estimate of each variable of binary chronic diseases more than 3 (with the reference group of 0-2 chronic diseases) and 0.2672 from the restricted model. We found the significance of changes in ln(expenditure) while the number of chronic diseases increases in individuals. The p-value of the differences' estimates showed that the restrictions are only untenable for individuals with 10 or more chronic diseases. Since we have a small number of individuals in these categories (0.3% of the total included population), we excluded them and re-estimated the unrestricted model (Williams, 2016).

In the re-estimated model, we failed to reject the null hypothesis that there were no differences between the estimate of binary variables of chronic diseases (more than 3 and less than 10) and the change in ln(expenditure) per chronic disease exceeding 2. Therefore, with the increase in chronic diseases from 3 to 9 in individuals, the ln(expenditure) did not change significantly. So, we grouped all individuals with 3 and 9 chronic diseases into one category.

Dependent Variables

The MEPS measures total medical expenditures by the dollar value, measured by the variable "TOTEXPY," which refers to personal healthcare expenditures that reflect total payments for all health care services used, including payments by third-party payers as well as out-of-pocket payments. We use this variable as a continuous variable after taking the logarithm of the healthcare expenditure. We used the logarithm of total expenditure, instead of the monetary value, because the total expenditure was left-skewed (i.e., people spending disproportionately low amounts on healthcare pulls the mean much lower than the median). Using log expenditure also ameliorates heteroskedasticity.

Covariates. We controlled for practice characteristics, including capitation and ACO participation. Capitation and ACO are categorized as "Yes," "No," and "Unknown," and almost one-third of patient-centered practices were grouped as unknown status for capitation or ACO. We also controlled for individual characteristics, including age, gender, race/ethnicity, marital status, family income, insurance status, and education. We included age as a continuous variable and age squared to find the non-linear correlation between age and healthcare expenditure. Race/ethnicity subpopulations were categorized into five groups: (a) Hispanic, (b) non-Hispanic White, (c) non-Hispanic Black, (d) non-Hispanic Asian, and (e) non-Hispanic other race or multiple races. We categorized marital status into three groups: (a) married, (b) widowed/divorced/separated, and (c) never married. Income was left-skewed because our sample population made disproportionately low amounts of income, which pulled the mean much lower than the median. Using log income also lowers the impact of heteroskedasticity. Education was categorized into six groups: (a) less than high school, (b) high school, (c) 1-3 years of college, (d) 4 years of college, (e) 5 or more years of college, and (f) inapplicable/refused and unknown.

Data Missing

Preliminary descriptive analyses showed missing values up to 13% in patient-centered attributes; the highest missing rates of PCMH attributes were the "clinical quality of care individually provided to physicians" and "preventive care reminders" with 13% and 12% missing rates, respectively. We found that the missing rates for covariates varied from 22% in education, 32% in ACO, and 29% in capitation payment method. In order to retain the greatest power and maximize the use of information, all these variables with missing covariates were imputed using multiple imputations by chained equations (MICE), including all covariates used in final models (details of the MICE method are described in the Appendix).

Statistical Analysis

We estimated the association between healthcare expenditures and patient-centered attributes/patient-centered category in an OLS regression model. We also tested the association between patient-centered practices and healthcare expenditures among individuals with 0-2 chronic diseases relative to individuals with 3-9 chronic diseases using an interaction term.

The unit of analysis was the individual in all the statistical models. Because of the complex sampling design, we used survey weights in all the analyses. Standard errors used for tests of statistical significance account for the complex survey design. We defined all statistical significance as $p<0.05$ and used Stata version 13 for all analyses.

Statistical Model for Research Question 1

$$\text{log transformed (healthcare expenditure)} = \beta_0 + \beta_1(\text{patient-centered category})_{it} + \beta_2(\text{education})_{it} + \beta_3(\text{income})_{it} + \beta_4(\text{race/ethnicity})_{it} + \beta_5(\text{marital status})_{it} + B_7(\text{age})_{it} + \beta_7(\text{age}^2)_{it} + \beta_8(\text{number of chronic conditions})_{it} + \beta_9(\text{insurance})_{it} + \beta_{10}(\text{ACO})_{it} + \beta_{11}(\text{capitation})_{it} + u_{it}$$

We ran the OLS regression model in the pooled data of 2015 and 2016 to estimate the percentage change in healthcare expenditure where $100*\beta_1$ indicates the approximate percentage change in healthcare expenditures among individuals who receive care from practices with high and medium patient-centered attributes compared to individuals who received care from practices with low patient-centered attributes.

Statistical Model for Research Question 2

$$\text{Log transformed (healthcare expenditure)} = \beta_0 + \beta_1(\text{patient-centered categories})_{it} + \beta_2(\text{number of chronic conditions})_{it} + \beta_3(\text{patient-centered category}_{it} * \text{number of chronic conditions})_{it} + \beta_4(\text{education})_{it} + \beta_5(\text{log of family income})_{it} + \beta_6(\text{race/ethnicity})_{it} + \beta_7(\text{marital status})_{it} + \beta_8(\text{age})_{it} + \beta_9(\text{age}^2)_{it} + \beta_{10}(\text{insurance}) + \beta_{11}(\text{ACO})_{it} + \beta_{12}(\text{capitation})_{it}$$

This is a regression OLS model where healthcare expenditure indicates the estimate of the percentage change in medical expenditures, capturing the effect of the patient-centered practices

moderated by the individuals with 3-9 chronic diseases compared to individuals with less than 3 chronic diseases.

We applied the Duan Smearing estimate to transfer predicted ln expenditures to monetary value of expenditures (Duan, 1983).

Sensitivity Analysis

We performed two sensitivity analyses for the association between patient-centered practices and healthcare expenditures, where the patient-centered practices were categorized in different ways. We also performed sensitivity analyses to confirm the effect of the patient-centered practices on healthcare expenditures among individuals with 0-2 chronic diseases relative to individuals with 3-9 chronic diseases using the patient-centered practices as a categorical variable by re-classifying patient-centered practices into 3 different sets of categories as below:

1) Practices with low (0-3), medium (4-7), and high (8-10) patient-centered attributes

2) Practices with low (0-4), medium (5-7), and high (8-10) patient-centered attributes

3) Practices with low (0-6), medium (7-8), and high (9-10) patient-centered attributes

In the second sensitivity analysis, OLS (model below) estimates the continuous percentage change in healthcare expenditures where $100*\beta_1$ indicates the approximate percentage change in healthcare expenditures associated with each patient-centered attribute, including the presence of a primary care provider, nurse practitioner, physician assistant or case manager; multiple specialty practices; follow-up with patients discharged from a hospital within 48 hours; reserved time for same-day appointments; preventive care reminders; use of EHRs to communicate with patients, decision or population management support; and provider report

cards, compared to individuals who receive care from practices without patient-centered attributes.

$$\text{log transformed (healthcare expenditure)} = \beta_0 + \beta_1(\text{10 patient-centered attributes})_{it} + \beta_2(\text{education})_{it} + \beta_3(\text{income})_{it} + \beta_4(\text{race/ethnicity})_{it} + \beta_5(\text{marital status})_{it} + B_6(\text{age})_{it} + \beta_7(\text{age}^2)_{it} + \beta_8(\text{number of chronic conditions})_{it} + \beta_9(\text{insurance})_{it} + \beta_{10}(\text{ACO})_{it} + \beta_{11}(\text{capitation})_{it} + u_{it}$$

4.4. Results

In our study, the unweighted sample size was 5,611, reflecting the weighted 50,169,640 individuals. Table 13 shows that most our sample were female (53%), White (70%), married (57%), had 3-9 chronic diseases (69%), were not employed (57%), and had some type of private insurance (74%). The mean age of our sample size was almost 54 years old. The mean annual family income was 68,100 dollars. There was no significant difference between population characteristics in 2015 and 2016.

Table 13 also presents the percent of the sample who received health care from practices with patient-centered attributes. Patient-centered practices were categorized based on the patient-centered attributes (low, medium, or high) and the payment model (ACO or capitation). Among the included individuals, 96% received care from practices with primary care providers, 76% received care from practices with either a physician assistant or nurse practitioner, 55% received care from practices with a case manager, 59% received care from practices without a specialist, 74% received care from practices that follow-up with patients within 48 hours after hospital discharge, 95% received care from practices that have same-day appointments, 78% received care from practices that use HER/EMR to exchange secure messages with patients, 82% received care from practices that use EHRs for decision supports and sending preventive care reminders, 91% received care from practices that send preventive care reminders to patients (without using

EHRs), and 91% received care from practices that report the quality of care to their healthcare providers.

The OLS regression model of the association between health care expenditures and patient-centered practices did not show significant differences in health care expenditures among individuals who receive care from practices with high and medium patient-centered attributes compared to individuals who received care from practices with low patient-centered attributes (Table 13). However, moderating the model with the number of chronic diseases showed that adults with 3-9 chronic diseases who received care from practices with high patient-centered attributes spent 52% (95% CI [-0.85-(-0.19)]; p-value<0.01) less on health care than individuals with less than 3 chronic diseases who received care from practices with low patient-centered attributes, and these findings were statistically significant. Furthermore, although this is not statistically significant, our results showed that individuals with 3-9 chronic diseases who received care from practices with medium patient-centered attributes spent less on health care expenditure by 31% compared to individuals with less than 3 chronic diseases who received care from practices with low patient-centered attributes (Table 13). Health care expenditure was positively correlated with the number of chronic diseases in both OLS regression models, including regressions with and without using the interaction terms of patient-centered category and number of chronic diseases. So, individuals who had 3-9 chronic diseases spent more on health care by 112% (95% CI [0.81-1.43]; p-value<0.001) than individuals with 0-2 chronic diseases in our moderation model (Table 14). The other factors that are significantly associated with health care expenditures were age, race, education level, employment status, and the type of health insurance.

Table 15 shows the predicted margins of the association of patient-centered category with healthcare expenditure by the number of chronic diseases. Assuming the value of all covariates at means, individuals with less than 3 chronic diseases who received care from practices with low patient-centered attributes spend $3,796 on average on healthcare annually compared to $4,826 and $5,778 for individuals who received care from practices with medium and high patient-centered attributes, respectively. There is a downward trend of healthcare expenditures for individuals with 3-9 chronic diseases who received care from practices with low to high patient-centered attributes. Individuals with 3-9 chronic diseases spend on average $11,633, $10,739, and $10,423 annually when they received care from practices with low, medium, and high patient-centered attributes, respectively. These results show individuals with 3-9 chronic diseases spend almost $1,210 less on average when they receive care from practices with high relative to low patient-centered attributes.

Sensitivity Analysis

After reclassifying into sets of attributes of patient-centered categories, the results of the sensitivity analyses did not change the main result showing the percentage change trend in healthcare expenditures among individuals who received care from practices with high and medium patient-centered attributes compared to individuals who received care from practices with low patient-centered attributes.

The OLS regression model of the correlation between healthcare expenditures and patient-centered attributes suggested that health care expenditures were associated with a 20% (95% CI [-0.34-(-0.06)]; p-value<0.01) reduction among individuals who received care from practices that had a physician assistant or nurse practitioner in place compared to practices

without (Table 16). Receiving care from practices with all other patient-centered attributes did not have a statistically significant correlation with health care expenditure.

4.5. Discussion

In this study, we aimed to find the association between the patient-centered category and the total payments for all healthcare services used, including payments by third-party payers and out-of-pocket payments, among adults who had a usual source of care in 2015 and 2016. Our results showed that the total healthcare expenditures among the sample differed significantly by the number patient-centered attributes. Individuals receiving care from practices with high patient-centered attributes spent more on healthcare than individuals who received care from practices with low patient-centered attributes. Adults with the usual source of care who had 3-9 chronic diseases spent more on healthcare services. However, adults with a usual source of care and 3-9 chronic diseases who received care from practices with high patient-centered attributes spent less on healthcare services compared to adults with 3-9 chronic diseases who received care from practices with low patient-centered attributes. Our results are consistent with the previous research that showed increased access to PCMH features might impact the distribution of Medicare healthcare expenditures differently, depending on the combination of chronic health conditions (Philpot, 2016). Patients with more chronic diseases are more costly, however, receiving care from high patient-centered practices with more integral and comprehensive services reduces the redundant and unnecessary services. So, receiving care from high patient-centered practices correlated with a reduction in healthcare expenditures among individuals who are sicker. However, patients with fewer chronic diseases show the opposite, so that they expend more on healthcare services when they receive care from practices with high patient-centered attributes. One reason could be that the patients who initially present with fewer chronic diseases

eventually become sick and begin receiving more comprehensive care at patient-centered practices to be evaluated for their conditions. Indeed, to be diagnosed with chronic diseases requires diagnostic tests. However, once diagnosed the expenditure trends were reversed. Patient-centered practices as a model of care delivery are beneficial in the healthcare system, because they improve the patient's experience of care, improve the health of populations, and reduce or control the costs of healthcare.

4.6. Limitations

Our study had some limitations. First, it is possible that the patient-centered practice variable is an endogenous variable as adults with more chronic diseases tend to seek more comprehensive healthcare, such as from a patient-centered practice. Although we cannot discount the possibility of some selection bias in this analysis, patients are not usually aware of the characteristics of the care model to choose one over another as their source of care. Research shows the first five reasons influencing patients' decisions when selecting a healthcare provider are the organizations' reputation, the physicians' reputation, being in the insurance provider's network, appointment availability, and referral from other healthcare providers (Abraham, 2011). Second, because of the cross-sectional nature of the data, there was a limited ability to make causal inferences. Third, although the whole sample of the MEPS data was drawn randomly, we should be cautious of a potential bias to select individuals based on their usual source of care and their permission to contact their practices. However, the expenditure data in MEPS is partially validated and corrected through a Medical Provider Survey. Distinct from MOS, the MPS contacts the providers of sampled members for the purposes of validating and sourcing missing data on healthcare expenditures.

4.7. Conclusion

Practices with high patient-centered attributes were associated with higher expenditures for all healthcare services used, including payments by third-party payers and out-of-pocket payments, among adults who had the usual source of care in 2015 and 2016. However, the practices with high patient-centered attributes were associated with lower healthcare expenditures for adults with multiple chronic diseases, relative to individuals with fewer chronic diseases.

Figures and Tables

Figure 10

Conceptual Framework of the Association Between Healthcare Expenditures and Patient-Centered Practices

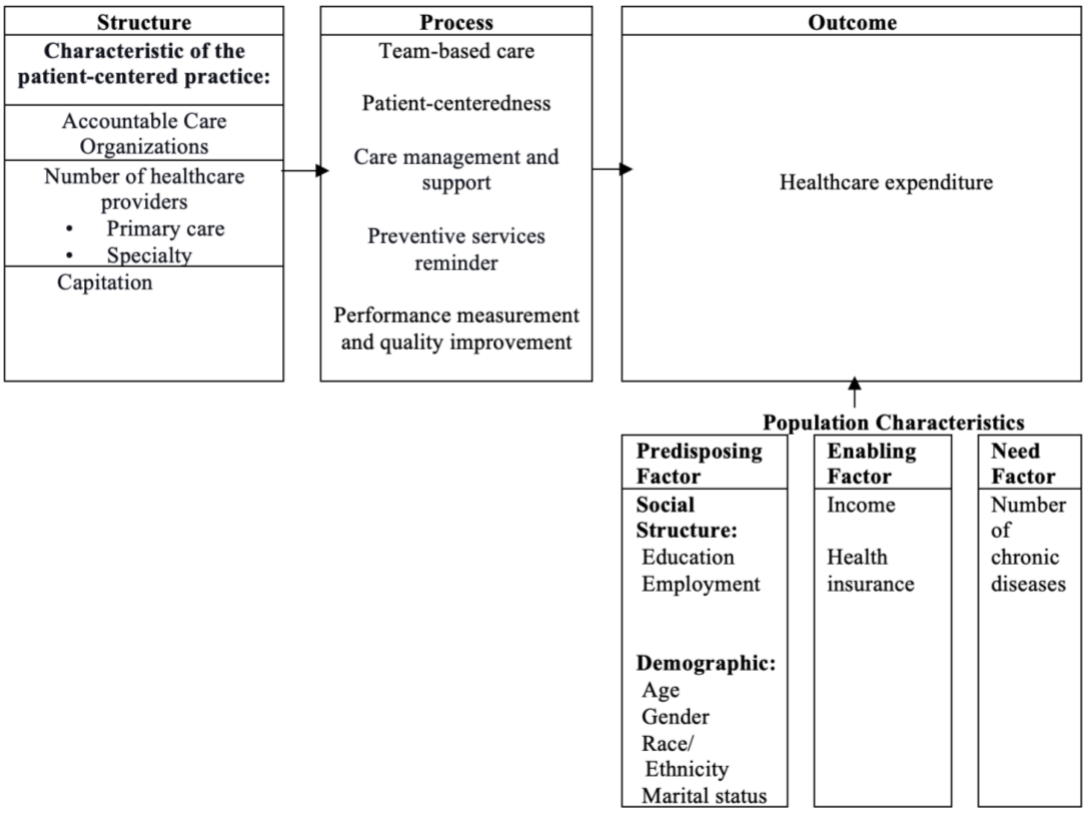


Table 13

Individuals and Providers' Characteristics
(N=5611, Weighted N= 50169640)

Individuals' characteristics	**Total**	**Practices' characteristics**	**Total**
Healthcare expenditure (mean, min-max)	11217 (0-423121)	**Patient-centered Category**	
Log Healthcare expenditure (mean, min-max)	8.4	Low	13.1%
Age (mean, min-max)	61.82 (18-85)	Medium	43.9%
Sex		High	43.0%
Female	53.2%	**ACO**	
Male	46.8%	Yes	67.9%
Race		No	32.1%
White	68.8%	**Capitation**	
Hispanic	10.9%	Yes	47.7%
Black	13.5%	No	52.3%
Asian	3.9%	**Primary Care Physician (PCP)**	
Other race or multiple race	2.9%	Has PCP	95.9%
Education		Not have PCP	4.1%
Less than high school	49.1%	**Physician Assistant/Nurse Practitioner (PA/NP)**	
High school	6.5%	Has PA/NP	76.1%
1-3 years of college	15.9%	Not have PA/NP	23.9%
4 years of college	15.5%	**Case manager**	
5 or more years of college	12.9%	Has case manager	54..9%
Marital Status		Not have case manager	45.1%
Married	56.9%	**Specialty**	
Widowed/Divorced/Separated	31.6%	Has specialty	41.2%
Never married	11.5%	Not have specialty	58.8%
Number of Chronic Diseases		**Check-in within hours after hospital discharge**	
0-2	30.7%	Yes	73.6%
3-9	69.3%	No	26.4%
Employment Status		**Same-day appointment**	
Employed/has job to return	43.1%	Yes	95.1%
Not employed	56.9%	No	4.9%
Insurance		**HER/EMR exchange secure messages**	
Private insurance	63.7%	Yes	77.6%
Public insurance	32.9%	No	22.4%
Uninsured	3.4%	**EHRs for decision support**	
Family income in thousands (mean, min-max)	68.1 (-18.1-582.8)	Yes	81.6%
		No	18.4%
Log Family income (mean, min-max)	10.6 (0.1-13.3)	**Send preventive care reminders to patient**	
		No	9.2%
		Yes	90.8%
		Reports to physician on clinical quality of care	
		Yes	91.4%
		No	8.6%

Table 14

OLS Regression Analysis of Patient-Centered Categories and Natural Log of Total Healthcare Expenditures

(N=5611, Weighted N=50169640)

	Log of total healthcare expenditure	**95% CI**	**Log of total healthcare expenditure**	**95% CI**
Patient-centered Categories				
Low	Ref		Ref	
Medium	0.02	-0.15-0.18	0.23	-0.06-0.53
High	0.04	-0.14-0.23	0.40**	0.11-0.70
Number of Chronic Diseases				
0-2	Ref		Ref	
3-9	0.8***	0.64-0.87	1.12***	0.81-1.43
Patient-centered Categories *Number of chronic diseases				
Low *0-2 chronic diseases	-		Ref	
Medium *3-9 chronic diseases	-		-0.31	0.67-0.05
High *3-9 chronic diseases	-		-0.52**	-0.85-(-0.19)
Age	0.04**	0.01-0.06	0.04**	0.01-0.06
Age Squared	-0.0*	-0.0-(-0.0)	-0.0*	-0.0-(-0.0)
Sex				
Male	Ref		Ref	
Female	0.06	-0.05-0.17	0.06	-0.05-0.17
Race				
White	Ref		Ref	
Hispanic	-0.37***	-0.52-(-0.21)	-0.36***	-0.51-(-0.21)
Black	-0.38***	-0.52-(-0.25)	-0.39***	-0.52-(-0.26)
Asian	-0.56***	-0.78-(-0.34)	-0.56***	-0.78-(-0.34)
Other race or multiple race	-0.08	-0.33-0.17	-0.09	-0.34-0.17
Education				
Less than high school	Ref		Ref	
High school diploma or GED	0.13	-0.11-0.38	0.13	-0.11-0.37
Some college or AA degrees	0.19	-0.01-0.39	0.19	-0.01-0.38
Bachelor	0.20	-0.0-0.40	0.19	-0.01-0.39
Masters' and above	0.33**	0.12-0.54	0.33**	0.12-0.53
Marital Status				
Married	Ref		Ref	
Widowed/Divorced/Separated	0.05	-0.07-0.16	0.06	-0.06-0.17
Never married	0.01	-0.17-0.19	0.01	-0.17-0.19
Employment				
Not employed	Ref		Ref	
Employed/has job to return	-0.48***	-0.63-(-0.34)	-0.48***	-0.63-(-0.34)
Insurance				

Uninsured	Ref		Ref	
Private insurance	0.82***	(0.55-1.09)	0.82***	(0.55-1.08)
Public	0.89***	(0.61-1.17)	0.89***	(0.61-1.17)
Log Family Income	0.00	-0.03-0.04	0.00	-0.03-0.04
ACO				
No	Ref		Ref	
Yes	0.06	-0.07-0.19	0.06	-0.07-0.18
Capitation				
No	Ref		Ref	
Yes	-0.10	-0.21-0.02	-0.10	-0.21-0.02

*P-value<0.05
**P-value <0.01
***P-value<0.001

Table 15

Monetary Value of the Effect of Patient-Centeredness on Healthcare Expenditures by the Number of Chronic Diseases Adjusted with Duan Smearing Estimate

	Low-level PCMH	**Medium-level PCMH**	**High-level PCMH**
Number of Chronic Diseases			
0-2	$3796*** ($2927-$4973)	$4826*** ($4195-$5551)	$5778*** ($5023-$6514)
3-9	$11, 6335*** ($9914-$13929)	$10,739*** ($9914-$11,829)	$10,423*** ($9431-$11,635)

Table 16

OLS Regression Analysis Between Patient-Centered Attributes and Natural Log of Total Healthcare Expenditures
(N=5611, Weighted N=50169640)

	Log of total healthcare expenditure	**95% Confidence Interval**
Patient-centered Attributes		
Primary Care Physician(PCP)		
Not have PCP	Ref	
Has PCP	-0.24	-0.50-0.02
Physician Assistant/ Nurse Practitioner (PA/NP)		
Not have PA/NP	Ref	
Has PA/NP	-0.20**	-0.34-(-0.06)
Case manager		
Not have case manager	Ref	
Has case manager	-0.04	-0.15-0.07
Specialty		
Not have Specialty	Ref	
Has specialty	0.09	-0.01-0.20
Check-in within hours after hospital discharge		
No	Ref	
Yes	0.11	-0.01-0.23
Same-day appointment		
No	Ref	
Yes	0.18	-0.04-0.40
HER/EMR exchange secure messages		
No	Ref	
Yes	0.10	-0.03-0.24
EHRs for decision support		
No	Ref	
Yes	0.07	-0.07-0.22
Send preventive care reminder to patient		
No	Ref	
Yes	-0.03	-0.22-0.16
Reports to physician on clinical quality of care		
No	Ref	
Yes	-0.13	-0.32-0.05

Chapter 5

Conclusion

In this dissertation, we examined whether coverage expansion and patient-centeredness care delivery improve patient health outcomes and care quality. Although policies are regulated to improve health outcomes and quality, there are still some barriers preventing patients from realizing the full benefits of some policies and programs. Policymakers should be aware of the impacts on and correlation of particular programs and policies, health outcomes, and quality of care in different populations and subpopulations to address potential barriers to improving patient outcomes. Current policies in Virginia (e.g., ARTS that was implemented in April 2017) improve behavioral healthcare delivery, and furthermore Medicaid expansion implemented in 2019 enhances the access to care by providing health insurance for the uninsured or underinsured population with incomes under 138% FPL.

We measure the number of hospitalizations as a measure of health outcomes for mental illnesses and/or SUD/OUD, which are among the prevalent and costly conditions both nationwide and in Virginia. Comparing Virginia with North Carolina as a control group that did not implement similar policies to address mental health and SUD/OUD issues, the ARTS implementation showed a reduction in the number of hospitalizations for mental illness and SUD/OUD. The reduction in behavioral health admissions after ARTS was offset by increased hospitalizations after Medicaid expansion, perhaps due to pent-up demand for behavioral health services among newly enrolled members who were previously uninsured. The significant effect of the ARTS program in high-median household income counties shows the contribution of the availability of healthcare services in the effect of this program.

Patient-centered practices are a method of care delivery and healthcare integrity that improve the patient's experience of care, improve the health of populations, and reduce or control healthcare costs. Patient-centered practices allow the primary care physician and the patient to be in the center of the healthcare system, to know what is going on, and help the patient be in control of their health (Health Advantage, 2022). Cardiovascular-related preventive care is among the quality care services to prevent cardiovascular events in medically high-risk populations. Although patient-centered practices improve health care quality, we could not find any correlation between this model of care and a higher probability of receiving preventive care and recommendations. We catagorized patient-centered practices into three sets (low, medium, and high) based on the number of patient-centered attributes. None of the three categories of patient-centered practices was associated with the probability of receiving cardiovascular preventive services or recommendations in any race/ethnicity subpopulation. Other research is needed to examine the reliability of this measure of patient-centered practices.

Although our results did not show a significant correlation between the patient-centered model of care and cardiovascular preventive care in medically ill patients, patient-centered practices correlated with other quality care measures. We found a reduction in healthcare expenditures among individuals with three or more chronic diseases when they received care from practices with a high number of patient-centered attributes. These results confirmed that comprehensive care reduces the healthcare system’s waste and improves the quality of care. More research is warranted to elucidate the impacts of patient-centered care on other patients’ health outcomes and to find the most impactful patient-centered practices. With this information, policymakers can allocate additional resources to those areas, improving aspects of this model of care, and therefore improving delivery of care.

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Appendices

APPENDIX A

Table 1

List of ICD-10-CM of Mental illness, SUD, and OUD

Mental illness	F4320 F4321 F4322 F4323 F4324 F4325 F4329 F438 F439 F064 F4000 F4001 F4002 F4010 F4011 F40210 F40218 F40220 F40228 F40230 F40231 F40232 F40233 F40240 F40241F40242 F40243 F40248 F40290 F40291 F40298 F408 F409 F410 F411 F413 F418 F419 F42 F422 F423 F424 F428 F429 F430 F4310 F4311 F4312 F488 F489 R452 R453 R454 R455 R456 R457 R4581 R4582 R4583 R4584 F900 F901 F902 F908 F909 F910 F911 F912 F913 F918 F919 R460 R461 R462 R463 R464 R465 R466 R467 R4681 R4689 F630 F631 F632 F633 F6381 F6389 F639 R45850 F0630 F0631 F0632 F0633 F0634 F3010 F3011 F3012 F3013 F302 F303 F304 F308 F309 F310 F3110 F3111 F3112 F3113 F312 F3130 F3131 F3132 F314 F315 F3160 F3161 F3162 F3163 F3164 F3170 F3171 F3172 F3173 F3174 F3175 F3176 F3177 F3178 F3181 F3189 F319 F320 F321 F322 F323 F324 F325 F328 F3281 F3289 F329 F330 F331 F332 F333 F3340 F3341 F3342 F338 F339 F340 F341 F348 F3481 F3489 F349 F39 R4586 F600 F601 F602 F603 F604 F605 F606 F607 F6081 F6089 F609 F69 F060 F062 F200 F201 F202 F203 F205 F2081 F2089 F209 F21 F22 F23 F24 F250 F251 F258 F259 F28 F29 R45851 T1491 T1491XA T1491XD T1491XS T360X2A T360X2D T360X2S T361X2A T361X2D T361X2S T362X2A T362X2D T362X2S T363X2A T363X2D T363X2S T364X2A T364X2D T364X2S T365X2A T365X2D T365X2S T366X2A T366X2D T366X2S T367X2A T367X2D T367X2S T368X2A T368X2D T368X2S T3692XA T3692XD T3692XS T370X2A T370X2D T370X2S T371X2A T371X2D T371X2S T372X2A T372X2D T372X2S T373X2A T373X2D T373X2S T374X2A T374X2D T374X2S T375X2A T375X2D T375X2S T378X2A T378X2D T378X2S T3792XA T3792XD T3792XS T380X2A T380X2D T380X2S T381X2A T381X2D T381X2S T382X2AT382X2D T382X2S T383X2A T383X2D T383X2S T384X2A T384X2D T384X2S T385X2A T385X2D T385X2S T386X2A T386X2D T386X2S T387X2A T387X2D T387X2S T38802A T38802D T38802S T38812A T38812D T38812S T38892A T38892D T38892S T38902A T38902D T38902S T38992A T38992D T38992S T39012A T39012D T39012S T39092A T39092D T39092S T391X2A T391X2D T391X2S T392X2A T392X2D T392X2S T39312A T39312D T39312S T39392A T39392D T39392S T394X2A T394X2D T394X2S T398X2A T398X2D T398X2S T3992XA T3992XD T3992XS T400X2A T400X2D T400X2S T401X2A T401X2D T401X2S T402X2A T402X2D T402X2S T403X2A T403X2D T403X2S T404X2A T404X2D T404X2S T405X2A T405X2D T405X2S T40602A T40602D T40602S T40692A T40692D T40692S T407X2A T407X2D T407X2S T408X2A T408X2D T408X2S T40902A T40902D T40902S T40992A T40992D T40992S T410X2A T410X2D T410X2S T411X2A T411X2D T411X2S T41202A T41202D T41202S T41292A T41292D T41292S T413X2A T413X2D T413X2S T4142XA T4142XD T4142XS T415X2A T415X2D T415X2S T420X2A T420X2D T420X2S T421X2A T421X2D T421X2S T422X2A T422X2D T422X2S T423X2A T423X2D T423X2S T424X2A T424X2D T424X2S T425X2A T425X2D T425X2S T426X2A T426X2D T426X2S T4272XA T4272XD T4272XS T428X2A T428X2D T428X2S T43012A T43012D T43012S T43022A T43022D T43022S T431X2A T431X2D T431X2S T43202A T43202D T43202S T43212A T43212D T43212S T43222A T43222D T43222S T43292A T43292D T43292S T433X2A T433X2D T433X2S T434X2A T434X2D T434X2S T43502A T43502D T43502S T43592A T43592D T43592S T43602A T43602D T43602S T43612A T43612D T43612S T43622A T43622D T43622S T43632A T43632D T43632S T43692A T43692D T43692S T438X2A T438X2D T438X2S T4392XA T4392XD T4392XS T440X2A T440X2D T440X2S T441X2A T441X2D T441X2S T442X2A T442X2D T442X2S T443X2A T443X2D T443X2S T444X2A T444X2D T444X2S T445X2A T445X2D T445X2S T446X2A T446X2D T446X2S T447X2A T447X2D T447X2S T448X2A T448X2D T448X2S T44902A T44902D T44902S T44992A T44992D T44992S T450X2A T450X2D T450X2S T451X2A T451X2D T451X2S T452X2A T452X2D T452X2S T453X2A T453X2D T453X2S T454X2A T454X2D T454X2S T45512A T45512D T45512S T45522A T45522D T45522S T45602A T45602D T45602S T45612A T45612D T45612S T45622A T45622D T45622S T45692A T45692D T45692S T457X2A T457X2D T457X2S T458X2A T458X2D T458X2S T4592XA T4592XD T4592XS T460X2A T460X2D T460X2S T461X2A T461X2D T461X2S T462X2A T462X2D T462X2S T463X2A T463X2D T463X2S T464X2A T464X2D T464X2S T465X2A T465X2D T465X2S T466X2A T466X2D T466X2S T467X2A T467X2D T467X2S T468X2A T468X2D T468X2S T46902A T46902DT46902S T46992A T46992D T46992S T470X2A T470X2D T470X2S T471X2A T471X2D T471X2S T472X2A T472X2D T472X2S T473X2A T473X2D T473X2S T474X2A T474X2D T474X2S T475X2A T475X2D T475X2S T476X2A T476X2D T476X2S T477X2A T477X2D

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SUD and OUD	
Alcohol-related	F1010 F10120 F10121 F10129 F1014 F10150 F10151 F10159 F10180 F10181 F10182 F10188 F1019 F1020 F1021 F10220 F10221 F10229 F10230 F10231 F10232 F10239 F1024 F10250 F10251 F10259 F1026 F1027 F10280 F10281 F10282 F10288 F1029 F10920 F10921 F10929 F1094 F10950 F10951 F10959 F1096 F1097 F10980 F10981 F10982 F10988 F1099 G621 I426 K2920 K2921 K700 K7010 K7011 K702 K7030 K7031 K7040 K709 K7041 K852 K860 E244 G312 G721
Pregnancy-related alcohol	O99310 O99311 O99312 O99313 O99314 O99315 O355XX0 O355XX1 O355XX2 O355XX3 O355XX4 O355XX5 O355XX9 O99320 O99321 O99322 O99323 O99324 O99325
Opioid-related	F1110 F11120 F11121 F11122 F11129 F1114 F11150 F11151 F11159 F11181 F11182 F11188 F1119 F1120 F1121 F11220 F11221 F11222 F11229 F1123 F1124 F11250 F11251 F11259 F11281 F11282 F11288 F1129 F1190 F11920 F11921 F11922 F11929 F1193 F1194 F11950 F11951 F11959 F11981 F11982 F11988 F1199
Cannabis	F1210 F12120 F12121 F12122 F12129 F12150 F12151 F12159 F12180 F12188 F1219 F1220 F1221 F12220 F12221 F12222 F12229 F12250 F12251 F12259 F12280 F12288 F1229 F1290 F12920 F12921 F12922 F12929 F12950 F12951 F12959 F12980 F12988 F1299
Sedative, hypnotic, or anxiolytic related disorders	F1310 F13120 F13121 F13129 F1314 F13150 F13151 F13159 F13180 F13181 F13182 F13188 F1319 F1320 F1321 F13220 F13221 F13229 F13230 F13231 F13232 F13239 F1324 F13250 F13251 F13259 F1326 F1327 F13280 F13281 F13282 F13288 F1329 F1390 F13920 F13921 F13929 F13930 F13931 F13932 F13939 F1394 F13950 F13951 F13959 F1396 F1397 F13980 F13981 F13982 F13988 F1399
Cocaine related disorders	F1410 F14120 F14121 F14122 F14129 F1414 F14150 F14151 F14159 F14180 F14181 F14182 F14188 F1419 F1420 F1421 F14220 F14221 F14222 F14229 F1423 F1424 F14250 F14251 F14259 F14280 F14281 F14282 F14288 F1429 F1490 F14920 F14921 F14922 F14929 F1494 F14950 F14951 F14959 F14980 F14981 F14982 F14988 F1499
Other stimulant related disorders	F1510 F15120 F15121 F15122 F15129 F1514 F15150 F15151 F15159 F15180 F15181 F15182 F15188 F1519 F1520 F1521 F15220 F15221 F15222 F15229 F1523 F1524 F15250 F15251 F15259 F15280 F15281 F15282 F15288 F1529 F1590 F15920 F15921 F15922 F15929 F1593 F1594 F15950 F15951 F15959 F15980 F15981 F15982 F15988 F1599
Hallucinogen related disorders	F1610 F16120 F16121 F16122 F16129 F1614 F16150 F16151 F16159 F16180 F16183 F16188 F1619 F1620 F1621 F16220 F16221 F16229 F1624 F16250 F16251 F16259 F16280 F16283 F16288 F1629 F1690 F16920 F16921 F16929 F1694 F16950 F16951 F16959 F16980 F16983 F16988 F1699
Inhalant related disorders	F1810 F18120 F18121 F18129 F1814 F18150 F18151 F18159 F1817 F18180 F18188 F1819 F1820 F1821 F18220 F18221 F18229 F1824 F18250 F18251 F18259 F1827 F18280 F18288 F1829 F1890 F18920 F18921 F18929 F1894 F18950 F18951 F18959 F1897 F18980 F18988 F1899
Other psychoactive substance related disorders	F1910 F19120 F19121 F19122 F19129 F1914 F19150 F19151 F19159 F1916 F1917 F1918 F19181 F19182 F19188 F1919 F1920 F1921 F19220 F19221 F19222 F19229 F19230 F19231 F19232 F19239 F1924 F19250 F19251 F19259 F1926 F1927 F19280 F19281 F19282 F19288 F1929 F1990 F19920 F19921 F19922 F19929 F19930 F19931 F19932 F19939 F1994 F19950 F19951 F19959 F1996 F1997 F19980 F19981 F19982 F19988 F1999

APPENDIX B

Factor Analysis

We did a factor analysis to reduce the number of patient-centered attributes by describing linear combinations of the attributes. Additionally, with factor loadings for the varimax orthogonal rotation we showed how the attributes are weighted for each factor. Appendix B Table 6 shows this factor analysis. In our factor analysis, most of the variance was driven by one common factor with an eigenvalue of 1.61, and all patient-centered attributes, except having a PCP in practice and giving the same-day appointments, seem to load reasonably highly on that one factor (Appendix B Table 7). Appendix B Table 8 shows the results of factor loadings for the varimax orthogonal rotation with two patient-centered attributes, using EHRs to communicate with patients and for decision support or population management support, weighted around factor 1. Four patient-centered attributes (presence of a nurse practitioner or physician assistant, multiple specialty practices, the presence of a case manager, and preparing provider report cards) weighted around factor 2. The other patient-centered attributes include the presence of a primary care provider, following up with patients discharged from a hospital within 48 hours, reserving time for same-day appointments, and preventive care reminders weighted around factor 3. In the next set of analyses, we summarized the attributes in three variables based on the performance of patient-centered practices but not the quantity of the attributes in each patient-centered practice. Appendix B Table 8 showed that the summarized variables were based on factors of rotated factor loading results, so that the two patient-centered attributes (EHR/EMR exchange secure messages and EHRs for decision support and screening) weighted around factor 1. We created a

new variable with three categories for the purpose of this analysis (0: none of the 2 attributes exists, 1: one of the 2 attributes exists, 2: both attributes exist). Four patient-centered attributes (physician assistant, case manager, specialty, and reports to the physician on clinical quality of care) weighted around factor 2. The variable created for the analysis had four categories based on the existence of the number of these four patient-centered attributes. The last four attributes (primary care physician, check-in within hours after hospital discharge, same-day appointments, send preventive care reminder to the patient) weighted around factor 3. We made a new variable of four categories based on the number of these four patient-centered attributes (Appendix B Table 9).

Logistic regression models with the new patient-centered categorization based on factor analyses did not show any statistically significant differences in the cardiovascular-related preventive care and the patient-centered practices in the total population and in the race/ethnicity subpopulations (Appendix B Table 10 and 11)

Imputation of the Missing Data

Multiple Imputation by Chained Equations (MICE)

We used the MICE method to impute our missing values. This method generates predicted estimates for these variables through multiple regression analyses with the information on the individual's characteristics used as covariates, including age, sex, marital status, insurance status, family income, race, and employment status, to reach missing values of cardiovascular-related preventive care, patient-centered attributes, ACO, capitation status, and education (Royston, 2011; Azur, 2011). We specified ten imputations to be performed. Stata executed the specified estimation model within each of the 10 imputed datasets to obtain 10 sets of coefficients and standard errors. Stata then combined these estimates to obtain one set of

inferential statistics. We reached completed data for all variables after imputation. All reported standard errors reflect adjustments made to account for complex survey design as well as added variance due to multiple imputation methods in the statistical analysis of data.

Table 2

Correlation Between Cardiovascular-Related Preventive Care and Covariates of the Model (Odds Ratio)[1]
Unweighted sample size=8764, Weighted=81459769

ACO				
No	Ref	Ref	Ref	Ref
Yes	1.0	0.9	0.9	1.3
Capitation				
No	Ref	Ref	Ref	Ref
Yes	1.3	1.0	1.1	1.1
Age	1.1**	1.1***	1.1***	1.3***
Age Square	1.0	1.0***	1.0***	1.0***
Sex				
Male	Ref	Ref	Ref	Ref
Female	1.3	0.8**	1.0	0.6***
Race				
White	Ref	Ref	Ref	Ref
Hispanic	1.3	1.7***	1.5***	0.7*
Black	2.5***	1.4**	1.4**	1.0
Asian	1.0	1.1	1.2	0.6*
Other race or multiple races	0.8	0.8	0.8	1.1
Education				
Less than high school	Ref	Ref	Ref	Ref
High school or GED	0.9	0.9	1.0	0.9
Some college or associate degree	1.3	1.0	1.0	0.8
Bachelor	1.1	0.9	0.8	0.8
Masters' and above	2.3	1.0	0.8	0.7*
Marital Status				
Married	Ref	Ref	Ref	Ref
Widowed/ Divorced/Separated	1.2	1.0	1.0	1.1
Never married	1.0	0.9	0.9	0.8
Employment Status				
Not employed	Ref	Ref	Ref	Ref
Employed	0.7*	0.8**	0.9	0.8*
Health insurance Status				
Uninsured	Ref	Ref	Ref	Ref
Any private	2.5***	1.3	1.2	1.0
Public	1.4	1.2	1.2	1.1
Family Income in thousand	1.0	1.0	1.0	1.0
Family income in thousand squared	1.0	1.0	1.0	1.0
Year				
2015	Ref	Ref	Ref	Ref
2016	1.0	1.0	1.0	0.9

[1] The odds ratio based on the statistical model that included patient-centered attributes as independent variables

Table 3

Predicted Margins of the Correlation Between Attributes of Patient-Centered Practices and Cardiovascular-Related Preventive Cares at Mean

	BP and cholesterol check based on guideline recommendation (95% CI)	**No-fat diet recommendation (95% CI)**	**Exercise recommendation (95% CI)**	**Taking Aspirin among age>=50 (95% CI)**
Primary Care Physician (PCP)				
Not have PCP	3.9*** (3.0-4.7)	-0.1 (-0.5-0.2)	0.2 (-0.1-0.5)	-0.3 (-0.7-0.2)
Has PCP	3.8*** (3.6-4.1)	0.2*** (0.1-0.3)	0.6*** (0.5-0.6)	-0.2*** (-0.3-(-0.1))
Physician Assistant (PA)				
Not have PA	3.6*** (3.3-4.0)	0.3** (0.1-0.4)	0.6*** (0.5-0.7)	-0.2** (-0.4-(-0.1))
Has PA	3.9*** (3.6-4.1)	0.2*** (0.1-0.2)	0.5*** (0.4-0.6)	-0.2*** (-0.3-(-0.1))
Case manager				
Not have case manager	3.8*** (3.6-4.1)	0.2** (0.1-0.3)	0.6*** (0.5-0.7)	-0.2** (-0.4-(-0.1))
Has case manager	3.8*** (3.5-4.1)	0.2*** (0.1-0.3)	0.5*** (0.4-0.6)	-0.2** (-0.3-(-0.1))
Specialty				
Not a multi-specialty	3.9*** (3.7-4.2)	0.2*** (0.1-0.3)	0.6*** (0.5-0.7)	-0.2** (-0.3-(-0.1))
Multi-specialty	3.7*** (3.4-4.0)	0. 1(-0.0-0.2)	0.4*** (0.3-0.5)	-0.2** (-0.4-(-0.1))
Check-in within hours after hospital discharge				
No	3.8*** (3.4-4.2)	0.1* (0.0-0.2)	0.4*** (0.3-0.6)	-0.2* (-0.4- (-0.0))
Yes	3.9*** (3.6-4.1)	0.2*** (0.1-0.3)	0.6*** (0.5-0.6)	-0.2*** (-0.3-(-0.1))
Same-day appointment				
No	3.3*** (2.7-4.0)	0.3* (0.0-0.6)	0.6*** (0.3-0.9)	-0.2 (-0.5 -0.1)
Yes	3.9*** (3.6-4.1)	0.2*** (0.1-0.2)	0.5*** (0.5-0.6)	-0.2*** (-0.3-(-0.1))
HER/EMR exchange secure messages				
No	3.7*** (3.2-4.0)	0.2* (0.0-0.3)	0.4*** (0.3-0.6)	-0.1 (-0.3-0.0)
Yes	3.9*** (3.6-4.1)	0.2*** (0.1-0.3)	0.6*** (0.5-0.6)	-0.2*** (-0.3-(-0.1))
EHRs for decision support and screening				
No	4.0*** (3.6-4.5)	0.2 (-0.0-0.4)	0.5*** (0.4-0.7)	-0.3 * (-0.5-(-0.1))
Yes	3.8*** (3.6-4.0)	0.2*** (0.1-0.3)	0.5*** (0.5-0.6)	-0.2*** (-0.3-(-0.1))
Send preventive care reminder to patient				
No	3.7*** (3.1-4.3)	-0.0 (-0.3-0.2)	0.6*** (0.4-0.9)	-0.2 (-0.4-0.1)
Yes	3.8*** (3.6-4.1)	0.2*** (0.1-0.3)	0.5*** (0.5-0.6)	-0.2*** (-0.3-(-0.1))
Reports to physician on clinical quality of care				
No	3.8*** (3.2-4.5)	0.3* (0.0-0.6)	0.5** (0.2-0.7)	-0.3 (-0.6-0.1)
Yes	3.8*** (3.6-4.1)	0.2*** (0.1-0.2)	0.5*** (0.5-0.6)	-0.2*** (-0.3-(-0.1))

Table 4

Correlation Between Attributes of Patient-Centered Practices and Cardiovascular-Related Preventive Cares in Each Race/Ethnicity Subpopulation (Odds Ratio)

	BP and cholesterol check based on guideline recommendation			**No-fat diet recommendation**			**Exercise recommendation**			**Taking aspirin among age>=50**		
	White subpop[a]	**Hispanic subpop[b]**	**African American subpop[c,1]**	**White subpop**	**Hispanic subpop**	**African American subpop**	**White subpop**	**Hispanic subpop**	**African American subpop**	**White subpop[d]**	**Hispanic subpop[e]**	**African American subpop[f]**
Primary Care Physician (PCP)												
Not have PCP	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Has PCP	1.3 (0.5-3.3)	0.6 (0.1-2.3)	0.1*** (0.0-0.3)	1.3 (0.8-2.0)	1.1 (0.5-2.4)	2.0* (1.1-3.5)	1.3 (0.9-2.0)	0.9 (0.4-2.1)	1.9 (1.0-3.7)	1.1 (0.7-1.9)	1.1 (0.4-3.0)	1.1 (0.5-2.4)
Physician Assistant (PA)												
Not have PA	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Has PA	1.6 (1.0-2.7)	0.8 (0.4-1.4)	1.1 (0.8-1.4)	0.9 (0.7-1.1)	0.8 (0.5-1.1)	1.0 (0.7-1.5)	1.0 (0.8-1.2)	0.7 (0.4-1.0)	0.9 (0.7-1.3)	1.0 (0.8-1.3)	1.1 (0.7-1.7)	0.9 (0.6-1.4)
Case manager												
Not have case manager	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Has case manager	0.9 (0.5-1.5)	1.0 (0.6-2.0)	1.0 (0.7-1.1)	0.9 (0.8-1.1)	1.2 (0.9-1.7)	1.0 (0.8-1.4)	0.8* (0.6-0.9)	1.2 (0.8-1.7)	1.3 (1.0-1.8)	1.0 (0.8-1.3)	0.9 (0.6-1.4)	1.5 (1.0-2.2)
Specialty												
Not have specialty	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Has specialty	0.7 (0.5-1.1)	1.2 (0.7-1.8)	1.6*** (1.2-2.1)	0.8* (0.7-1.0)	1.2 (0.9-1.6)	0.9 (0.7-1.2)	0.8** (0.6-0.9)	1.3 (0.9-1.8)	1.0 (0.8-1.3)	1.0 (0.8-1.3)	0.9 (0.6-1.3)	1.1 (0.8-1.6)
Check-in within hours after hospital discharge												
No	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref

Yes	1.0 (0.6-1.8)	1.0 (0.5-2.0)	1.6*** (1.3-2.1)	1.1 (0.9-1.3)	1.0 (0.7-1.4)	0..9 (0.7-1.3)	1.2 (0.8-1.5)	1.0 (0.7-1.5)	0.9 (0.6-1.3)	1.0 (0.8-1.3)	1.0 (0.7-1.6)	1.1 (0.7-1.7)
Same-day appointment												
No	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Yes	1.0 (0.4-2.6)	1.7 (0.5-6.0)	2.9*** (1.8-4.5)	0.8 (0.6-1.2)	1.6 (1.0-2.7)	1.1 (0.5-2.1)	0.8 (0.5-1.1)	1.6 (0.9-2.8)	1.8 (0.8-4.2)	0.9 (0.6-1.4)	1.2 (0.7-2.2)	1.0 (0.5-2.0)
HER/EMR Exchange secure messages												
No	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Yes	1.1 (0.6-1.9)	1.6 (0.9-3.1)	1.3 (0.9-1.7)	1.0 (0.8-1.2)	0.9 (0.6-1.2)	1.3 (0.9-1.7)	1.1 (0.9-1.5)	1.0 (0.7-1.5)	1.4 (1.0-2.0)	1.0 (0.7-1.3)	1.0 (0.7-2.2)	0.8 (0.5-1.1)
EHRs for decision support and screening												
No	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.9 (0.5-1.8)	1.4 (0.4-1.5)	0.7* (0.5-0.9)	1.1 (0.8-1.4)	0.9 (0.6-1.3)	0.9 (0.6-1.4)	1.1 (0.8-1.4)	1.0 (0.6-1.6)	0.7 (0.4-1.0)	1.2 (0.9-1.7)	0.9 (0.5-1.5)	0.9 (0.5-1.4)
Send preventive care reminder to patient												
No	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Yes	1.0 (0.4-2.3)	0.8 (0.6-3.1)	0.8 (0.4-1.3)	1.4* (1.0-1.9)	1.4 (0.8-2.2)	0.9 (0.6-1.5)	0.9 (0.7-1.2)	1.0 (0.6-1.8)	1.0 (0.6-1.7)	1.1 (0.7-1.6)	0.8 (0.4-1.7)	0.4** (0.2-0.7)
Reports to physician on clinical quality of care												
No	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Yes	1.0 (0.4-2.3)	1.4 (0.4-1.5)	1.0 (0.7-1.6)	0.9 (0.6-1.4)	0.8 (0.5-1.3)	1.0 (0.6-1.8)	1.2 (0.8-1.8)	1.1 (0.7-2.0)	0.7 (0.4-1.3)	1.1 (0.7-1.6)	2.1* (1.0-4.4)	0.9 (0.5-1.7)

[a] sample size: 4296 Weighted: 57023260
[b] sample size: 2137 Weighted: 9641705
[c] sample size : 1649 Weighted: 9188899

[d] sample size: 3184 Weighted: 42510489
[e] sample size: 1274 Weighted: 5763090
[f] sample size: 1129 Weighted: 5960921

[1] We estimated the probability of BP/cholesterol check with unimputed data in the Black subpopulation, because the estimation of the specified model that is fitted on the Black subpopulation changed from one imputation to another which caused the estimation sample to be different between imputations; a varying estimation sample can lead to biased or less efficient estimates. As a result, -suest- cannot be done between estimations of imputed data (Hispanic and White subpopulations) and unimputed data (Black subpopulation).

Table 5

Marginal Effect of the Correlation Between Patient-Centered Attributes and Cardiovascular-Related Preventive Cares in Each Race/Ethnicity Subpopulation at Means

	BP and cholesterol check based on guideline recommendation			**No-fat diet Recommendation**			**Exercise Recommendation**			**Taking aspirin Among age>=50**		
	White subpop[a]	**Hispanic subpop[b]**	**African American subpop[c,1]**	**White subpop**	**Hispanic subpop**	**African American subpop**	**White subpop**	**Hispanic subpop**	**African American subpop**	**White subpop[d]**	**Hispanic subpop[e]**	**African American subpop[f]**
Primary Care Physician (PCP)												
Not have PCP	97.6 (95.3-100)	97.9 (95.0-100)	99.9 (99.7-100)	46.3 (35.3-57.2)	62.5 (43.7-81.2)	43.8 (29.8-57.9)	54.3 (44.3-64.3)	72.4 (56.5-88.3)	56.1 (41.1-71.1)	43.7 (31.5-55.9)	33.9 (11.5-56.4)	41.4 (21.5-61.4)
Has PCP	98.1 (97.6-98.7)	96.4 (95.1-97.8)	98.6 (98.4-98.9)	52.4 (49.9-54.9)	63.7 (60.3-67.2	60.4 (56.9-63.9)	61.2 (59.1-63.3)	71.0 (67.9-74.0)	70.9 (67.7-74.2)	46.9 (44.3-49.4)	35.7 (31.3-40.1)	42.7 (38.6-46.8)
Physician Assistant (PA)												
Not have PA	97.3 (96.1-98.5)	97.2 (95.5-98.9)	98.7 (98.3-99.1)	55.3 (50.5-60.1)	68.2 (61.4-74.9)	59.2 (51.7-66.7)	61.8 (57.4-66.3)	76.9 (71.2-82.7)	71.3 (65.4-77.2)	47.2 (42.6-51.8)	34.0 (24.8-43.3)	43.8 (36.4-51.2)
Has PA	98.3 (97.7-98.9)	96.3 (94.8-97.8)	98.8 (98.5-99.0)	51.3 (48.6-54.1)	62.3 (58.4-66.2)	59.9 (56.0-63.9)	60.7 (58.3-63.1)	69.1 (65.2-73.0)	70.1 (66.5-73.7)	46.6 (43.3-49.9)	36.1 (31.4-40.8)	42.2 (36.6-47.9)
Case manager												
Not have case manager	98.2 (97.5-98.9)	96.3 (94.3-98.2)	98.8 (98.5-99.1)	53.3 (49.7-57.0)	60.7 (54.9-66.5)	59.4 (54.2-64.6)	64.2 (61.1-67.4)	68.7 (63.0-74.4)	67.1 (61.5-72.6)	46.7 (42.5-50.9)	36.8 (29.9-43.8)	37.6 (30.8-44.4)
Has case manager	98.0 (97.3-98.8)	96.6 (95.2-98.1)	98.7 (98.4-99.0)	51.2 (48.2-54.2)	65.4 (61.0-69.8)	59.9 (56.0-63.9)	58.0 (55.0-61.0)	72.4 (68.6-76.2)	72.8 (69.1-76.4)	46.8 (42.8-50.9)	34.8 (28.6-41.0)	46.8 (40.6-53.1)
Specialty												
Not have specialty	98.3 (97.8-98.9)	96.4 (94.6-98.1)	98.5 (98.1-98.8)	53.9 (51.1-56.8)	61.9 (57.2-66.6)	60.6 (56.4-64.8)	63.2 (60.6-65.8)	68.6 (64.4-72.8)	70.3 (66.4-74.3)	46.8 (42.9-50.8)	37.1 (31.2-42.9)	41.7 (35.7-47.7)
Has specialty	97.7 (96.9-98.6)	96.7 (95.3-98.1)	99.0 (98.8-99.3)	49.4 (45.6-53.2)	65.6 (61.0-70.3)	58.6 (53.4-63.8)	57.2 (53.7-60.7)	73.7 (69.0-78.4)	70.5 (66.0-75.0)	46.7 (42.8-50.6)	33.8 (27.6-39.9)	44.1 (37.8-50.4)
Check-in within hours after hospital discharge												
No	98.1 (97.1-99.1)	96.5 (94.3-98.7)	98.3 (97.8-98.7)	50.6 (47.0-54.3)	63.8 (57.0-70.5)	61.3 (54.4-68.2)	57.8 (53.9-61.7)	71.0 (64.3-77.8)	72.1 (65.2-78.9)	47.1 (41.6-52.5)	34.9 (26.2-43.5)	41.2 (33.7-48.8)
Yes	98.1 (97.5-98.8)	96.5 (95.0-98.0)	98.9 (98.7-99.2)	52.7 (49.8-55.6)	63.6 (60.0-67.3)	59.2 (55.3-63.0)	62.0 (59.5-64.4)	71.0 (67.5-74.5)	69.7 (66.2-73.3)	46.7 (43.6-49.8)	35.9 (31.1-40.6)	43.2 (37.3-49.1)

Same-day appointment												
No	98.1 (96.3-100)	94.4 (87.6-100)	96.7 (95.2-98.1)	57.0 (47.9-66.1)	52.9 (40.4-65.4)	58.6 (42.5-74.7)	66.5 (58.2-74.7)	61.3 (48.6-74.0)	57.3 (37.4-77.3)	49.1 (38.1-60.1)	31.0 (19.0-43.1)	43.3 (27.8-58.9)
Yes	98.1 (97.6-98.7)	96.1 (95.3-97.9)	98.8 (98.6-99.1)	52.0 (49.5—54.5)	64.3 (61.0-67.6)	59.8 (56.2-63.4)	60.7 (58.7-62.8)	71.5 (68.5-74.6)	71.1 (68.1-74.2)	46.7 (44.0-49.3)	36.0 (31.6-40.4)	42.6 (38.2-47.0)
HER/EMR exchange secure messages												
No	98.0 (97.0-99.1)	95.0 (92.6-97.3)	98.5 (98.1-98.9)	52.9 (47.6-58.2)	66.4 (60.2-72.7)	55.3 (48.9-61.8)	58.3 (52.9-63.7)	70.5 (63.3-77.8)	64.4 (57.9-71.0)	47.5 (41.0-54.0)	35.9 (28.5-43.3)	48.3 (38.9-57.6)
Yes	98.2 (97.6-98.8)	97.0 (95.6-98.4)	98.8 (98.6-99.1)	52.0 (49.2-54.8)	62.6 (58.5-66.7)	61.0 (56.9-65.0)	61.6 (59.1-64.1)	71.2 (67.9-74.5)	71.9 (68.2-75.7)	46.6 (43.4-49.8)	35.5 (30.2-40.8)	41.2 (36.7-45.6)
EHRs for decision support and screening												
No	98.2 (97.1-99.4)	97.3 (95.3-99.3)	99.1 (98.8-99.4)	50.9 (44.5-57.2)	66.3 (58.5-74.2)	61.5 (52.8-70.2)	59.5 (53.4-665.6)	71.4 (63.3-79.5)	77.1 (69.8-84.4)	43.1 (35.7-50.5)	37.6 (27.4-47.7)	45.8 (34.8-56.9)
Yes	98.1 (97.5-98.7)	96.3 (94.9-97.8)	98.7 (98.5-99.0)	52.5 (49.8-55.1)	63.1 (59.1-67.0)	59.7 (56.1-63.3)	61.3 (58.9-63.6)	70.9 (67.0-74.8)	68.9 (65.7-72.1)	47.6 (44.8-50.4)	35.2 (30.2-40.1)	42.0 (37.4-46.7)
Send preventive care reminder to patient												
No	98.1 (96.7-99.6)	95.5 (92.2-98.9)	99.0 (98.5-99.6)	44.7 (38.0-51.4)	56.9 (45.6-68.2)	61.0 (50.0-72.0)	62.9 (56.6-69.2)	70.6 (59.5-81.8)	70.9 (60.8-81.1)	45.3 (36.3-54.3)	39.9 (23.9-55.8)	64.5 (52.3-76.7)
Yes	98.1 (97.5-98.7)	96.6 (95.2-98.0)	98.7 (98.5-99.0)	53.0 (50.3-55.7)	64.1 (60.8-67.4)	59.7 (56.1-63.3)	60.7 (58.5-62.9)	71.0 (68.0-74.0)	70.4 (67.1-73.6)	46.9 (44.3-49.6)	35.3 (30.9-39.8)	40.9 (36.7-45.1)
Reports to physician on clinical quality of care												
No	98.1 (96.5-99.6)	94.8 (90.6-99.1)	98.7 (98.2-99.3)	54.1 (44.3-63.9)	68.3 (58.5-78.2)	58.9 (46.9-71.0)	57.2 (48.2-66.1)	68.3 (57.2-79.5)	76.0 (66.4-85.6)	45.2 (36.4-54.1)	21.6 (10.1-33.1)	44.5 (30.7-58.3)
Yes	98.1 (97.6-98.7)	96.6 (95.3-98.0)	98.7 (98.5-99.0)	52.0 (49.4-54.6)	63.3 (59.9-66.7)	59.8 (56.1-63.5)	61.3 (59.1-63.5)	71.2 (68.0-74.4)	69.9 (66.4-73.3)	46.9 (44.2-49.7)	36.8 (32.3-41.3)	42.5 (38.1-46.8)

[a] sample size: 4296 Weighted: 57023260
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[f] sample size: 1129 Weighted: 5960921

[1] We estimated the probability of BP/cholesterol check with unimputed data in the Black subpopulation because the estimation of specified model that is fitted on the Black subpopulation changed from one imputation to another which caused the estimation sample to be different between imputations; a varying estimation sample can lead to biased or less efficient estimates.

Table 6

Factor Analysis of Patient-Centered Attributes

Factors	Eigenvalue
Factor 1	1.61
Factor 2	0.32
Factor 3	0.20
Factor 4	0.02
Factor 5	-0.00
Factor 6	-0.08
Factor 7	-0.12
Factor 8	-0.14
Factor 9	-0.19
Factor 10	-0.22

Table 7

Factor Loadings (Pattern Matrix) and Unique Variances

Variables	Factor1
Primary Care Physician (PCP)	0.14
Physician Assistant (PA)	0.34
Case manager	0.46
Specialty	0.34
Check-in within hours after hospital discharge	0.35
Same-day appointment	0.21
EHR/EMR Exchange secure messages	0.56
EHRs for decision support and screening	0.57
Send preventive care reminder to patient	0.39
Reports to physician on clinical quality of care	0.44

Table 8

Rotated Factor Loadings (Pattern Matrix) and Unique Variances

Variables	Factor 1	Factor 2	Factor 3	Uniqueness
Primary Care Physician (PCP)	−	−	0.3053	0.9056
Physician Assistant (PA)	−	0.3710	−	0.8331
Case manager	−	0.4018	−	0.7543
Specialty	−	0.4211	−	0.8085
Check-in within hours after hospital discharge	−	−	0.3490	0.8230
Same-day appointment	−	−	0.3498	0.8686
EHR/EMR Exchange secure messages	0.5422	−	−	0.6247
EHRs for decision support and screening	0.5496	−	−	0.6190
Send preventive care reminder to patient	−	−	0.2643	0.8345
Reports to physician on clinical quality of care	−	0.2844	−	0.7955

Table 9

Summarized Variables Based on Rotated Factor Results

Variables	Categories	Values
Variable 1 (HER-related)	None	0
	EHR/EMR exchange secure messages, OR EHRs for decision support and screening	1
	EHR/EMR exchange secure messages, AND EHRs for decision support and screening	2
Variable 2 (Staff-related)	None	0
	One of the attributes: Have PA, case manager, specialty, and reports to physician on clinical quality of care	1
	Two of the attributes: Have PA, case manager, specialty, and reports to physician on clinical quality of care	2
	Three of the attributes: Have PA, case manager, specialty, and reports to physician on clinical quality of care	3
	Four of the attributes: Have PA, case manager, specialty, and reports to physician on clinical quality of care	4
Variable 3 Quality-related)	None	0
	One of the attributes: Have PCP, check-in within hours after hospital discharge, same-day appointment, send preventive care reminder to patient	1
	Two of the attributes: Have PCP, check-in within hours after hospital discharge, same-day appointment, send preventive care reminder to patient	2
	Three of the attributes: Have PCP, check-in within hours after hospital discharge, same-day appointment, send preventive care reminder to patient	3
	Four of the attributes: Have PCP, check-in within hours after hospital discharge, same-day appointment, send preventive care reminder to patient	4

Table 10

Correlation Between Summarized Patient-Centered Attributes Based on Factor Analysis and Cardiovascular-Related Preventive Cares (Odds Ratio).
Unweighted sample size=8764, Weighted=81459769

	BP and cholesterol check based on guideline recommendation	**No-fat diet recommendation**	**Exercise recommendation**	**Taking aspirin among age>=50**
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Patient-centered Practices				
HER-related				
0 HER-related attributes	Ref	Ref	Ref	Ref
1 HER-related attribute	0.9 (0.6-1.3)	1.0 (0.8-1.3)	1.1 (08-1.4)	1.0 (0.7-1.4)
2 HER-related attributes	0.9 (0.6-1.3)	1.0 (0.8-1.3)	1.1 (0.9-1.5)	1.0 (0.8-1.3)
Staff-related				
0 staff-related attributes	Ref	Ref	Ref	Ref
1 staff-related attribute	0.5 (0.1-2.4)	1.1 (0.5-2.2)	1.3 (0.7-2.4)	1.1 (0.5-2.6)
2 staff-related attributes	0.5 (0.1-2.3)	1.0 (0.5-2.0)	1.2 (0.7-2.1)	1.1 (0.5-2.7)
3 staff-related attributes	0.6 (0.1-2.5)	1.0 (0.5-1.9)	1.1 (0.6-1.9)	1.2 (0.5-2.7)
4 staff-related attributes	0.5 (0.1-2.4)	0.9 (0.4-1.7)	0.9 (0.5-1.6)	1.1 (0.5-2.6)
Quality-related				
0 quality-related attributes	Ref	Ref	Ref	Ref
1 quality-related attribute	0.8 (0.1-4.7)	1.1 (0.4-3.0)	1.2 (0.5-3.2)	0.7 (0.2-2.0)
2 quality-related attributes	1.1 (0.2-5.4)	1.3 (0.5-3.3)	1.4 (0.6-3.4)	0.6 (0.2-1.4)
3 quality-related attributes	1.1 (0.2-5.1)	1.7 (0.6-4.3)	1.8 (0.7-4.6)	0.5 (0.2-1.4)
4 quality-related attributes	1.2 (0.3-5.6)	1.4 (0.6-3.4)	1.5 (0.6-3.6)	0.6 (0.2-1.4)

Table 11

Correlation Between Summarized Patient-Centered Attributes Based on Factor Analysis and Cardiovascular-Related Preventive Cares in Each Race/Ethnicity Subpopulation at Means (Odds Ratio)

	BP and cholesterol check based on guideline recommendation[1]			**No-fat diet recommendation**			**Exercise recommendation**			**Taking aspirin among age>=50**		
	White[a]	**Hispanic[b]**	**African American[c]**	**White**	**Hispanic**	**African American**	**White**	**Hispanic**	**African American**	**White[d]**	**Hispanic[e]**	**African American[f]**
Patient-centered Practices												
HER-related												
0 HER-related attributes	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
1 HER-related attribute	1.4** (1.1-1.8)	0.9 (0.7-1.1)	1.4 (1.0-2.2)	1.0 (0.7-1.3)	0.9 (0.5-1.5)	1.1 (0.7-1.7)	1.0 (0.7-1.5)	1.2 (0.7-2.1)	1.1 (0.6-1.9)	1.0 (0.7-1.5)	1.2 (1.0-1.4)	0.9 (0.4-1.7)
2 HER-related attributes	1.1 (0.9-1.3)	1.2 (1.0-1.4)	1.1 (0.8-1.5)	1.0 (0.7-1.3)	0.8 (0.5-1.1)	1.2 (0.8-1.8)	1.2 (0.9-1.6)	1.1 (0.7-1.7)	1.0 (0.7-1.6)	1.1 (0.8-1.6)	0.9 (0.8-1.1)	0.6 (0.3-1.1)
Staff-related												
0 staff-related attributes	Ref	Empty	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
1 staff-related attribute	0.3* (0.1-1.0)	1.2 (0.9-1.6)	0.2 (0.0-1.6)	1.0 (0.4-3.0)	0.4 (0.0-3.7)	1.5 (0.4-4.9)	1.5 (0.6-3.6)	0.6 (0.1-3.8)	0.9 (0.2-3.4)	1.4 (0.4-5.1)	0.2 (0.1-0.4)	0.6 (0.0-16.1)
2 staff-related attributes	0.3* (0.1-0.9)	0.9 (0.7-1.1)	0.1* (0.0-0.8)	0.9 (0.3-2.7)	0.4 (0.0-3.5)	1.0 (0.3-3.4)	1.3 (0.5-3.2)	0.5 (0.1-2.7)	0.9 (0.2-3.3)	1.6 (0.5-5.5)	0.2 (0.1-0.3)	0.6 (0.0-16.7)
3 staff-related attributes	0.3* (0.1-0.9)	1.2* (1.0-1.4)	0.1* (0.0-0.9)	0.9 (0.3-2.4)	0.4 (0.0-3.7)	1.3 (0.4-4.3)	1.2 (0.5-2.8)	0.5 (0.1-2.9)	1.0 (0.3-4.1)	1.6 (0.5-5.7)	0.2 (0.1-0.3)	0.6 (0.0-16.7)
4 staff-related attributes	0.3* (0.1-0.9)	Ref	0.2 (0.0-1.6)	0.7 (0.2-2.0)	0.5 (0.1-4.7)	1.3 (0.4-4.3)	0.9 (0.4-2.1)	0.6 (0.1-3.6)	1.2 (0.3-4.4)	1.4 (0.4-5.1)	0.2 (0.1-0.3)	0.8 (0.02-25.7)
Quality-related												
0 quality-related attributes	Ref	Ref	Empty	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
1 quality-related attribute	1.1 (0.6-1.9)	0.6 (0.1-2.5)	0.8 (0.4-1.7)	1.9 (0.5-7.2)	1.2 (0.1-14.5)	0.5 (0.1-2.2)	1.9 (0.6-6.9)	1.0 (0.1-8.9)	0.7 (0.1-3.9)	0.7(0.2-2.5)	1.0 (0.5-2.3)	1.5 (0.4-6.3)
2 quality-related attributes	1.4 (0.8-2.5)	0.7 (0.2-2.9)	0.6*** (0.5-0.8)	3.1 (0.8-11.5)	2.3 (0.2-21.1)	0.6 (0.2-2.3)	2.6 (0.7-9.0)	1.3 (0.2-10.1)	0.9 (0.2-4.2)	0.7 (0.2-2)	0.6 (0.3-1.4)	0.5 (0.1-1.4)
3 quality-related attributes	1.3 (0.7-2.4)	0.9 (0.2-4.2)	1.0 (0.6-1.7)	3.4 (0.9-12.9)	3.7 (0.3-40.1)	0.7 (0.2-2.8)	3.4 (0.9-12.5)	1.2 (0.2-10.0)	1.2 (0.2-6.5)	0.6 (0.2-2.2)	0.5 (0.2-1.1)	0.6 (0.2-2.0)
4 quality-related attributes	1.3 (0.7-2.2)	0.8 (0.2-3.6)	Ref	3.2 (0.9-11.7)	2.1 (0.2-21.5)	0.6 (0.2-2.1)	2.7 (0.8-9.4)	1.4 (0.2-10.2)	0.9 (0.2-4.5)	0.7 (0.2-2.3)	1.0 (0.5-2.0)	0.6 (0.2-1.8)

[a] sample size: 4296 Weighted: 57023260
[b] sample size: 2137 Weighted: 9641705

[c] sample size : 1649 Weighted: 9188899
[d] sample size: 3184 Weighted: 42510489
[e] sample size: 1274 Weighted: 5763090
[f] sample size: 1129 Weighted: 5960921
[1] We estimated the probability of BP/cholesterol check with unimputed data in the Black subpopulation because the estimation of a specified model that is fitted on the Black subpopulation changed from one imputation to another which caused the estimation sample to be different between imputations; a varying estimation sample can lead to biased or less efficient estimates.

APPENDIX C

Factor Analysis

We did the factor analysis to reduce the number of patient-centered attributes by describing linear combinations of the attributes. Furthermore, we did the factor loadings for the varimax orthogonal rotation to show how the attributes are weighted for each factor (Appendix C Table 12). In our factor analysis, most of the variance is driven by one common factor with the eigenvalue of 1.62, and all patient-centered attributes, except having a primary care provider in practice and giving the same-day appointments, seem to load reasonably highly on that one factor (Appendix C Table 13). The results of factor loadings in Appendix C Table 14 for the varimax orthogonal rotation show that two patient-centered attributes (using EHRs to communicate with patients and for decision or population management support) weighted around factor 1. Four patient-centered attributes (the presence of a nurse practitioner or physician assistant, multiple specialty practices, the presence of a case manager, and preparing provider report cards) weighted around factor 2. The other patient-centered attributes, including the presence of a primary care provider, following up with patients discharged from a hospital within 48 hours, reserving time for same-day appointments, and preventive care reminders, weighted around factor 3. In the next set of analyses, we summarized the attributes in three variables based on the performance of patient-centered practices but not the quantity of the patient-centered attributes. Appendix B Table 8 showed that the summarized variables were based on factors of rotated factor loading results, so that two patient-centered attributes (EHR/EMR exchange secure messages and EHRs for decision support and screening) weighted around factor 1. We created a new variable with three categories for the purpose of analysis (0: none of the 2 attributes exists, 1: one of the 2 attributes exists, and 2: both attributes exist).

The regression models with the new patient-centered categorization based on the factor analysis showed that the total healthcare expenditure was 21.5% (95% CI [0.1-0.4]) higher among individuals who received care from patient-centered practices with both EHR/EMR to exchange secure messages and EHRs for decision support and screening attributes and 17.6% (95% CI [-0.0-0.4]) higher among individuals who received care from patient-centered practices with one of the abovementioned attributes compared to individuals who received care from patient-centered practices with neither of these two attributes. The staff-related and quality-related variables based on the factor analysis did not show any association with the total healthcare expenditure among individuals who received care from patient-centered practices with these attributes (Appendix C Table 15)

Imputation of the Missing Data

Multiple Imputation by Chained Equations (MICE)

We used the MICE method to impute our missing values. This method generates predicted estimates for these variables through multiple regression analyses using the information on the individual's characteristics information used as covariates, including age, sex, marital status, insurance status, family income, race, employment status, and number of chronic diseases to reach missing values of the following patient-centered attributes: ACO, capitation status, and education (Royston, 2011; Azur, 2011). We specified 10 imputations to be performed. Stata executed the specified estimation model within each of the 10 imputed datasets to obtain 10 sets of coefficients and standard errors. Stata then combined these estimates to obtain one set of inferential statistics. We reached completed data for all variables after imputation. All reported standard errors reflect adjustments made to account for complex survey design as well as added variance due to multiple imputation methods in the statistical analysis of data.

Table 12

Factor Analysis of Patient-Centered Attributes

Factors	Eigenvalue
Factor 1	1.62
Factor 2	0.32
Factor 3	0.21
Factor 4	0.02
Factor 5	-0.00
Factor 6	-0.09
Factor 7	-0.11
Factor 8	-0.14
Factor 9	-0.19
Factor 10	-0.22

Table 13

Factor Loadings (Pattern Matrix) and Unique Variances

Variables	Factor1
Primary care physician (PCP)	0.16
Physician assistant (PA)	0.32
Case manager	0.46
Specialty	0.34
Check-in within hours after hospital discharge	0.36
Same-day appointments	0.23
EHR/EMR exchange secure messages	0.54
EHRs for decision support and screening	0.57
Sends preventive care reminder to patient	0.40
Reports to physician on clinical quality of care	0.44

Table 14

Rotated Factor Loadings (Pattern Matrix) and Unique Variances

Variables	Factor 1	Factor 2	Factor 3	Uniqueness
Primary care physician (PCP)	–	–	0.3137	0.9001
Physician assistant (PA)	–	0.3793	–	0.8342
Case manager	–	0.3962	–	0.7527
Specialty	–	0.4221	–	0.8075
Check-in within hours after hospital discharge	–	–	0.3365	0.8209
Same-day appointments	–	–	0.3704	0.8526
EHR/EMR exchange secure messages	0.5471	–	–	0.6292
EHRs for decision support and screening	0.5575	–	–	0.8230
Sends preventive care reminder to patient	–	–	0.2891	0.7944
Reports to physician on clinical quality of care	–	0.2755	–	0.6126

Table 15

Correlation Between Summarized Patient-Centered Attributes Based on Factor Analysis and Total Healthcare Expenditure and Predicted Margins (N=5611, Weighted N= 50169640)

	Log of total healthcare expenditure	**Predicted margins**	**Predicted of the mean total expenses per individual**
Patient-centered Practices			
HER-related			
0 HER-related attributes	Ref	8.2 (8.1-8.4)	$3641
1 HER-related attribute	0.167 (-0.0-0.3)	8.4 (8.3-8.5)	$4447
2 HER-related attributes	0.186* (0.0-0.3)	8.4 (8.4-8.5)	$4447
Staff-related			
0 staff-related attributes	Ref	8.6 (8.2-9.1)	$5432
1 staff-related attribute	-.074 (-0.5-0.4)	8.5 (8.4-8.7)	$4915
2 staff-related attributes	-0.234 (-0.7-0.2)	8.4 (8.3-8.5)	$4447
3 staff-related attributes	-0.252 (-0.7-0.2)	8.4 (8.3-8.5)	$4447
4 staff-related attributes	-0.270 (-0.7-0.2)	8.3 (8.2-8.5)	$4024
Quality-related			
0 quality-related attributes	Ref	8.7 (8.3-9.2)	$6003
1 quality-related attribute	-0.329 (-0.9-0.2)	8.4 (8.1-8.7)	$4447
2 quality-related attributes	-0.445 (-0.9-0.0)	8.3 (8.2-8.4)	$4024
3 quality-related attributes	-0.285 (-0.8-0.2)	8.5 (8.2-8.7)	$4915
4 quality-related attributes	-0.309 (-0.8-0.2)	8.4 (8.4-8.5)	$4447

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- Collaborate with *Department of Medical Assistance Services (DMAS) to evaluate Medicaid programs; Addiction and Recovery Treatment Services(ARTS), Medicaid Expansion, and Managed Long-Term Services and Supports (MLTSS) program*
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- Draft journal articles, conference abstracts, and policy briefs

Clinical Research Assistant, Infectious Diseases Department — January 2017-August 2018
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- Designed a research study aimed at microbiologic diagnostics and outcome in children with complicated pneumonia
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- Coordinated collection and analyzed the data using SPSS

Clinical Research Assistant, Cancer Center — June 2010-December 2010
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POSTER AND ABSTRACTS

- **Salehian, S.,** Saunders, H., Cunningham, P. (2021, November). Does Switching Health Plans Lead to Greater Health Plan Satisfaction? Results from a Survey of Members Enrolled in a Managed Long-Term Services and Support (MLTSS) Program in Virginia.
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- **Salehian, S.,** Hamdy, R.(2019, April 27). Microbiologic Results and Clinical Outcomes of Children with Complicated Pneumonia [Poster presented].
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- **Salehian, S.,** Cunningham, P.(2021, August). Hospital Uncompensated Care Costs in the First Year of Medicaid Expansion in Virginia.

PAPERS ACCEPTED FOR PUBLICATION

Salehian, S., Saunders, H., Cunningham, P. (2022, December). Health Plan Switching in a Medicaid MLTSS Program. American Journal of Managed Care.

RESEARCHES IN PROGRESS

- **Salehian, S.**, Cunningham, P. The Effect of the COVID-19 Pandemic on Virginia Hospitals' Inpatient Admission After Medicaid Expansion

- **Salehian, S.**, Cunningham, P. Do Addiction and Recovery Treatment Services (ARTS) Program and Medicaid Expansion Affect the Number of Inpatient Admissions for Mental Illness, Substance Use Disorder (SUD), and Opioid Use Disorder (OUD)?

- **Salehian, S.**, Cunningham, P. Correlation of the Patient-Centered Medical Home(PCMH) and Use of Preventive Services Among the High-risk Patients?

- **Salehian, S.**, Cunningham, P. Do Patients Receiving Care from Patient-Centered Medical Homes (PCMH) Spend Less on Healthcare Services?

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