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Clinically Integrated Networks: The 'Magic Pill' for Improving the Quality of Health Care?

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CLINICALLY INTEGRATED NETWORKS: THE 'MAGIC PILL' FOR IMPROVING THE QUALITY OF HEALTH CARE?

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DEDICATION

This dissertation is dedicated to my beloved girls, Faye and Loretta. Completing this PhD was an arduous endeavor while you were babies, but my hope is this achievement makes you half as proud of me as I am proud to be your mother. I love you.

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ABSTRACT

The Patient Protection and Affordable Care Act (ACA) served as a paradigm shift to reimburse physicians based on health outcomes or quality of care patients receive in relation to and conscious of the cost to provide care, rather than the traditional fee-for-service (FFS) system. To implement value-based care under the ACA, value-based care models (VBCM), such as patient-centered medical homes (PCMH) and accountable care organizations (ACO), were formed with the ultimate goal to advance quality of care. Among commercially insured populations, clinically integrated networks (CIN) have emerged as another type of VBCM.

Since CINs are the newest type of VBCM, the current literature explains their formation and intended goals, yet no studies examine a CIN's ability to improve quality. This dissertation fills that knowledge gap by examining a large and advanced CIN in the Midwestern US to evaluate the effect the CIN's formation has on the improvement of the quality of care. In particular, this study focuses on evaluating whether a physician becoming a participating member of the CIN improves performance outcomes in readmissions and cardiovascular disease (CVD).

I developed a framework using Donabedian theory to explain why a change in structure through physicians becoming members of the CIN may have an effect on process and outcome quality metrics. To empirically investigate the framework, this dissertation uses a retrospective, longitudinal study design. To estimate the effect of a physician becoming a participating member of the CIN on quality improvement in

readmissions and CVD, a regression discontinuity in time (RDiT) empirical strategy is deployed. Using the CINs own data collection and analytics platform, quality metrics were collected across approximately 3.1 million patients and 180 million patient encounters from 2016-2018.

There was no observed effect between the formation of the CIN and the quality of care delivered. This was explained in the data by the near optimal performance of participating physicians within the CIN. For example, the national average for 30-day readmissions is approximately 20%; yet, the CINs average is around 2.2%. These findings suggest that a strategy targeted directly toward physicians within the CIN could more clearly enhance quality outcomes; implementing a strategy that disseminates these quality metrics to each individual physician is the logical next step for quality improvement. Taking the additional step to unblind these results allows physicians to see their own performance and how they compare to their peers. This holds the potential for an even greater effect on quality outcomes.

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LIST OF SYMBOLS

$CIN_{i,c,t}$ Indicator or dummy variable representing "treatment" of the physician becoming a participating member of the CIN.

$y_{i,c,t}$ The independent variable or quality metric for readmissions or CVD for each physician, *i*, in chapter, *c*, during month, *t*.

$\propto_0$ Constant or y-intercept.

δ_1 A parameter capturing the effect of the physician becoming a member of the CIN on the readmission or CVD quality metric (physician performance).

θ_i Physician fixed-effects.

$X'_t\lambda_t$ Time fixed-effects (1-36)

$Y'_{ic}\beta_{ic}$ Chapter fixed-effects (8)

$\varepsilon_{i,c,t}$ Error term representing unobserved variation in physician attributes.

LIST OF ABBREVIATIONS

ACA.....Patient Protection and (Affordable Care Act)

ACO..... Accountable Care Organization

AMI ..... Acute Myocardial Infarction

CAD.....Coronary Artery Disease

CHF .....Congestive Heart Failure

CIN .....Clinically Integrated Network

CMS..... Centers for Medicare and Medicaid Services

CVD..... Cardiovascular Disease

DOJ.....Department of Justice

DRG..... Diagnosis-Related Group

ED.....Emergency Department

EMR .....Electronic Medical Record

EMT.....Emergency Medical Technician

FFS .....Fee-For-Service

FTC..... Federal Trade Commission

HHS .....Department of Health and Human Services

HTA.....Health Transformation Alliance

IHI..... Institute for Healthcare Improvement

IT .....Information Technology

LATE.....Local Average Treatment Effect

MS-DRG..... Medicare Severity-Diagnostic Related Group

MSSP ..... Medicare Shared Savings Program

PCMH ..... Patient-Centered Medical Home

RD ..... Regression Discontinuity

RDiT ..... Regression Discontinuity in Time

TPA ..... Third Party Administrator

VBCM ..... Value-Based Care Model

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND: A GROWING NEED FOR VALUE-BASED CARE

In 2007, the Institute for Healthcare Improvement (IHI) began recruitment efforts for participation in a groundbreaking collaboration of what eventually became known as the Triple Aim. In total, 141 participating organizations around the world took part including hospitals, health care systems, insurance companies, social service groups, community coalitions and public health agencies. By 2008, the Triple Aim was announced as the solution to simultaneously improve individual experience of care, improve health of populations and reduce per capita costs of care. This solution was necessary because most of the major global health systems lacked the capacity to integrate cost-conscious and high-quality health care across multiple sites over time. [1,2]

For the United States, the Triple Aim initiative could not have been introduced at a more pertinent time. During the early 2000's, the Commonwealth Fund Commission on a High Performance Health System released their report stating weaknesses of the US health care system.[3] The Commission gave an overall score of 66 percent, with 100 percent referring to the top decile of known measured performance. Furthermore, they noted that even though US health care expenditures continue to rise and are exceptionally higher than similarly developed countries, the results regarding quality outcomes are far worse. In fact, health care spending in the US is nearly double that of the next most costly nation, yet the US ranks thirty-first among nations on life expectancy, thirty-sixth

on infant mortality, twenty-eighth on male healthy life expectancy and twenty-ninth on female healthy life expectancy. [4] Similar studies found despite the US ranking highest in the world regarding healthcare spending, the US ranks lowest on health performance and outcome indicators among eleven comparable nations.[5,6]

The need for value is clear; as a nation the US has successfully built the most expensive health care system in the world without necessarily achieving the best outcomes. The US was well justified in using the Triple Aim as a guidepost for the trajectory of the health care reform efforts. [7] In 2010, the Triple Aim officially became part of the US national strategy for solving health care deficiencies through the passage and implementation of the Patient Protection and Affordable Care Act (ACA). Traditionally, the US health care system has depended on fee-for-service (FFS) compensation, where physicians are reimbursed retrospectively for each service completed based on billed charges or annual fee schedules, regardless of cost or quality outcomes. The traditional FFS reimbursement model results in physicians being incentivized to order more tests and procedures,[8] which, in turn, increases health care spending but does not necessarily directly contribute to improving patient outcomes.[9] Furthermore, the FFS model challenges care coordination, as physicians see more patients than their workflow allows.[8] As a concept, FFS promotes quantity over quality, creating a siloed and fragmented system.

The ACA forced a paradigm shift to instead begin paying for value, defined as the health outcomes or quality care the patient receives in relation to and conscious of the cost to provide care.[9,10] Value-based care reimbursement ties payments for care delivery directly to the quality of care provided and rewards physicians for both efficient and

effective practices. To pay for performance, physicians must report selected quality metrics and demonstrate improvement over time. Under this new model of health care delivery, physicians are expected and incentivized to improve performance by using: 1) a team approach, 2) evidence-based medicine, 3) patient engagement, 4) upgraded health technology, and 5) advanced data analytics. Physicians receive financial rewards only when patients are provided with coordinated care that is both effective and appropriate.[11,12]

To implement value-based care under the ACA, the federal government was the first to design value-based care models (VBCM) with the ultimate goal to advance quality of care while increasing patient access and accounting for price at the point of service. Medicare is a good starting point to advance health care quality as this population is large and extremely costly to the US health system. Reflecting this shift, in 2015, the Department of Health and Human Services (HHS) announced their goal to have 85 percent of all Medicare FFS payments tied to quality or value by 2016, and 90 percent by 2018. Furthermore, they set a target of 30 percent of Medicare payments tied to quality or value are to come via VBCMs by the end of 2016, and 50 percent of payments through VBCMs by the end of 2018. [13,14]

Patient-centered medical homes (PCMH) are a type of VBCM that have gained in popularity; the ACA included federal PCMH demonstration programs that have since expanded to a variety of private settings across the country.[15] PCMHs host a myriad of primary care improvements including the assignment of patients to a personalized primary care physician responsible for directing "whole person" care.[16] In general, medical homes encourage primary care practices to invest in state-of-the-art electronic

medical records (EMR), enhanced access options, team-based medicine approaches, population health management, personal care management and consistent quality care results in exchange for enhanced payments, usually seen as per-patient-per-month fees for comprehensive services.[17,18]

Accountable care organizations (ACO) are another VBCM based on primary care and were originally designed by the Centers for Medicare and Medicaid Services (CMS) to provide Medicare beneficiaries with high quality health care and have been deemed the most promising approach to address care fragmentation, poor quality outcomes and achieve the Triple Aim.[19] There are now more than 700 ACOs that participate in a CMS payment program such as the Medicare Shared Savings Program (MSSP), Advanced Payment ACO Model or the Pioneer ACO Model. Within an ACO, physicians, hospitals and other health care clinicians work as a networked team to deliver the best possible coordinated care at the lowest possible cost. Under the payment structure, the ACO shares savings if it is able to deliver high quality care at reduced costs but also goes at risk to lose money if it underperforms.[20]

Lastly, clinically integrated networks (CIN) consist of a network of otherwise independent physicians and hospitals who collectively commit to the cost and quality improvements under which the ACA is based. Members of the CIN are able to negotiate directly and take on risk for the cost of medical claims with employers for commercial payer contracts under safe harbor antitrust law. CINs are multi-specialty based compared to the primary care foundation of PCMHs and ACOs. They are physician led organizations that abide by a set of performance and outcome metrics (both inpatient and outpatient in nature) and have a robust data system to monitor physician performance

against these goals. Membership is selective and limited only to physicians who can maintain and advance the CIN quality metrics with the lowest possible cost to the employer partner. VBCMs such as PCMHs, ACOs and CINs are all examples of models that have come forth in response to the Triple Aim; however, the success of these models in lowering health care costs and improving health care quality is still to be determined.[21-23]

1.2 CLINICALLY INTEGRATED NETWORKS: A BETTER APPROACH?

The current body of research on VBCMs is primarily focused on the taxonomy, formation and implementation of these models. While recent literature evaluates the effect of VBCMs ability to lower health care costs, the evidence regarding the models' impact on quality outcomes still remains scarce and with mixed results. For instance, while the PCMH has shown promising results as a means for reorganizing health care systems and improving care continuity and chronic disease management, systematic reviews evaluating PCMH quality outcomes are inconclusive and often produce conflicting results. [24-27] Various studies have shown improvements in physician experience, patient satisfaction, improved practice-level quality metrics, better preventive health, higher levels of disease management and a reduction in emergency department (ED) visits.[15,28-30] However, other studies presented mixed results such as a Pennsylvania PCMH showing performance improvement on only 1 out of 11 quality measures.[31] Other systematic reviews of PCMHs suggest that although PCMHs were associated with reduction in specialty visits and cancer screenings they were not associated with the majority of outcomes studied including primary care, inpatient hospitalization and emergency department visits across multiple metrics.[31-33] On the opposite end of the

spectrum, one study observed not a single impact on quality improvement metrics from 9 separate PCMH pilots studied.[34]

Likewise, ACO quality results vary. Many studies mirror CMS' general conclusion that ACOs have succeeded in most quality metrics, with the greatest improvements in heart failure, surgery outcomes, depression screening, blood pressure, pneumonia vaccinations and fall risks.[19,35-38] Conversely, several studies showed mixed results. For example, while preventable hospitalizations for chronic obstructive pulmonary disease, asthma and diabetes decreased, congestive heart failure hospitalizations and 30-day readmissions increased.[39,40] In addition, studies found ACOs to actually hinder areas of quality improvement such as: adverse perioperative outcomes, emergency department and inpatient readmissions, a decline in prostate cancer treatments and no discernable decrease in post-operative morbidity, mortality and readmissions.[41-45]

In terms of cost, PCMHs and ACOs have proven their ability to control costs because cost is easy to measure, and data is readily available. Overall success though, lies in both cost containment and quality improvement. Quality improvement poses challenges; quality is difficult to define and measure, which makes data difficult to obtain. Literature on PCMHs cite methodological concerns regarding quality outcomes due to the vague nature under which PCMHs are formed and organized. Six practice improvement categories are set forth via guidelines form the National Committee for Quality Assurance, but the guidelines poorly lay out how to define, measure and collect quality outcomes data.[46] Similarly, ACOs have struggled with the inability to produce the quality arm of the Triple Aim. Although the taxonomy of ACOs is better defined

than in a PCMH, care coordination and the ability to capture and report quality metrics is still proving difficult.[47]

To control costs in the CIN model, the CIN guarantees either a reduction in overall spend or a reduction in spending growth and takes on risk for any amount over the guarantee. If the CIN spends less than the cost guarantee, savings are shared between the CIN and the employer. Where the CIN model takes cost one step further than other VBCMs is their commitment to quality; a CIN must meet or exceed quality metrics before it can qualify for the risk sharing payout. Given the legal requirements, organizational structure and commercial patient population, the CIN may be more conducive for studying its effect on quality compared to other VBCMs. This is because the CIN has: 1) a stable, employed patient population, 2) quality measures are formed and defined by member physicians, 3) quality metrics are rigorously tracked on a monthly basis, 4) a formation and organizational structure bound by legal standards, 5) a more advanced risk and incentive structure and 6) incentives are tied to guaranteed patient populations through employer contracts with the CIN.[21-23]

1.3 SIGNIFICANCE AND OBJECTIVES

CINs are the newest type of VBCM to enter the market; the current literature explains their formation and intended goals. However, based on extensive literature searches, no studies examine the ability of a CIN to improve quality outcomes. This dissertation aims to fill this knowledge gap by examining a large and advanced CIN in the Midwestern US to evaluate the effect the CINs formation has on the improvement of medical care provided. In particular, this study is focused on evaluating whether a

physician becoming a participating member of the CIN improves their performance as measured by quality metric outcomes.

To begin, Chapter 2 provides an overview of the CIN model including legal structure, clinical integration strategy and data infrastructure along with explanation on how CINs lower health care costs and improve health care quality outcomes within the commercial payer market. Next, a case study is presented for a specific CIN, whose impact on quality is evaluated in Chapters 3 and 4. A brief history of this CIN is provided along with specific details, concluding with an example demonstrating the early success of this particular CIN in containing costs for a particular employer, the Springfield Missouri School District. In Chapters 3 and 4, this dissertation evaluates whether a physician becoming a participating member of this CIN improves quality metrics in the areas of readmissions and cardiovascular disease (CVD). Chapters 3 and 4 utilize this CIN's own unique, longitudinal dataset of quality metrics (both process and outcome) collected for approximately 3 million patients (180 million patient encounters) from 2016 to 2018.

Chapter 3 evaluates whether a physician (emergency medicine, hospital medicine and internal medicine) becoming a participating member of the CIN improves quality outcomes in emergency department and inpatient readmissions. Readmissions were chosen for this dissertation as they are associated with both high utilization and high cost. Furthermore, readmission costs to employers are higher amongst the private sector due to higher payment rates. Secondly, hospitals and physicians need assistance in tracking their performance with respect to readmissions, because 20 to 40% of patients are "lost" in the system, as these patients were readmitted to a hospital or health system outside of

the original admitting entity.[48] Only a model such as a CIN or large government agency, like CMS, has the ability to track patients across physicians and systems via EMR integration. Lastly, preventable readmissions are commonly associated with indicators of substandard care during the initial hospitalization such as poor resolution of the main diagnosis, unstable therapy at discharge and inadequate post discharge care; all these factors are controlled by health care physicians and organizations and thus hold merit to be studied.[49]

Chapter 4 evaluates whether a physician (cardiothoracic surgeon or cardiologist) becoming a participating member of the CIN improves quality outcomes in CVD. CVD was chosen for three reasons, 1) it is highly prevalent in the working population, 2) is extremely costly to employers and 3) the CVD community has established guidelines and protocols leading to the evaluation of CVD outcomes.[9] This proposal provides a comprehensive study of CVD through utilizing process metrics to determine the effect of a physician becoming a participating member of the CIN has on CVD.

CHAPTER 2

CLINICALLY INTEGRATED NETWORKS: A CASE STUDY

2.1 A SHIFTING LANDSCAPE

Health care spending in the US is becoming more costly with each passing year; Medicare and Medicaid account for one of the largest segments of the federal budget, commercial premiums continue to rise and consumers are plagued with high copayments and deductibles.[50] Most industry leaders believe fee-for-service (FFS) to be the culprit of this continued growth, which incentivizes quantity over quality, regardless of the cost.[8,51] The Patient Protection and Affordable Care Act (ACA) of 2010 has since shifted physician payments to quality or value over quantity via the use of value-based care models (VBCMs), which tie payments directly to the quality of care provided and rewards physicians for both efficient and effective practices. The two most prevalent types of VBCMs are patient-centered medical homes (PCMHs) and accountable care organizations (ACOs). Both were initially introduced by the federal government and have seen promising early results in cost savings but have shown mixed results in quality improvement.[24,30,35,40] The vast majority of VBCM literature focuses on Medicare beneficiaries and does not address costs or quality for the 150 million people who are part of the US workforce and use commercial health insurance carriers.[52]

While the federal government was the first to move toward value, commercial health insurance carriers have slowly adopted the VBCM approach. Large carriers have implemented small-scale commercial PCMH and ACO models, but the majority of

contracts reside under the FFS approach. This may be due to a myriad of barriers including: 1) the lack of updated information technology infrastructure, including multiple claims systems unable to communicate with one another, 2) no easy means of incorporating shared-savings payments into self-insured contracts, and 3) employers have not demanded insurance carriers to move toward value. To date, employers have focused on altering their benefit plan designs to control cost and improve quality, since directly influencing the delivery of care itself is more complex. These changes, such as wellness programs and decreased premiums that act as incentives for employees to improve their health behaviors, have only shown modest results in controlling costs and improving quality.[53] While employers have been slow to adopt VBCM approaches, they are beginning to focus on supply-side mechanisms to improve cost and quality in health care. The National Business Group on Health found that almost 25% of self-insured employers are planning to direct their payments toward a VBCM by 2018 and it is expected to double over the next two years.[50]

One of the first major efforts on behalf of employers was in early 2016 when forty companies, among them American Express, Verizon, Johnson and Johnson and Macy's, formed the Health Transformation Alliance (HTA) aimed at lowering the companies' health care spending. However, thus far the HTA has only used this bargaining power in the pharmacy landscape through negotiations with two major pharmacy benefit managers (OptumRx and CVS Caremark) to receive consistent pricing on branded drugs. The alliance did announce contract negotiations with Cigna and United Health for medical benefits in 2017, but this partnership was limited to patients with diabetes or those undergoing hip and knee replacements and in the geographic areas of Phoenix, Chicago

and Dallas-Fort Worth.[54] The HTA has yet to provide any updates regarding medical care cost and quality improvement results.[50] Recently, an initiative announced by Amazon, JP Morgan and Berkshire Hathaway has again heralded a new wave of employer activism in the health benefits arena but is too new to gauge what outcomes may persist.[50,55] While commercial health plans and employers still remain somewhat stuck in the FFS system, a new type of VBCM, the clinically integrated network (CIN) may be a viable solution to curb costs and improve quality within this sector.

2.2 WHAT IS A CLINICALLY INTEGRATED NETWORK?

A CIN is a legal structure that facilitates physician collaboration in pursuit of cost containment and quality improvement. A CIN should not be confused with the loosely defined term "clinical integration," which has been a popular buzzword in the health care industry over the last decade since the passage of the ACA. By definition, a CIN can describe everything from vague collaboration among physician rivals to mergers that bring hospitals and physicians under single ownership. [56] The CIN model is similar to an ACO or PCMH but ups the ante in a number of ways.[1]

First, the CIN is a legal entity and must meet the guidelines set forth by the Federal Trade Commission (FTC) and Department of Justice (DOJ); whereas, commercial PCMHs and ACOs can be involved in contracts without meeting the legal mandate.[2] A CIN applies the concept of 'clinical integration' by joining a network of otherwise independent physicians to form a legal entity under "safe harbor" from antitrust laws accepted by the FTC and DOJ. The CIN then forms commercial payer contracts

[1] Hospitals or health systems can simultaneously be any combination of PCMH, ACO and CIN

[2] Non-commercial PMCHs and ACOs are subject to CMS regulations

with employers (removing the traditional insurance carrier) where employees/patients receive care from the network of physicians within the CIN. In essence, to qualify as a CIN pursuant to the legal definition, the following conditions must exist: 1) a network of physicians must be clinically integrated by demonstrating "a high degree of interdependence and cooperation" through 2) a program of initiatives designed to "control costs and ensure quality," which 3) is supported by an "infrastructure" that allows the physicians to "evaluate and modify practice patterns."[57-59]

The second differentiator between a CIN and other VBCMs is that a CIN is physician-centric, while an ACO is hospital-centric. To comply with antitrust laws, a CIN can consist of multiple entities (hospitals, independent physician practices, health systems, etc.) but it must have physician-leadership at the center of its governance model, which is not required for other VBCMs.[8,22,51,57,59,60] Recall the first component from the FTC guidelines is for the CIN to be clinically integrated through interdependence and cooperation. Since a CIN contracts directly with employers, part of its value lies in having a robust network of physicians (across specialties and geographic regions) who are able to provide necessary services to its patient population. If there are notable gaps in the network, the CIN is a less attractive solution for employers. Therefore, the majority of CINs are centered around major hospitals or health systems, typically referred to as sponsors, who employ an array of physician specialties. However, rarely is even a predominantly physician-employed CIN robust enough to be able to negotiate an employer contract without supplementing services to round out its network.[61]

Figure 2.1 presents different possibilities for the clinical integration of physicians within a CIN. An ideal CIN appears at the center, where complete integration is

represented by 100% of physicians being employed within the CIN network. When physicians are employed within the network, the CIN has complete control over the cost, quality, EMR, data, etc. of all physicians. Moving out from the center, the clinical integration structure of the CIN becomes less binding and therefore less desirable. For example, the first ring (CIN at-risk) depicts physicians who are not employed within the CIN but are at risk for their own portion of the overall cost of care. These physicians must still provide quality metrics to the CIN and are essentially carved out of the network but still reap the benefits of greater market share through employer contracts. If these physicians meet the quality and cost goals, they receive some form of dividend or profit sharing from the CIN. The next ring (CIN with incentives) illustrates non-employed physicians who supply quality data and have some ability to capitalize in upside risk but do not have downside risk; if they meet the quality and cost standards, they receive the additional volume from theses risk-based employer contracts but no bonus or incentive payment. The subsequent ring (CIN fee-for-service) represents non-employed physicians who are committed to supplying data for the purpose of quality and best practice but are not financially aligned; there is no cost sharing, as these physicians are paid on a FFS basis. The last ring (contracted, non-CIN and no data) are physicians who are not cooperative to the network as they do not provide quality data or participate in any sort of risk-sharing for cost.[62] It is the clinical integration structure (shown in Figure 2.1) that provides a third differentiator between a CIN and other VBCMs. A CIN must fully meet FTC standards when hospitals or health systems collaborate with independent physicians or physician groups that involve incentives. A commercial ACO can use their own employed physicians and be outside the scope of a CIN, as long as the physicians are

being paid FFS. However, if independent physicians begin to receive incentives for performance from the ACO, the ACO would then need to meet the FTC standards.

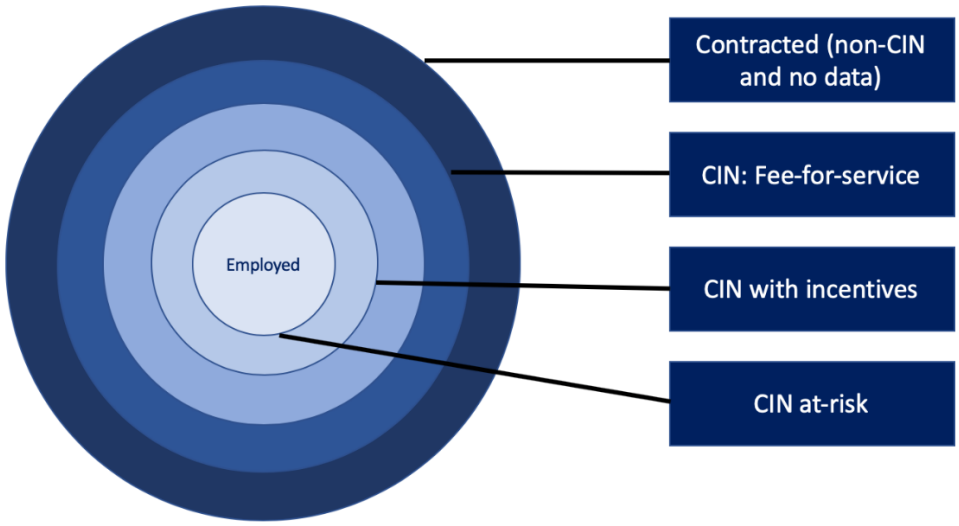

Figure 2.1 Dante's Rings Diagram Representing Clinical Integration in a CIN

2.3 CINS: LOWERING HELTH CARE COSTS AND IMPROVING QUALITY

Cost containment is a vital component of any VBCM and is included in the FTC as a mandatory condition for CINs. To date, ACOs have shown some success in cost savings for the Medicare population.[36,39,40,45] However, the private sector has yet to make similar progress. Therefore, the vast majority of PCMHs and ACOs across the country cover Medicare beneficiaries (where success in cost containment has been proven)[3] whereas a CIN covers a commercial/employed population.[63]

There is no one way for a CIN to lower health care costs in their contracts; the only necessary element is that of risk. In the traditional benefits landscape, the insurance carrier (and any brokers involved) acts as a third-party payer between the

[3] This may be due to the fact that non-commercial ACOs (those in a contract with CMS) have generated greater savings than commercial ACOs and therefore have been slower to adopt.

employer/employees/patients and the physician/health system; the insurance carrier accepts the risk (cost) of medical claims. The CIN model greatly diminishes the role of the insurance carrier in this equation and instead contracts directly with the self-insured employer; thereby accepting the risk (cost) associated with medical claims[4] [64]

CINs can leverage a broad range of cost containment methods but at its simplest form there are usually two basic approaches: price and utilization. For a CIN to lower cost based on price, the CIN must simply be the lowest cost provider. Some CINs have achieved this end by providing prices based on a menu-type basis where discounts are given per individual diagnosis-related group (DRG). Other CINs have focused on lowering pharmaceutical prices, as employers' pharmacy costs are approaching thirty percent of insurance premiums.[61] To leverage cost through utilization, a CIN strives to be the highest quality provider of care while achieving the appropriate volume. The Mayo Clinic, for example, is known for being a high-cost health care provider. However, their business model is such that in their highly specialized surgery department alone, enough appropriate testing is done up front that 30% of all these specialized surgery patients in fact do not need a procedure and are treated with cheaper alternatives. This due diligence allows them to reduce overall utilization and ultimately drives down cost. [64,65]

Similar to cost, ensuring high-quality outcomes is paramount to VBCMs and is also a requirement in the FTC guidelines. Thus far, both PCMHs and ACOs have shown mixed results in quality improvement, therefore postulating the CIN as a potentially

[4] CINs must have reinsurance (which keeps them from needing an insurance license) in the case of any substantially high medical claims as a form of stop-loss.

better solution.[17,27,28,30,38-40,42,66] The quality improvement component is where the CIN model truly differentiates itself from the other VBCMs. First, the PCMH and ACO models are centered around primary care and therefore the vast majority of quality metrics are attributed to the primary care specialty; whereas in a CIN, all specialties across the CIN must have quality metrics applicable to each specialty; primary care metrics cannot be blindly applied to a cardiologist, for example. [67] Secondly, since a CIN is required to be physician-led, it is physicians who choose the quality metrics. Unlike non-commercial ACOs, whose quality metrics are provided to them solely from CMS. Third, PCMHs and ACOs include metrics on physician and patient satisfaction, a CIN does not include such metrics. CINs focus exclusively on physician performance through process or outcome measures, as the FTC standards are to "ensure quality", not to ensure satisfaction.

This segues to another distinction: the quality standard in a CIN is higher than in other VBCMs. The third condition under the FTC guidelines is that physicians are to be "evaluated and modified". Therefore, if physicians do not meet the minimum thresholds for their applicable quality measures, they must be removed from the CIN network, whereas, in a PCMH or ACO removal is not a requirement.[58,59,68] Furthermore, within the contract between the CIN and an employer, cost savings cannot be deemed a success without fully achieving quality guarantees. A CIN cannot simply forsake quality as a means to lower costs. Only when quality metrics are met can shared savings between the CIN and the employer transpire.[68]

Lastly, in order to achieve a high-quality network (with the ability to evaluate and modify physician practices), the CIN must be supported by the infrastructure condition

issued by the FTC. Therefore, advanced EMRs and data systems must be put in place for data to be shared with members across the network so performance monitoring and evaluation can ensue.[51,57,58] The data from the CIN serves three purposes. First, since data can be collected at both the patient and physician level, it allows the CIN to accurately evaluate individual physician performance and determine whether or not a modification approach is needed to yield better quality outcomes including removal of physicians from the network, if necessary. Second, it provides greater detail into specific quality metrics to take on further risk with employers. For example, if an employer is particularly concerned about cancer screenings, they can ask the CIN to take on greater risk (cost responsibility) for these specific metrics. This holds the CIN to an even greater quality responsibility in a particular area for the employer to cater to their own beneficiaries. Third, it provides the CIN data to present to the market as being a high-performing network.[69]

2.4 THE CIN: A HARD SELL BUT A GOOD BET

Employers have it hard; they are drowning in high dollar medical claims. Likewise, physicians and health systems are struggling as they see continued decreasing reimbursement. In theory, CINs can create a symbiotic relationship between physicians/health systems and employers/patients as they allow for shared accountability for quality improvement, provide a legal structure for combining multiple entities and have the potential to deliver a coordinated care model. Furthermore, CINs offer the "halo effect", which posits that all patients, not just those in CIN at-risk contacts, will benefit from better care coordination. However, to date, there is no literature rigorously

assessing the CIN models' ability to lower health care costs and improve quality outcomes.

CIN research (usually from consulting firms) has primarily focused on their taxonomy, formation and cost benefits to member health systems. While this research is important, these cost-benefit questions have already been answered for VBCMs in general, regardless of the specific model (PCMH, ACO or CIN). It is easy and straightforward for CINs, along with other VBCMs, to prove their worth in cost containment but we have yet to see any results in utilization and quality.[60]

2.5 MPACT HEALTH: AN OVERVIEW

To generate evidence of a CINs impact on cost and quality, this dissertation focuses on a large, advanced CIN located in the Midwestern US called MPact Health (MPact). There were multiple drivers of change in the health care industry that led MPact to form: high health care and insurance costs, inconsistent quality of care, lack of value-added services and employers searching for better options. Physicians in the region voiced the desire to practice high quality medicine while receiving reasonable compensation and having minimal administration interruptions to their workflow. These factors spurred physicians, health systems and employers in this region to find solutions via the CIN model.[59]

In 2013, the former Vice-Chancellor of the medical school at the University of Missouri Health System (MU Health), located in Columbia, Missouri, saw the healthcare market moving in a different direction across the state and region; moving away from FFS and toward value. While he wanted MU Health to be a part of this paradigm shift, rewiring an academic medical center away from quantity and toward quality is a hard

battle; he knew partners were needed for this lofty endeavor. At the time, Mosaic Life Care (Mosaic), located in St. Joseph, Missouri was the number two performing ACO in quality in the country. Likewise, Mercy Health (Mercy), headquartered in St. Louis, MO and spanning across multiple regions in the Midwest, was the number ten performing ACO in quality in the country. The first meeting between the three entities was in the spring of 2015, with the initial focus being to share best practices with one another. Soon after, it was decided to take this collaboration one step further by formally forming a CIN (MPact), which was fully functioning by the end of the same year.[70] Figure 2.2 depicts the geographic distribution of hospitals (blue dots) and clinics (grey dots) that exist within MPact's physician network.

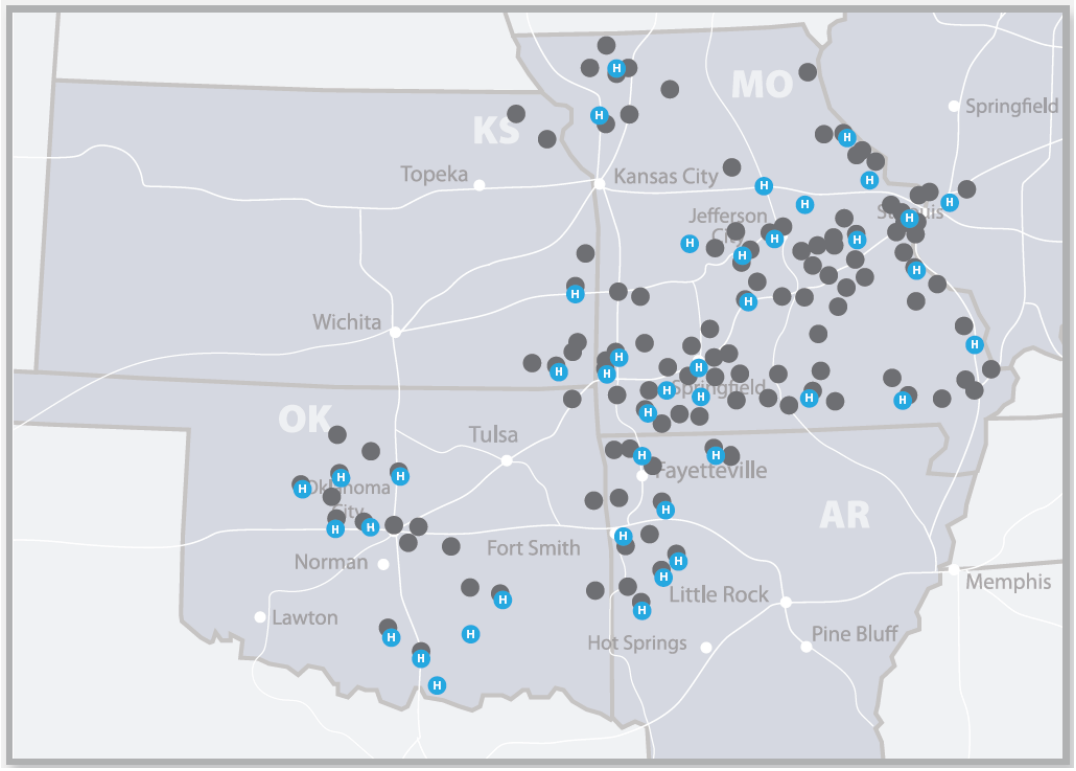

Figure 2.2 Geographic Distribution of MPact's Physician Network

MPact was initially represented by the Chicago-based Hogan Marren law firm, who also successfully represented the first CIN, Advocate Health. MPact's legal team

cite that a proper analysis of any physician-led network's clinical integration program must pass a three-part test. First, whether the network's clinical integration program is *"real"*; meaning that authentic initiatives are actually undertaken by the CIN which involve all physicians in the network and apply to the physicians' practice patterns relative to patients who obtain health benefits. Second, the initiatives of the program are designed to achieve *likely improvements* in health care quality and efficiency. And third, whether joint contracts with FFS health plans are "*reasonably necessary"* to achieve the efficiencies of the clinical integration program. This means that adding a physician based in New York to the network even though the employer contract is in Missouri would be deemed *not* reasonably necessary.[57,62]

Table 2.1 MPact Chapters and Sponsoring Entities

Chapter Number	Chapter Name	Sponsoring Entity
1	Western Arkansas	Mercy
2	Central Missouri	MU
3	St. Louis	Mercy
4	MO-KAN	Mercy
5	Springfield	Mercy
6	NW Arkansas	Mercy
7	Oklahoma	Mercy
8	NW Missouri	Mosaic
9	SE Missouri	St. Francis Healthcare

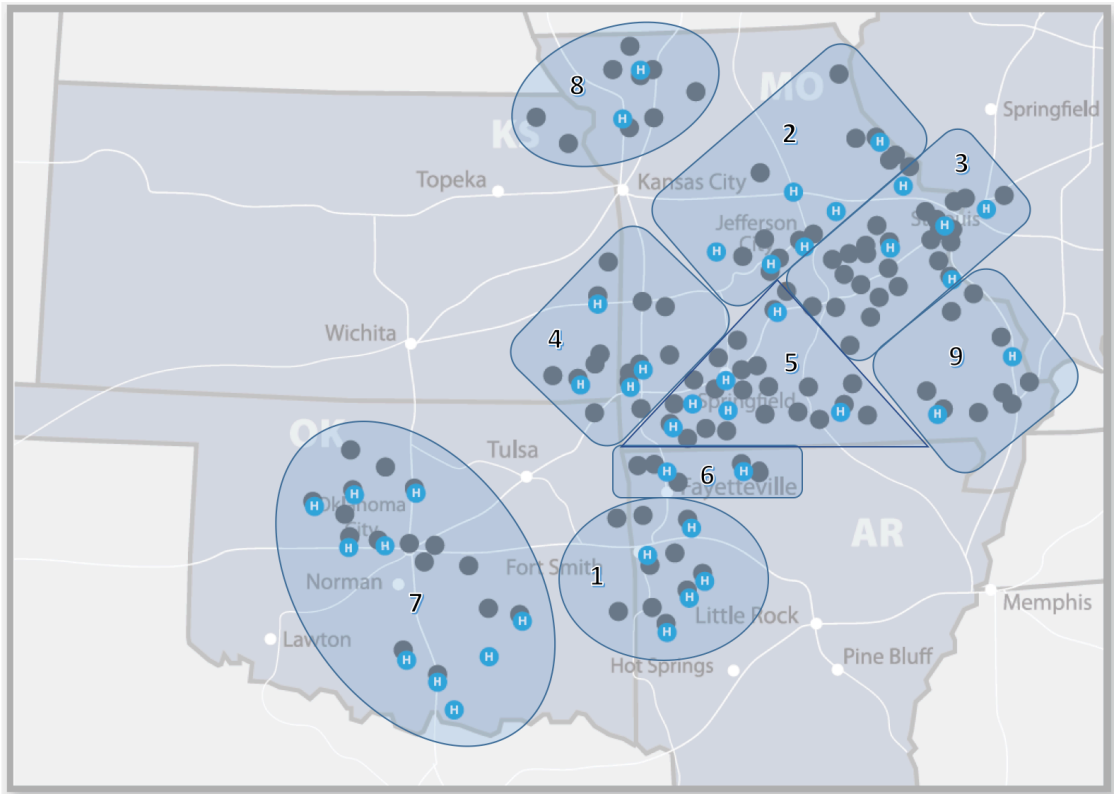

Figure 2.3 Geographic Distribution of MPact's Physician Network by Chapter

MPact is a multi-state[5] CIN that meets the FTC and DOJ definition of clinical integration with a business model of single-signature, value-based contracting direct to employers. Table 2.1 presents the chapter numbers with the corresponding chapter name and sponsoring entity; Figure 2.3 depicts these chapters geographically.

2.6 THE CLINICAL INTEGRATION OF MPACT

The vast majority of physicians in the MPact network are employed by the three sponsors, therefore almost achieving complete clinical integration.[6] Of the 4,000 physicians in the network; 3,600 are employed and 400 (10%) are independent; these independent physicians are not involved in any risk-taking contracts, they are on a FFS

[5] MPact Health spans across 5-states in the Midwest including Missouri, Arkansas, Kansas, Oklahoma and Illinois

[6] Refer to Figure 2.1

setup, but do submit quality data. Altogether, MPact has 31 specialties in its network and quality database they feel make up 99% of the volume of health care demanded but may not cover 99% of health care costs. Any services the MPact network cannot provide, such as transplants or burn care, are carved out of the network and the employer assumes the costs and quality associated with those services.[62]

Recall that CINs prefer to have complete clinical integration through employed physicians; however, this is difficult to achieve as even Mercy (the largest health system within MPact), does not employ all physician specialties. Therefore, MPact, acting as the CIN, provides Mercy the legal structure to round-out their network with independent physician practices that keeps them above reproach.

2.7 THE ORGANIZATIONAL STRUCTURE OF MPACT

MPact's daily operations are managed by a Chief Executive Officer and Chief Operations Officer along with analysts. Just as the FTC guidelines stipulate, MPact is a physician-led entity and is structured as such. Figure 2.4 demonstrates the organizational structure of MPact.

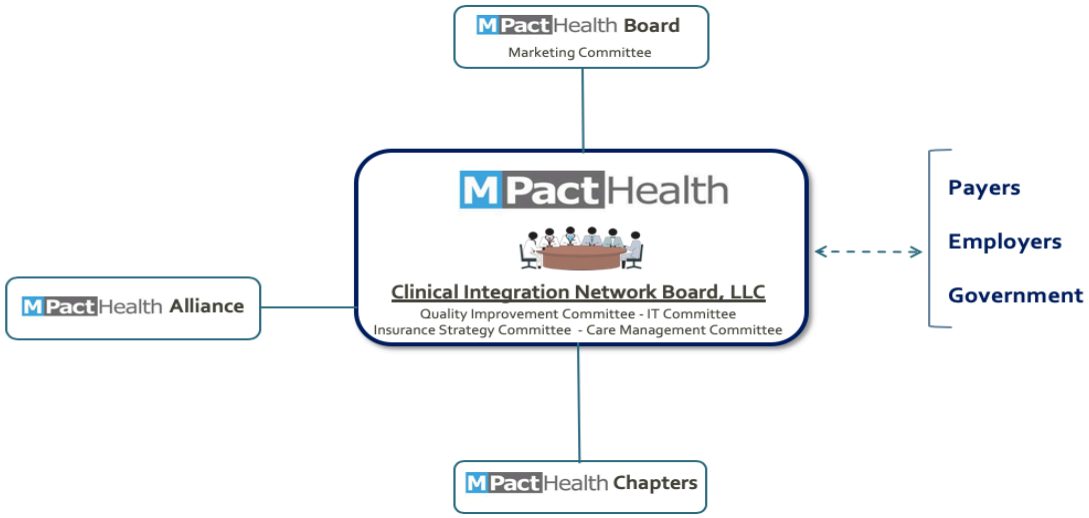

Figure 2.4 Organizational Structure of MPact

The MPact Health Board is comprised of physicians and executives from the three sponsoring entities who set the strategy for MPact and dictate which physicians may join the CIN. The MPact Health Alliance consists of physicians who serve as chairs of their respective chapters and are deemed best practice implementers. The Alliance focuses their efforts on streamlining high volume and high variance practice patterns across the network. For example, this group streamlined processes and vendor contracts after data had shown a high volume of knee surgeries across the network but at greatly different cost points. Figure 2.5 takes a closer look at the physician-led CIN board, which serves as the operational arm of MPact.[70]

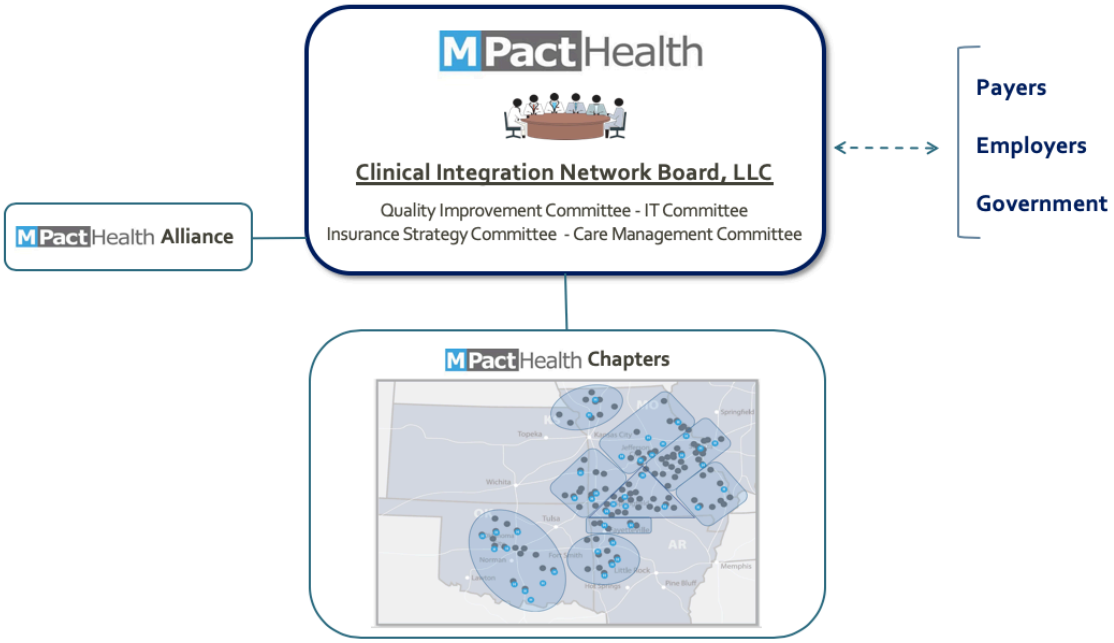

Figure 2.5 Organizational Structure of MPact CIN Board

This board decides which employers or government entities to establish at-risk contracts with, along with having the responsibility of managing the operations committees: quality, information technology (IT), insurance and care management. Committees include physicians across the network and members from the CIN board to

maintain continuity.[70] The quality improvement committee is responsible for choosing the quality metrics and maintaining up-to-date definitions and criteria for all metrics. This group also establishes the goals and minimum thresholds (percentages) for each measure along with tracking the performance on these measures for all physicians. The IT committee serves as the main contact for Optum, MPact's data platform, and decides on any updates and modifications. The insurance strategy committee oversees the live contracts with any employers and government agencies and is responsible for any contractual modifications and future contractual updates. The care management committee focuses on dispersing effective care management programs back to the network as a whole. For example, this committee would create and/or disseminate to the network any best practices that come forth either internally (physicians in the network) or externally (national/association recommendations) [70]

The MPact chapter committees serve as the operational units on the ground and are involved in-depth with the physicians in each chapter. Their main responsibility is to ensure quality on behalf of all participating physicians within their chapter by utilizing quality reports on a monthly basis for each metric and every physician in their respective chapter. The local chapters hold the power to "evaluate and modify" physician practices, with potential to remove under-performing physicians from the network.

2.8 MPACT: LOWERING HEALTH CARE COSTS

MPact structures their contracts with employers around one total cost number at the end of the year, with the expectation the quality metrics are achieved first and foremost; MPact cannot forsake quality to decrease cost. Their commitment to the employer is to reduce overall spending or at least reduce spending growth; this guarantee

is the risk they take on. If MPact meets this total cost guarantee by providing all health care services for less, then the difference in savings is split 50/50 between MPact and the employer. This arrangement creates ownership for both the employer and MPact to drive down costs and improve quality. For example, MPact physicians can lean into care management techniques while employers can incentivize employees to receive wellness screenings through premium reductions.[65]

When an employer contracts with MPact they are essentially contracting with the sponsoring health plan and chapters associated with their geographic region. For example, if an employer in Oklahoma does not have employees outside of this region, they only contract with and receive care from Mercy health system in Oklahoma and the associated Oklahoma chapter of physicians.

2.9 MPACT: IMPROVING HEALTH CARE QUALITY

Recall the FTC guidelines state all specialties included in a CIN network must have meaningful and sensible quality metrics applicable to each specialty; MPact's legal team has interpreted these requirements as needing 5-7 quality metrics per specialty within the network. [58] The physician-led quality improvement committee has established 75 metrics and is currently reporting performance outcomes on 44 of these metrics (data platform restrictions prohibit reporting on all metrics).[68]

Furthermore, a CIN is mandated to have an infrastructure to rigorously monitor physician performance in order to evaluate and modify physician practice patterns. MPact uses an award-winning data analytics platform to quantify quality on a monthly basis for each physician in the network. Today's database encompasses 180 million patient encounters, 3 million patient lives, 3,600 active physicians sharing data measuring 44

unique clinical metrics across 31 specialties. The quality database includes all patients and all payers: commercial, Medicare, Medicaid, self-pay, etc. in order to hold physicians to a higher accountability.[7] This is a crucial component of the CIN as physicians may be removed from the network for underperformance; removal is necessary to maintain quality outcomes for patients, maintaining the integrity of the at-risk contract with the employer and the assurance to the market MPact is a high-performing network. [67,68,70]

Within the quality metric database, there is an adequate mix of process and outcome measures along with both inpatient and outpatient/ambulatory measures. Each metric has a goal (percentage) and minimum threshold (percentage); this minimum threshold is used as a baseline for the CIN to evaluate and modify physician practices. All metrics were derived from best practice research within each specialty and other outlets such as CMS ACO metrics. [67]

2.10 PUTTING IT ALTOGETHER: AN EXAMPLE OF MPACT'S SUCCESS

To begin, MPact, through the sponsoring entity (Mercy) analyzes the previous 2-3 years of employer claims data to obtain an overall cost amount guarantee. For example, an employer was spending $1 million per year in medical costs (and the incumbent insurance carrier charges the employer $1.2 million to take on the risk and tacks on administration fees). MPact cross-references these claims with their own prices (determined by Mercy's prices) and guarantees the employer they can lower their costs to $800 thousand per year; MPact goes at risk for anything over that guarantee.[8] This saves $200 thousand for the employer through reduced utilization plus the reduction in

[7] Cost containment strategy refers only to employer, at-risk patient populations
[8] MPact uses a reinsurance provider for catastrophic amounts beyond the total cost guarantee

insurance carrier administration fees.[65,68] Once the year is over (and assuming quality metrics are met or exceeded), if MPact exceeded the cost guarantee, they simply pay the employer the difference. [65,68] Established employer contracts have likely trimmed all possible costs and therefore the guarantee is to not exceed a certain growth percentage year over year. After time, MPact has cut all possible costs and may no longer be able to guarantee a flat rate; instead they may guarantee a slow growth percentage.[65,68]

From the patient/employee perspective the adjudication system is seamless with little to no disruption in their benefits structure. Through a third-party administrator (TPA), the beneficiaries still receive identification cards and a summary plan description including their in-network physicians. Through this overall cost approach and detailed patient management, MPact does not compete on price but instead, competes through utilization and quality. Figure 2.6 details a success story between MPact (Mercy-Springfield chapter) and the Springfield School District.[71]

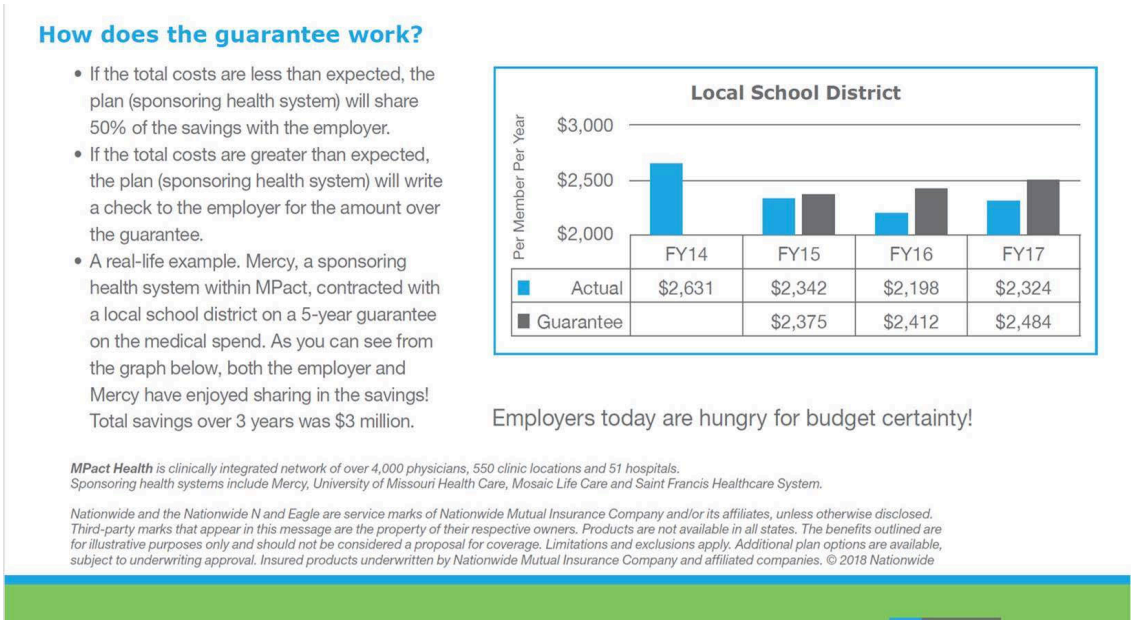

Figure 2.6 MPact Example of Successful Contract[71]

CHAPTER 3

READMISSIONS AS A MEASURE OF QUALITY

3.1 BACKGROUND: A GROWING NEED FOR VALUE-BASED CARE

Historically, the US health system has relied upon fee-for-service (FFS) compensation, in which physicians are reimbursed retrospectively for each service rendered based upon billed charges or annual fee schedules without considering the cost or resulting health outcomes. While this model has its benefits in instituting and monitoring, it has resulted in physicians being incentivized to overuse and misuse medical services, which in turn, has increased the health care industry's overall spending but has not produced higher patient outcomes and value.[7,8] The Affordable Care Act (ACA) served as the catalyst to reimburse physicians based on health outcomes or quality care patients receive in relation to and conscious of the cost to provide such care.[9,10] To implement this paradigm shift, a value-based care model (VBCM) has emerged, which identifies quality metrics on an organizational level and uses those to measure and reimburse physicians for their performance over time.[11,12]

Patient-centered medical homes (PCMHs) are a type of VBCM that have gained popularity across the country; the ACA included federal PCMH demonstration programs that have since expanded to private payers.[15] PCMHs promote primary care improvements including the assignment of patients to a personal primary care physician who is responsible for directing "whole person" care coordinated efforts.[16-18] Accountable care organizations (ACOs) are another VBCM based upon primary care

and originally designed by the Centers for Medicare and Medicaid Services (CMS) to provide Medicare beneficiaries with high quality health care.[19] The organizational structure of an ACO is comprised of physicians, hospitals and other health care clinicians seeking to work as a fluid team to deliver the best possible coordinated care at the lowest possible cost. The payment structure is such that an ACO shares in any reimbursed savings from CMS if able to deliver high quality care at a reduced cost; the ACO goes at risk for loss if it underperforms.[20]

Although PCMHs and ACOs have shown promising results regarding cost reduction, the evidence regarding the models' impact on quality improvement still remains scarce and with mixed results. [25,30,35,40] For instance, while the PCMH model has shown promising results as a means for reorganizing health care systems and improving care continuity and chronic disease management, systematic reviews evaluating PCMH quality outcomes remain inconclusive and produce conflicting results.[24,27] These studies reported that although PCMHs were associated with a reduction in specialty visits and improved cancer screenings, they were not positively associated with the improvement of the majority of outcomes measured including primary care, inpatient hospitalization and emergency department metrics.[31-33]

Similarly, ACOs have also shown inconsistencies in quality outcomes. Many studies have mirrored CMS' general conclusion that ACOs have succeeded in the majority of quality metrics, with the greatest improvements shown in heart failure patients, surgery outcomes, depression screenings, pneumonia vaccinations, blood pressure control and fall risks.[19,35-38] Still, additional studies found ACOs to actually hinder areas of quality improvement such as: emergency department and inpatient

readmissions, adverse perioperative outcomes, a decline in prostate cancer treatment and no discernable decrease in post-operative morbidity, mortality and readmissions.[41-45]

The major challenge to presenting a VBCMs success lies in understanding their effect on quality, just as much as their effect on cost. However, quality of care is difficult to define and measure, as data is not readily accessible. Even when a VBCM can define quality metrics, these metrics are difficult to collect and analyze because many inconsistencies exist. For example, PCMH literature has posited that methodological concerns are looming regarding quality outcomes due to organizational discrepancies under which a PCMH is formed. While the National Committee for Quality Assurance provides guidelines for practice improvement across six categories, the components are poorly established as to how to define, measure and collect the quality outcomes data.[46] Although the taxonomy of the ACO is much better defined than in a PCMH, care coordination and information technology to capture and report quality metrics has proven difficult for many ACOs.[47] Furthermore, ACOs have received criticism regarding the need for a more strongly incentivized risk-sharing contract with CMS claiming they are still a model built and dependent upon the FFS architecture, resulting in inconsistent quality outcomes..[72]

A new VBCM called a clinically integrated network (CIN) has emerged amongst the commercially insured population. A CIN is a legal entity under the Federal Trade Commission (FTC) and Department of Justice (DOJ) consisting of a network of otherwise independent physicians and hospitals/health systems who collectively commit to cost and quality improvements.[58,60] To control cost, members of the CIN are able to negotiate directly and take on risk via an overall cost guarantee with employers for

commercial payer contracts under safe harbor antitrust law.[59,65] To meet the quality requirement, a CIN must be physician-led and abide by a set of performance and outcome metrics (both inpatient and outpatient in nature) decided upon by physicians. Whereas ACOs tend to be hospital-centric and focus on primary care quality metrics, CINs are physician-centric and their quality metrics span across all specialties within the network. Furthermore, the CIN must have a robust data collection and analytics system in place to monitor physician performance against these goals, where physicians are removed from the network for consistent underperformance.[59,68]

Since CINs are the newest type of VBCM, the current literature explains their formation and intended goals. However, no studies examine a CIN's ability to improve quality, particularly within readmissions where specialists such as hospital medicine and emergency medicine physicians can be assessed on their individualized performance for quality in relation to readmissions. This dissertation fills that knowledge gap by examining one specific CIN in the Midwestern US to evaluate the effect the CIN's formation has on the improvement of the quality of care. In particular, this study focuses on evaluating whether a physician (emergency medicine, internal medicine and hospital medicine) becoming a participating member of the CIN[9] reduces emergency department and inpatient readmissions.

3.2 READMISSION QUALITY METRICS

Hospital readmissions are touted as one of the most vital quality measures available, because their reduction is one of the best ways to bend the health care cost

[9] There is slight variation in how the three major sponsors (and accompanying chapters) facilitated the physicians becoming participating members in the CIN.

curve. Readmissions are generally defined as a patient being admitted to a hospital within a specified time period after being previously discharged from an earlier (initial) hospitalization.[73] Most readmissions have been reported to occur early, within one month of discharge, which is why this 30-day time frame has been widely adopted and has shown no recognizable difference between a readmission at 29 days versus 31 days after discharge.[49] As a measure of scrutiny, the 30-day readmission metric is easily obtained, granular and simple to measure through an electronic medical record (EMR).[74] The key focus of the readmission outcome measure is not whether any individual readmission is appropriate, but rather whether physician-level variations in readmissions are preventable. While there are no truly unavoidable readmissions, most readmissions are preventable and therefore are the responsibility of the physician and organization.[75]

Readmissions are of utmost importance to track as they are associated with both high utilization and high cost. The frequency of readmissions has been well documented; approximately 20% of Medicare patients discharged are readmitted within 30 days and 34% are readmitted within 90 days. Thus, CMS contends that 75% of these readmissions are potentially preventable.[48,76,77] In terms of cost, CMS reports that expenditures for potentially preventable readmissions may be as high as $15 billion annually amongst the Medicare population and as such has been made a national priority.[75]

Preventable hospital readmissions are just as burdensome to employers. Although patients with private insurance are less likely to experience a readmission than those with public health insurance, the cost of readmitting commercially insured patients is actually higher due to higher payment rates. Nationally, readmissions cost an estimated $25 billion per year for all payers and happen frequently in the commercially insured

population. Furthermore, employers also pay for these readmissions indirectly in reduced productivity and absenteeism.[76] Preventable readmissions are commonly associated with indicators of substandard care during the initial hospitalization such as poor resolution of the main diagnosis, unstable therapy at discharge and inadequate post discharge care; all factors controlled by physicians and health care organizations and thus hold merit to be studied.[49] Therefore, an outcome measure such as readmissions can better reflect the overall performance of the health system being studied and incentivizes physicians and hospitals to emphasize care that is coordinated as a global approach for all patients.

3.3 THEORY: WHY JOINING A CIN MIGHT REDUCE READMISSIONS

Donabedian posited a three-pronged approach to assessing quality derived from structure, process and outcome by suggesting structural factors affect outcomes via their impact on care processes.[78-80] The goal of this theory is to make more explicit the complex relationship between structural elements (hospital volume, organizational makeup, physician attributes, etc.), process elements (surgery or other care pathways) and outcomes (readmissions).[81]

This dissertation's application of Donabedian's theory suggests that a change in structure occurs when physicians become participating members of the CIN and begin providing monthly quality reporting metrics to chapter and sponsor leadership, altering the healthcare setting. This change potentially alters the process through which physicians deliver emergency department (ED) and inpatient care because 1) they are now being evaluated on a monthly basis 2) can be removed from the network if underperforming, and 3) they do not want to lose membership status in the CIN and the accompanying market share of patients that comes with CIN membership. Process

changes can be in the form of physician behavior (the way in which they provide care to the patient) or through reporting (ensuring data capture is correct and complete). Thus, the physicians focus on improving quality outcomes, which are measured in a CIN as outcome metrics for readmissions. This process is shown in Figure 3.1.

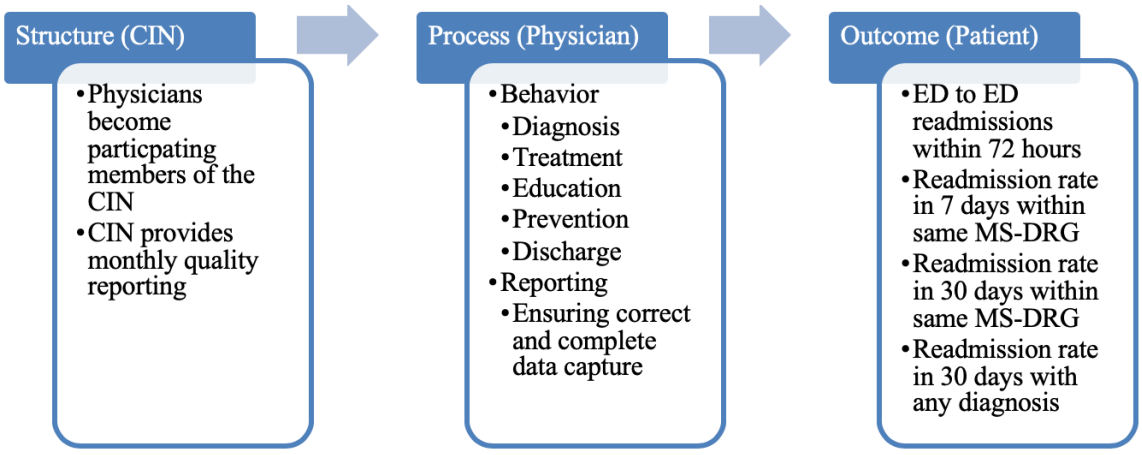

Figure 3.1 Donabedian Theory Relating to Readmission Performance

3.4 STUDY DESIGN AND SETTING

This dissertation uses a retrospective, longitudinal study design. The setting is MPact Health (MPact), a large multi-state CIN in the Midwest spanning across Missouri, Kansas, Oklahoma, Illinois and Arkansas. The CIN is organized into nine regional chapters (eight of which comprise the data) and are labeled as such: Central Missouri, Missouri-Kansas, Northwest Arkansas, Northwest Missouri, Oklahoma, Springfield, MO, St. Louis, MO, Western Arkansas and Southeast Missouri.[10]

MPact is comprised of over 4,000 physicians, 550 clinics and 50 hospitals that are participative members in the network. This dissertation estimates the effect of a

[10] Please note the Southeast Missouri chapter is part of the MPact CIN, but at the time this dissertation was written is not yet collecting and transferring data to the analytics platform and is therefore excluded from this analysis.

physician becoming a participating member of the CIN on quality improvement in readmissions using regression discontinuity (RD) as the empirical strategy. This study is novel compared to the literature as the longitudinal (panel) data structure is comprised of monthly measures following each individual physicians' performance on readmission quality metrics from 2016-2018, for a total of 36 months. The data also includes other supply-side and macroeconomic time-varying covariates from 2016-2018.

3.5 DATA AND SAMPLE

Using the CINs own unique data collection and analytics platform, quality metrics data were collected across approximately 3.1 million patients and 180 million patient encounters from 2016-2018. The sample was constructed by aggregating patient encounters into a monthly readmission quality metric for each physician. This yielded 185 emergency medicine physicians and 189 hospital and internal medicine physicians over the three-year period. The practice location of the physician measured at the Zip Code level was merged by county, with other time-varying characteristics obtained from the Bureau of Labor Statistics (Occupational Employment Statistics) and from the Census Bureau (American Community Survey) for 2016-2018.

3.6 INDEPENDENT VARIABLES

Between the months of October-December of 2017, the MPact executive team embarked on a roadshow by visiting each chapter across the five-state region of the CIN. The purpose of the roadshow was to roll out implementation of the CIN to the practicing physicians within the three sponsoring entities. While attendance was mandatory for physician-leaders, attendance for all other participating physicians was not; however, the roadshow presentation was made available via internal avenues such as internal shared

network drives and human resource files. The roadshow presentation included information on 1) the market landscape, 2) the legality of a CIN, 3) MPact's cost containment strategy and, 4) an overview of the quality metrics chosen by physician leaders. It was explicitly explained membership within the CIN comes with the expectation each physician is to meet or exceed the thresholds of their assigned quality metrics, given their medical specialty. If physicians should fail to meet these goals, action would be taken to "evaluate and modify" their performance with the potential of being removed from the CIN. Furthermore, physicians were given policies regarding participation, performance evaluation, improvement and remediation.

The key independent variable is an indicator (dummy) variable that takes on a value of one in the month of October, November, or December 2017 in which the physician became a participating member of the CIN (when that particular chapter received the roadshow). Below is the mathematical notation that determines the variable:

$$CIN_t = \begin{cases} 1 \; if \; t \geqslant October \; 2017 \; (or \; November \; 2017 \; or \; December \; 2017) \\ 0 \; if \; t \prec October \; 2017 \; (or \; November \; 2017 \; or \; December \; 2017) \end{cases}$$

Here, becoming a member of the CIN is a deterministic function of time. Once the time of the presentation is known, then it is known when the physician became a member of the CIN. Becoming a member of the CIN is also a discontinuous function in time, in that once the month where the presentation took place is reached the physician essentially becomes "treated" by becoming a member of the CIN. Table 3.1 displays the timeline of each chapter in the CIN receiving the roadshow or "treatment".

Table 3.1 Timing of MPact Roadshow by Chapter

Chapter Number	Chapter Name	Treatment Date
1	Western Arkansas	November 2017
2	Central Missouri	October 2017
3	St. Louis	November 2017
4	Missouri-Kansas	October 2017
5	Springfield	December 2017
6	NW Arkansas	November 2017
7	Oklahoma	December 2017
8	NW Missouri	November 2017

3.7 DEPENDENT VARIABLES

The dependent variables are outcome quality metrics associated with readmissions within eight specific chapters of the CIN.

ED to ED readmissions within 72 hours (ED): This metric is a hospital-care metric for physicians within the emergency medicine specialty, yielding 6,624 observations. The metric is defined as the percentage of patients readmitted within 72 hours from ED to ED with any diagnosis. Specifically, a patient qualifies if they are discharged from an emergency department admission and is subsequently readmitted to the emergency department within 72 hours. For ED to ED readmissions, any attending physicians attached to the patient receive the readmission count. As a result, a particular patient could have multiple physicians involved. However, this is unlikely in the ED setting, as the more prevalent encounter is where only one physician attends the initial

ED visit. Figure 3.2 depicts how the assignment of a readmission count is attributed to an emergency medicine physician.

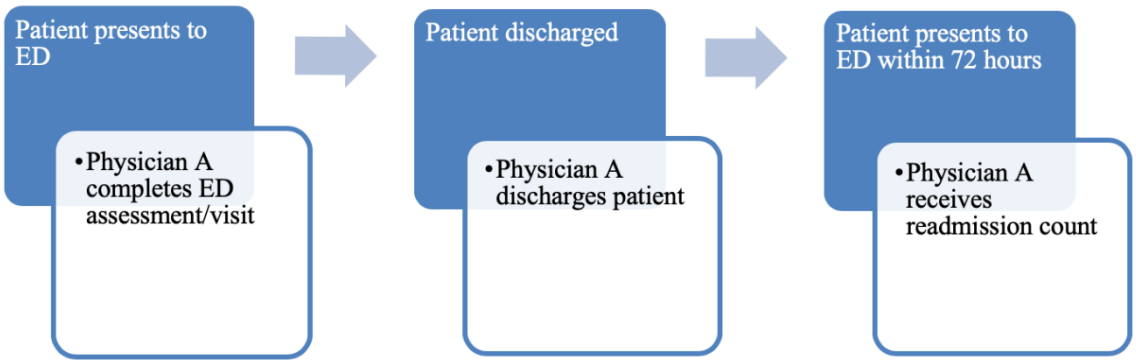

Figure 3.2 Assignment of ED Readmission Count

Readmissions in seven days within same MS-DRG[11] (7Day): This metric is a hospital-care metric for physicians within the specialties of hospital medicine and internal medicine, yielding 6,804 observations. The metric is defined as the percentage of patients readmitted within seven days with the same MS-DRG. Specifically, a patient qualifies if they are discharged after an inpatient encounter and then readmitted for an inpatient encounter for an issue in the same MS-DRG within seven calendar days.

Readmissions in 30 days within same MS-DRG (30DaySame): This metric is a hospital-care metric for physicians within the specialties of hospital medicine and internal medicine, yielding 6,804 observations. The metric is defined as the percentage of patients readmitted within 30 days with the same MS-DRG. Specifically, a patient qualifies if they are discharged after an inpatient encounter and then readmitted for an inpatient encounter for an issue in the same MS-DRG within 30 calendar days.

[11] MS-DRG is the Medicare Severity-Diagnostic Related Group used to classify hospital care into one of 476 groups. Patients are assigned to a particular MS-DRG based on diagnosis, procedures, age, sex and discharge status.

Readmissions in 30 days with any diagnosis (30DayAny): This metric is a hospital-care metric for physicians within the specialties of hospital medicine and internal medicine, yielding 6,840 observations. The metric is defined as the percentage of patients readmitted within 30 days with any diagnosis. Specifically, a patient qualifies if they are discharged after an inpatient encounter and then readmitted for an inpatient encounter for any issue within 30 calendar days.

For all inpatient readmission dependent variables (7Day, 30DaySame and 30DayAny), the last attending physician attached to the patient receives the readmission count, regardless of how many physicians treated the patient receiving care during the inpatient stay. Figure 3.3 depicts how the assignment of a readmission count is attributed to a hospital medicine or internal medicine physician.

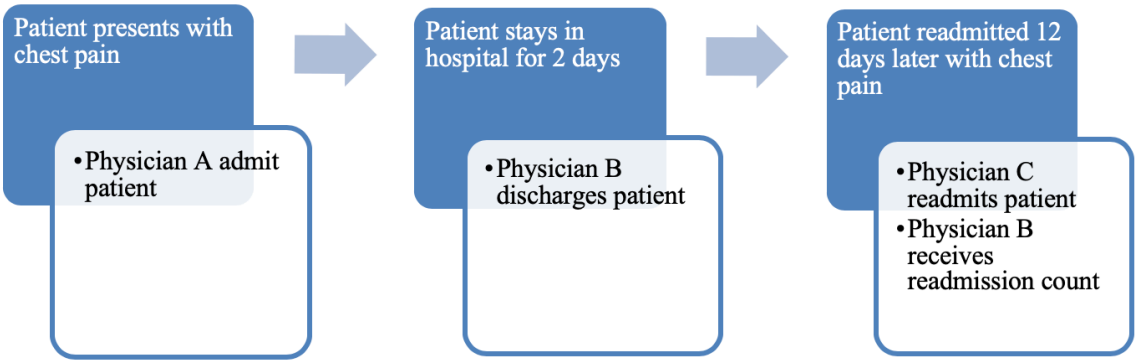

Figure 3.3 Assignment of Inpatient Readmission Count

All the dependent variable metrics are considered to be rolling metrics; meaning the metrics are reported on a rolling 12-month basis. For example, if a patient is readmitted (and this count is therefore attributed to a physician), the particular readmitted patient will be counted as a part of this total metric for 12 months until the encounter drops out of the calculation. The reason a rolling metric is utilized for measurement of performance is it allows physicians who may go on vacation or who are not on call for a

particular month to consistently have data reported across the time they are affiliated with the CIN. Furthermore, the data analytics tool from which MPact gathers their quality metric data is only able to pull data from physicians who have a total patient count of at least 30 over a specified time period. This minimum count is not typically a concern when looking at a physicians' performance on readmissions, as even in the most rural areas of MPact's network, readmissions still meet this minimum count. However, this minimum count does become problematic for sub-specialists such as neurosurgeons and cardiothoracic surgeons whose total patient counts are far less in any given month. Couple this with surgeons who serve rural communities or go on vacation for several weeks and the total patient count dips dramatically. The 12-month rolling reporting system is put in place to counteract these possible fluctuations and ensure data is being recorded for all physicians on a monthly basis.

3.8 EMPIRICAL STRATEGY

To determine the effect of physicians becoming participating members of the CIN on physician performance, this dissertation employs a regression discontinuity (RD) design on physician-level panel data to estimate a local average treatment effect (LATE). RD designs are of growing importance within economics;[82-84] a handful of applications are being used to understand how changes in health insurance policies affect utilization and cost.[85-88] However, these designs are still underutilized within medicine and public health.[89,90]

This dissertation follows an application of the RD design by using time as the assignment variable to identify the effects of CIN membership; referred to as RDiT. [82,91-94] To apply RDiT in this dissertation, panel data on physician performance is needed.

With this data structure, following the individual physician's performance over each month in time from 2016 to 2018 allows for the use of time-invariant aspects associated with the physician that might affect their performance to be controlled for using "fixed" effects.

In this RDiT design, the month acts as the assignment variable determining when a physician became a member in the CIN ($CIN_{i,c,t}$). In sharp RD designs, the treatment switches on as the assignment variable passes a cutoff. Applied to this context, when *t* passes October 2017 (or November or December 2017 depending on when the chapter received the presentation) the physician becomes "treated" by becoming a member of the CIN. A linear regression estimating equation demonstrating the RDiT is:

$$y_{i,c,t} = \propto_0 + \delta_1 CIN_{i,c,t} + \theta_i + X'_t\lambda_t + Y'_{ic}\beta_{ic} + \varepsilon_{i,c,t}$$

Where, $y_{i,c,t}$ is the readmission quality metric (ED, 7Day, 30DaySame or 30DayAny) for each physician (emergency medicine, hospital medicine or internal medicine), *i*, in chapter, *c*, during month, *t.* The parameter, δ_1, captures the effect of the physician becoming a member of the CIN on the readmission quality metric (physician performance). The equation includes, θ_i, which represents physician fixed effects mentioned above, $X'_t\lambda_t$, which is a time fixed effect including months 1-36 and $Y'_{ic}\beta_{ic}$, which captures a chapter fixed effect for eight chapters. The error term, $\varepsilon_{i,c,t}$, represents the remaining unobserved variation in physician attributes.

The key assumption for identification in an RD is physicians are unable to precisely manipulate the assignment variable (month in which their chapter joined the CIN) then the variation in the quality metric near the time of joining is randomized. This assumption holds because MPact determined the date of the roadshow within each

chapter, not the individual physician. Descriptive summary statistics were conducted to characterize the data, identify outliers, and address any misreported data. All descriptive and inferential statistics were conducted using Stata/MP 15.1 (StataCorp LP; College Station, TX).

3.9 VALIDATING THE USE OF REGRESSION DISCONTINUITY

Guidance to researchers in applying and validating the RD and RDiT designs has been evolving since 2010.[82,90,95,96] Keys to validation of the design lie in a graphical inspection of the data and conducting careful sensitivity analyses. In applying this guidance, I first graphed the quality metrics that represent the dependent variable against the individual months from 2016 to 2018 and visually looked for breaks in trend around the time of the roadshow. It has become standard to summarize the effect of RD and RDiT designs by showing the relationship between the dependent variable and the assignment variable.[90] Visualization of the quality metrics against time should show whether a change in performance occurred around the time of the road show. It also helps to elucidate whether the relationship between physician performance and time is linear, or if other non-linear specifications are needed.

My estimation accounts for the presence of time-varying confounders by running specifications that include controls for other major supply and demand factors that might affect physician performance. A description of these variables and their sources is outlined in Section 3.10.

3.10 IMPORTANCE OF CONTROLS AND TIME-VARYING COVARIATES

Since this study uses panel data that follows each individual physicians' monthly performance on readmission quality metrics, I am primarily relying on the within

physician variation to control for some of the unmeasured physician characteristics. The assumption is the physician is serving as his or her own control and that the unmeasured physician characteristics that are fixed will not confound the estimate of the roadshow. In this context, a "fixed" effect means the variable has the same effect on the physician performance prior to and after the roadshow. For example, the gender or race of the physician does not change from 2016 to 2018; therefore, they do not have an effect on the dependent variables of interest, when panel data is used to estimate the effect. However, aspects about the physician or their environment that can affect performance must be controlled for. Additional time varying physician level data is not available; however, examples of time-varying county-level variables from the macro level that might affect a physicians' performance are found in Table 3.2.

Table 3.2 Covariate Data Sources

Variable	Year(s)	Geographic Level	Source
Number of Primary Care Providers (Supply-Side)	2016-2018	Metropolitan and Non-Metropolitan Areas	Occupational Employment Statistics, Bureau of Labor Statistics
Total Population (Demand-Side)	2016-2017 2018*	County	American Community Survey, 1-year estimates, Census Bureau
Percent Insurance (Demand-Side)	2016-2017 2018*	County	American Community Survey, 1-year estimates, Census Bureau
Percent Non-White or Hispanic (Demand-Side)	2016-2017 2018*	County	American Community Survey, 1-year estimates, Census Bureau

*2018 data to be released in October 2019

These variables change over time and might affect readmission quality metrics because they affect the demand and supply of patients with readmissions. They are

measured at the county level and vary annually because this is the smallest geographic level that allows for the most variation over time. Searches of publicly available data at the county-level did not reveal monthly measures. The variables found in Table 3.2 were also used in similar studies evaluating the impact of PCMHs and ACOs on quality.[24,30,36,40]

3.11 RESULTS

Table 3.3 presents descriptive statistics of dependent variables (quality metrics) and covariates by year (2016-2018).

Table 3.3 Descriptive Characteristics of Readmission Quality Metrics

Dependent Variables	***2016 (1)***	***2017 (2)***	***2018 (3)***	***2016-2018 (4)***
ED				
n	2,208	2,208	2,208	6,624
Mean	0.036	0.038	0.040	0.038
Standard Deviation	0.012	0.012	0.013	0.012
Min	0	0	0	0
Max	0.079	0.091	0.101	0.101
7Day				
n	2,268	2,268	2,268	6,804
Mean	0.007	0.007	0.008	0.007
Standard Deviation	0.007	0.009	0.012	0.009
Min	0	0	0	0
Max	0.063	0.111	0.111	0.111
30DaySame				
n	2,268	2,268	2,268	6,804
Mean	0.021	0.022	0.022	0.022
Standard Deviation	0.037	0.021	0.018	0.027
Min	0	0	0	0
Max	1	0.333	0.119	1
30DayAny				
n	2,280	2,280	2,280	6,840
Mean	0.123	0.136	0.146	0.137
Standard Deviation	0.062	0.069	0.078	0.070
Min	0	0	0	0
Max	1	1	1	1
Covariates				

Physician			
n	5,8685	6,048	5,832
Mean	1,193.19	1,044.702	952.099
Standard Deviation	1,218.768	1,094.032	962.482
Min	50	50	90
Max	2,750	2,570	2,340
Total Population			
n	5,544	5,544	
Mean	436,585.40	438,067.40	
Standard Deviation	356,244.00	355,815.40	
Min	83,972	85,006	
Max	986,410	984,505	
Percent Uninsured			
n	5,544	5,544	
Mean	8.680	9.266	
Standard Deviation	2.221	2.268	
Min	6.50	6.40	
Max	13.60	13.70	
White			
n	5,544	5,544	
Mean	327,133.20	326,168.60	
Standard Deviation	234,623.70	230,774.40	
Min	77,933	76,775	
Max	684,030	674,608	
Black			
n	3,168	2,232	
Mean	123,794.20	172,850.30	
Standard Deviation	101,284.90	84,293.60	
Min	10,029	14,127	
Max	238,612	241,023	

In general, quality measures remained consistent across the three-year time period and saw a very slight increase as the years progressed. Across the entire sample, average ED readmissions performance (Column 4) was 3.8% with a minimum of zero and a maximum of 10%. In each individual year, average ED readmissions increased from 3.6% in 2016 to 4% in 2018 (Columns 1-3). Both 7Day readmissions and 30DaySame readmissions saw smaller averages across the sample, 0.7% and 2.2% (Column 4), respectively. For both these variables, variation in the average across the individual years

was limited. Average 30DayAny readmissions across the sample were higher as compared to the 30DaySame metric, 13.7% vs. 2.2% (Column 4). This is expected since readmissions for the 30DayAny metric 30-day period are counted for any diagnosis within this 30-day period, whereas the readmission for the 30DaySame metric is only counted for the same MS-DRG. Both 30DaySame and 30DayAny metrics had maximum values of 100%. While initially these maximum values may seem like outliers, these physicians remained within the sample for two reasons. First, many physicians within Mpact's network practice in rural settings. As such, a physician may care for only one patient in a given month. If that one patient is readmitted within the 30-day timeframe, the metric shows a 100% readmission performance for the physician and still warrants inclusion. Second, this scenario was seen across numerous physicians and chapters, further justifying inclusion in the estimation.

Across each individual year, averages for both 30DaySame and 30DayAny readmissions showed little variation across the sample. 30DaySame slightly increased from 2.1% in 2016 to 2.2% in 2018 while 30DayAny increased from 12.3% in 2016 to 14.6% in 2018 (Columns 1-3). The covariates also demonstrated had little fluctuation in their averages across individual years. Number of primary care physicians in the sample showed a slight decrease year over year (Columns 1-3); this follows suit to the national trend.[97,98] Total population slightly increased as well as percent uninsured. Lastly, percent of the population that is white slightly decreased while percent black had a sizable increase.

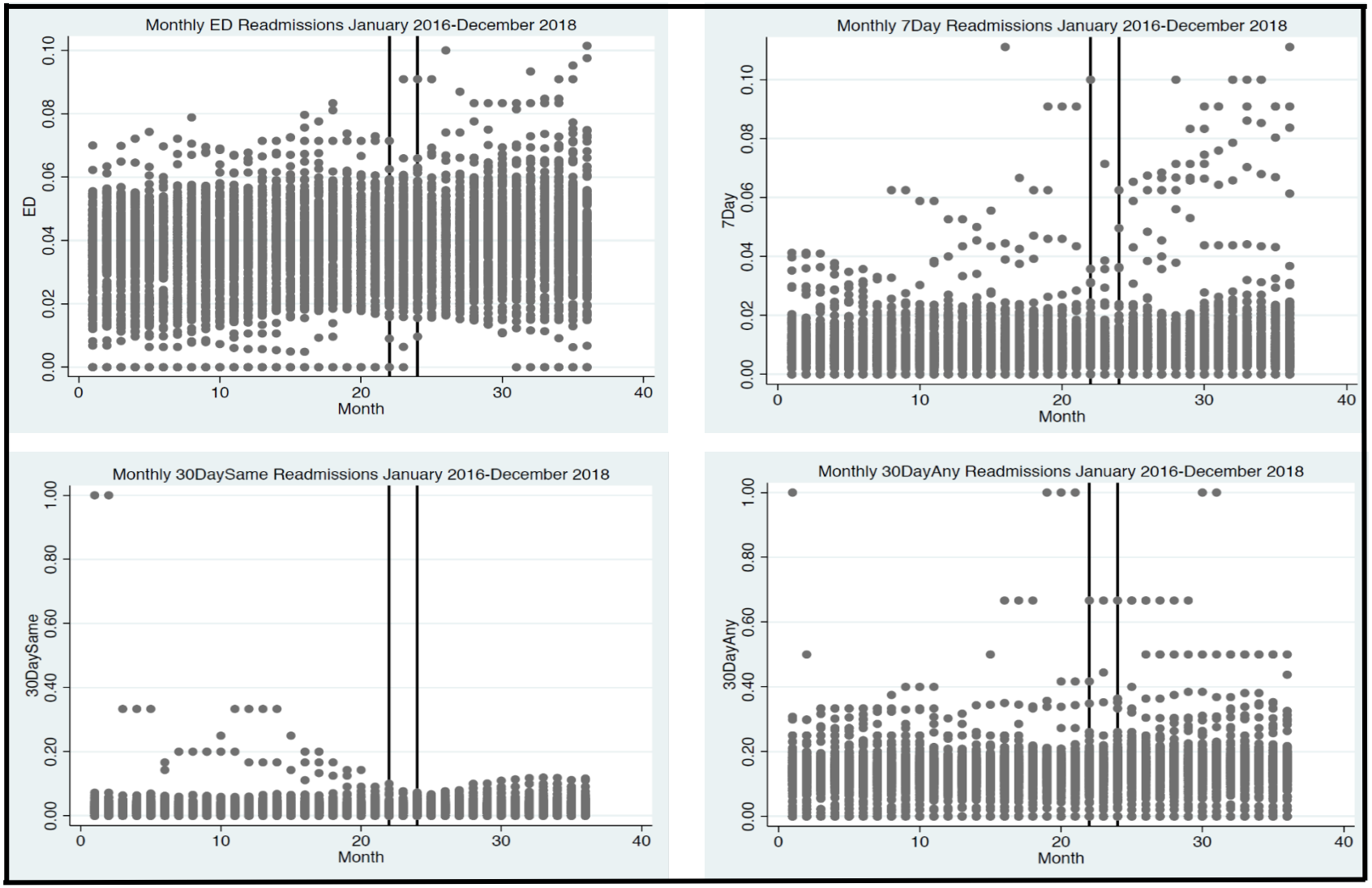

Figure 3.4 Scatter Plots of Dependent Variable Readmission Metrics Over Time

In Figure 3.4, scatter plots show the relationship of the readmission metrics over time. These were examined for visible breaks or discontinuity in trend around the time of the roadshow to see if the CINs formation may have an impact on physician performance. Upon inspection in the top left panel and bottom left panel of Figure 3.4, the ED and 30DaySame metrics remained relatively static over time. For the ED metric many of the observations lie between 1% and 6%; for the 30DaySame metric most observations lie between 0 and 1.5%. In the top right panel and bottom right panel, the 7Day and 30DayAny measures show a bit more variation overall. While both metrics show most observations lie between 0 and 2.5%, there are considerably more outlying data points than in the ED and 30DaySame metrics.

In Table 3.4, I present estimates demonstrating the impact of physicians becoming participating members of a CIN (MPact) on readmissions. I employed three models consisting of different empirical specifications. The first model exploits the variation in the readmission metrics over time and controls for physician-fixed effects. In the second model, chapter and time fixed effects are added to the first model's specification. In the third model, time-varying county-level controls are added to the second model's specification.

Overall, there were no discernable statistically significant findings for the impact of physicians becoming participating members of the CIN on emergency department and inpatient readmissions (Table 3.4). Three statistically significant findings indicate a slight increase in ED (0.003), 7Day (0.0013) and 30DayAny (0.0133) readmissions when including only physician-fixed effects in the estimating model.

Table 3.4 The Effect of Physicians Becoming Members of a CIN on Emergency Department and Inpatient Readmissions Quality Metrics

Dependent Variable	*Model*	$\delta_1 CIN_{i,c,t}$	*Physician Fixed Effect*	*Chapter & Time Fixed Effect*	*Time-Varying Controls*
ED	***1***	0.0003* (0.0007)	X		
	2	-0.0002 (0.0007)	X	X	
	3	-0.0009 (0.0008)	X	X	X
7Day	***1***	0.0013* (0.0007)	X		
	2	-0.0005 (0.0011)	X	X	
	3	0.0012 (0.0012)	X	X	X
30DaySame	***1***	0.0004 (0.0014)	X		
	2	0.0011 (0.0021)	X	X	
	3	-0.0088 (.0042)	X	X	X
30DayAny	***1***	0.0133* (0.0038)	X		
	2	-0.0072 (0.0051)	X	X	
	3	-0.0040 (0.0057)	X	X	X

* Significant at <.01

Although this model shows an increase in readmissions, the magnitude is virtually zero, and factors outside of the roadshow within the chapter, or a specific month in time may be driving these effects. In controlling for those factors, models two and three demonstrate declines in all readmission metrics, however the effects are not statistically significant.

3.12 DISCUSSION

Across specifications, there were no meaningful statistically significant findings of the effect of physicians becoming members of a CIN (MPact) across all four

readmissions quality metrics. These findings are consistent with previous literature on VBCMs that examine quality of care as an outcome of interest [34,36,39,40,99] There are two main explanations for these findings. First, looking at the presence of the treatment (the CIN formation through the roadshow) and expecting there to be a comprehensive impact on physician-level readmission outcome metrics may be too indirect. Physicians were not required to attend the CIN presentation by MPact in person. This lack of a requirement for attendance makes sense, as requiring all emergency medicine, hospital medicine and internal medicine physicians to leave their work to attend a presentation would almost certainly result in adverse patient events. Furthermore, while the roadshow presentation was made available through internal channels such as human resources and shared network drives, there is no way to know exactly which physicians viewed the presentation, and if they did view it, the timing of when it was viewed. The lack of a requirement to attend the presentation in person or view it via internal channels explains the lack of effect on readmission quality metrics.

Second, MPact is comprised of already high-performing health systems, whose readmission quality metrics are fairly low. For example, the average 30DaySame readmission across the sample showed limited variation (2.1% to 2.2% average) across time; while the national average readmission variation is between 7% and 14%.[100] Since the readmission quality metrics are already low (the national average is around 20%)[100] demonstrating limited readmissions, improving upon them is fundamentally more difficult. Mosaic and Mercy have been two of the leading success stories in the country amongst ACOs. While ACO metrics differ from those evaluated in this dissertation, it is reasonable to assume the high performance demanded within an ACO may spillover to

the physician quality metrics assessed by the CIN. This may also explain the low averages for each readmission metric such as 7Day readmissions, which averaged a 0.7% readmission performance. Therefore, the impact of the roadshow presentation may not have had an effect because physicians were already at near optimal performance.

The findings from this chapter suggest that a strategy targeted directly towards physicians within MPact could more clearly improve readmission metrics. Per the Donabedian model, the next logical step would be to make the conceptual framework tighter by conducting a more impactful structural change targeted toward dissemination of metrics. Such a strategy would involve dissemination of each individual physicians' readmission metric outcomes being given directly to each emergency medicine, hospital medicine and internal medicine physician. Furthermore, taking an additional step to unblind these results so that physicians can not only see their own performance but the performance of their peers, would potentially have an even greater effect on quality. Behavioral economic literature has shown that physicians who have a true sense of ownership will exhibit the strongest response to quality-based incentives as their reputations are at stake and they hold residual claim to any value added to the organization.[101-103]

Another possible strategy could be the implementation of financial incentives tied to each readmission metric. While MPact's current incentives increase market share with risk of being removed from the network for underperformance, these may not be strong enough to elucidate an effect. There is substantial literature regarding positive physician response through the use of financial motivation.[14,104-107]

These findings should be interpreted within the limitations of the study. First, this analysis did not compare this CIN to other VBCMs such as ACOs and PCMHs but instead compared physicians within this one CIN over time. Thus, these findings cannot make conclusions about quality outcomes in the CIN model versus other models. Likewise, this study cannot assert findings on any other established CINs. Instead, the goal was to evaluate physician performance both within individual physicians and across physicians over time through the use of readmission quality metrics. Second, these readmission metrics, while evaluated monthly for each physician, are aggregated and reported on for a rolling 12-months. MPact's reasoning for this is twofold. One, by using a rolling 12 months it eliminates small sample sizes on a monthly basis and two, this is the standard way their data analytics platform reports data. Unfortunately, this method of reporting thwarts variation whereas using the raw monthly performance per physician maintains greater variation both within and amongst physicians for a more accurate measure. Third, although the quality metrics in the database encompass all payers (private, self-insured, Medicare, Medicaid, Tricare, etc.), I do not know if certain physicians have a predominant payer mix, which could influence results. This was somewhat adjusted for using covariates, but this method was imperfect as many physicians could not be matched to a specific zip code.

3.13 CONCLUSION

This dissertation provides the first early evaluation of quality performance of physicians participating in a CIN. Furthermore, this study contributes to the growing body of literature on the impact of VBCMs on health care quality outcomes. Overall, the findings of this chapter of the dissertation suggest little impact on readmission metrics

after physicians became participating members of the CIN. Because the CIN model is new, it is likely its impact will increase over time. Therefore, future research should incorporate additional years of data to evaluate these effects along with any future strategies MPact adopts to improve quality outcomes.

CHAPTER 4

QUALITY IN CARDIOVASCULAR DISEASE

4.1 BACKGROUND: THE NEED FOR VALUE-BASED CARE

Fee-for-service (FFS) is the historically popular mechanism the US has used for physician compensation. Through FFS, physicians are reimbursed retrospectively for each service rendered based upon annual fee schedules or billed charges without taking into account the cost or resulting outcome. While this model is beneficial due to its ease of implementation and monitoring, it has resulted in physicians being incentivized to overuse and misuse medical services. As a concept, FFS promotes quantity over quality where physicians assume an overbearing number of patients. This fosters poor time commitment for communication and coordination between other physicians, creating a siloed and fragmented system.[7,8] The Affordable Care Act (ACA) forced a paradigm shift to instead begin paying for value, defined as the health outcomes or quality of care the patient receives in relation to and conscious of the cost to provide such care.[9,10] This new reimbursement method is referred to as a value-based care model (VBCM) as it ties payment for the delivery of health care services directly to the quality of health care being provided and rewards physicians for implementing an efficient and effective medical practice; incentivizing quality over quantity.[11,12]

The patient-centered medical home (PCMH) is one model included as a federal demonstration program in the ACA and has since expanded to private payers.[15] PCMHs promote improvements to primary care coupled with the implementation of advanced

electronic medical records (EMR), care transition teams, population health initiatives and quality outcome reporting for payments, typically seen as per-patient-per-month fees for services rendered.[16-18] Accountable care organizations (ACOs) are another type of VBCM centered around primary care and introduced by the Centers for Medicare and Medicaid Services (CMS) to provide these beneficiaries with high quality medical care. They have been touted as the most promising result to drive down cost and improve quality; there are now more than 700 ACOs across the country. If an ACO succeeds in delivering coordinated care at the lowest possible cost, the savings are shared with CMS. However, the ACO does go at risk to lose money if it underperforms on cost and quality and is taken as financial loss.[20]

The vast majority of PCMH and ACO literature focuses on improvement in cost reduction; quality results have been scarce and mixed.[25,30,35,40] Various studies amongst PCMHs have shown improvements in patient satisfaction, disease management and preventive health while other studies have shown poor quality outcomes in hospitalization and emergency medicine.[28-33] Alternatively, one study found there was no impact on any quality improvement metrics from nine separate and distinct PCMHs.[34]

Similarly, ACOs have shown inconsistencies in quality outcomes. The greatest improvements in quality have been in the areas of heart failure, surgery outcomes, fall risk, pneumonia vaccinations and depression screenings.[19,35-38] Conversely, studies have shown poor quality outcomes among ACOs in the areas of 30-day readmissions, asthma and diabetes care, prostate cancer treatment, adverse perioperative outcomes and no discernable decrease in post-operative morbidity, mortality and readmissions.[39-45]

Overall, VBCM success lies in both cost containment and quality improvement; the latter is difficult to define and measure as data is not readily accessible. Even when a VBCM is able to define quality metrics, they are often difficult to collect and analyze, as many inconsistencies exist. PCMHs were originally formed as a way to practice medicine with the primary care physician at the epicenter and did not include any incentive or penalty designs, which could explain why many have resulted in small amounts of overall quality improvements.[108] Likewise, PCMHs have focused on their patient population using a fixed set of structural features where high-risk patients are unaccustomed to utilizing primary care services and instead utilize inpatient and emergency services, which results in low comorbidity control and care continuity for these patients.[109] Similarly, some ACO literature has concluded the Medicare population of an ACO, linked with old age and chronically ill patients, is credited with the quality demise. It has therefore been suggested this population is simply not ideal to study quality outcomes.[19]

In response to the challenges facing PCMHs and ACOs, a new VBCM called a clinically integrated network (CIN) has emerged amongst the commercially insured population. The CIN originated as employers began to search for better options to control health care costs and ensure consistent quality of care for their employees. A CIN is considered a legal entity under the Federal Trade Commission (FTC) and Department of Justice (DOJ) consisting of a network of otherwise independent physicians and hospitals/health systems collectively committing to cost containment and quality improvements, built upon the ACA. [58,60] Through an overall cost guarantee, a CIN negotiates directly and takes on risk with employers for commercial payer contracts

under safe harbor antitrust law. Where the CIN model takes cost one step further than other VBCMs is the commitment to quality; the CIN must meet or exceed quality metrics before the CIN can qualify for the risk sharing payout.[59,65] In order to properly monitor quality outcome metrics (both inpatient and outpatient) through physician performance, the CIN must have a robust data collection and analytics platform. This is necessary for the CIN to measure physicians against the metrics in order to "evaluate and modify" practice patterns and behavior. Lastly, any physicians continuously not meeting the threshold for the quality metrics can be removed from the network.[59,68] Given the legal requirements, organizational structure and commercial patient population, the CIN may be more conducive for studying its effect on quality compared to other VBCMs.

Since CINs are the newest type of VBCM to enter the market, the current literature explains their formation and intended goals. However, no studies examine the ability of a CIN to improve quality outcomes, particularly with a condition like cardiovascular disease (CVD) where specialists, such as cardiologists and cardiothoracic surgeons, can be assessed on their individualized performance for quality in relation to CVD. This dissertation fills this knowledge gap by examining one specific CIN in the Midwestern US to evaluate the effect the CINs formation has on the improvement of the quality of care. In particular, this study focuses on evaluating whether a physician (cardiologist or cardiothoracic surgeon) becoming a participating member of the CIN_{12} improves quality outcomes in CVD.

[12] There is slight variation in how the three major sponsors (and accompanying chapters) facilitated the physicians becoming participating members in the CIN.

4.2 CARDIOVASCULAR DISEASE QUALITY METRICS

CVD is a class of diseases or diagnoses that involve the heart or blood vessels. The most common diseases under the CVD umbrella are Coronary Artery Disease (CAD), Congestive Heart Failure (CHF), Acute Myocardial Infarction (AMI), hypertension, cardiomyopathy and arrhythmias.[110] CVD is the leading cause of death in the US accounting for approximately 800,000 deaths per year; moreover, nearly 965,000 people a year suffer AMI. Likewise, CVD is associated with a significant risk of mortality and reduced quality of life.[111]

CVD costs the US health care system around $315 billion dollars annually in health care services, medications and lost productivity and is projected to triple by 2030 to almost $900 billion. [112] CVD also sees the highest utilization rates in the health care industry compared to other prevalent diseases. It is estimated that by 2030, almost half of the US population will present with some form of CVD. [113,114] The economic burden of CVD is just as troublesome to employers due to its chronic nature. This disease is highly prevalent among the working population; almost 47% of CVD patients are younger than 64 years of age and therefore are likely to need to continue working.[115] Employers are interested in reducing rates of chronic diseases such as CVD as they bear about 85% of the total employee medical costs, with hypertension comprising the largest share.[116] Furthermore, the impact of CVD on physical and mental wellbeing greatly impairs an individual's ability to engage in work and productivity. Estimated CVD-related productivity loss is around $192 billion and presenteeism costs around $43 billion in the US. Likewise, people employed while suffering CVD often require long lengths of time off to recover from illness and surgery related to this illness; reducing their income and

overall employer output. This creates a productivity loss in the wider economic sense when people of working age die due to CVD; it is approximated that 17% of CVD death occur in people younger than age 65.[111] Employers are growing more concerned for their workforce and their bottom line and are in need of physicians and programs to help curb the costs and utilization of CVD. A model such as the CIN may be able to help reduce cost and improve quality for CVD patients and employers alike.

4.3 THEORY: WHY JOINING A CIN MIGHT IMPROVE QUALTY IN CVD

Donabedian posited a three-pronged approach in the assessment of quality derived from structure, process and outcome; postulating structural factors affect outcomes via their impact on processes.[79] The goal of this theory is to explicitly describe the complex relationship between structural elements (hospital volume, organizational makeup, physician attributes, etc.), process elements (diagnosis, procedures or other care pathways) and outcome (disease improvement).[117,118]

This dissertation's application of the Donabedian theory suggests a change in structure occurs when physicians become participating members of the CIN, altering the setting. This change then potentially alters the process through which physicians deliver care to patients with CVD because 1) they are now being evaluated on a monthly basis, 2) can be removed from the network if underperforming, and 3) they do not want to lose membership status in the CIN and the accompanying market share of patients that naturally transpires with CIN membership. Process changes can be in the form of physician behavior (the way in which they provide care to the patient) or through reporting (ensuring data capture is correct and complete). Thus, the physicians focus on

improving corresponding process outcomes, which are measured in a CIN as process metrics for patients with CVD. This process is shown in Figure 4.1.

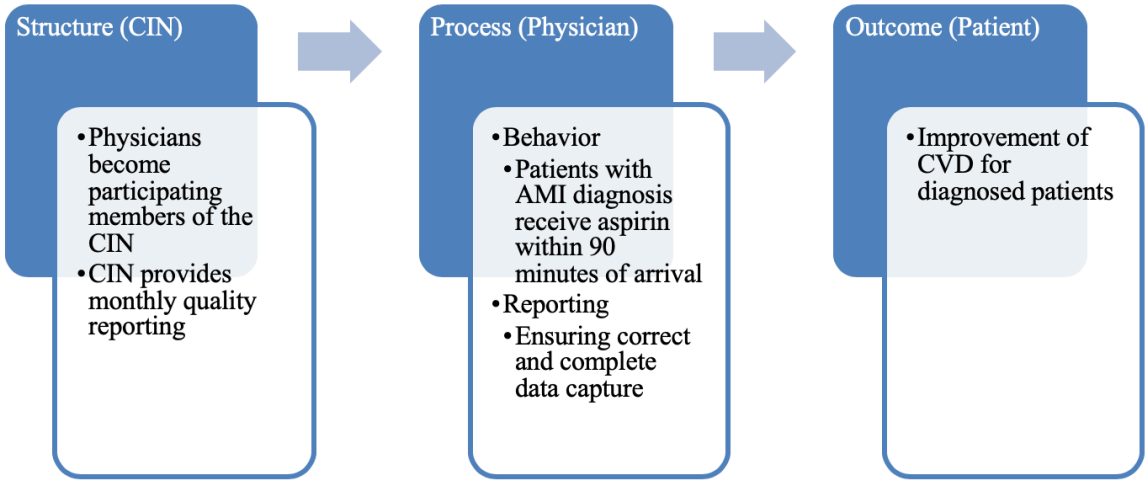

Figure 4.1 Donabedian Model in Relation to CVD Quality

4.4 STUDY DESIGN AND SETTING

This dissertation uses a retrospective, longitudinal study design. The setting is MPact Health, a large multi-state CIN in the Midwest spanning across Missouri, Kansas, Oklahoma, Illinois and Arkansas. The CIN is organized into nine regional chapters (eight of which comprise the data) and are labeled as such: Central Missouri, Missouri-Kansas, Northwest Arkansas, Northwest Missouri, Oklahoma, Springfield, MO, St. Louis, MO, Western Arkansas and Southeast Missouri.[13]

MPact is comprised of over 4,000 physicians, 550 clinics and 50 hospitals that are participative members in the network. This dissertation estimates the effect of a physician becoming a participating member of the CIN on quality improvement in CVD using regression discontinuity (RD) as the empirical strategy. This study is novel

[13] Please note that the Southeast Missouri chapter is a part of the MPact CIN, but at the time this dissertation was written is not yet collecting and transferring data to the CIN collections and analytics platform and is therefore excluded from this analysis.

compared to the literature as the longitudinal (panel) data structure is comprised of monthly measures following each individual physician's performance on CVD quality metrics from 2016-2018, for a total of 36 months. The data also includes other supply-side and macroeconomic time-varying covariates on a monthly basis from 2016-2018.

4.5 DATA AND SAMPLE

Using the CINs own award-winning data collection and analytics platform, quality metrics data were collected across approximately 3.1 million patients and 180 million patient encounters from 2016-2018. The sample was constructed by aggregating patient encounters into a monthly CVD quality metric for each physician. To be included in the sample, the physician had to be a participating member of MPact in 2016, 2017 and 2018. This yielded 35 cardiothoracic surgeons and 55 cardiologists over the three-year period. The practice location of the physician measured at the Zip Code level was merged by county with other time-varying characteristics obtained from the Bureau of Labor Statistics (Occupational Employment Statistics) and from the Census Bureau (American Community Survey) for 2016-2018.

4.6 INDEPENDENT VARIABLES

Between the months of October-December of 2017, the MPact executive team embarked on a roadshow by visiting each chapter across the five-state region of the CIN. The purpose of the roadshow was to roll out implementation of the CIN to the practicing physicians within the three sponsoring entities. While attendance was mandatory for physician-leaders, attendance for all other participating physicians was not; however, the roadshow presentation was made available via internal avenues such as internal shared network drives and human resource files. The roadshow presentation included

information on 1) the market landscape, 2) the legality of a CIN, 3) MPact's cost containment strategy and, 4) an overview of the quality metrics chosen by physician leaders. It was explicitly explained membership within the CIN comes with the expectation each physician is to meet or exceed the thresholds of their assigned quality metrics, given their medical specialty. If physicians should fail to meet these goals, action would be taken to "evaluate and modify" their performance with the potential of being removed from the CIN. Furthermore, physicians were given policies regarding participation, performance evaluation, improvement and remediation.

The key independent variable is an indicator (dummy) variable that takes on a value of one in the month of October, November, or December 2017 in which the physician became a participating member of the CIN (when that particular chapter received the roadshow). Table 4.1 displays the timeline of each chapter in the CIN receiving the roadshow or "treatment".

Table 4.1 Timing of MPact Roadshow by Chapter

Chapter Number	***Chapter Name***	***Treatment Date***
1	Western Arkansas	November 2017
2	Central Missouri	October 2017
3	St. Louis	November 2017
4	Missouri-Kansas	October 2017
5	Springfield	December 2017
6	NW Arkansas	November 2017
7	Oklahoma	December 2017
8	NW Missouri	November 2017

Below is the mathematical notation that determines the variable:

$$CIN_t = \begin{cases} 1 \; if \; t \geqslant October \; 2017 \; (or \; November \; 2017 \; or \; December \; 2017) \\ 0 \; if \; t \prec October \; 2017 \; (or \; November \; 2017 \; or \; December \; 2017) \end{cases}$$

Here, becoming a member of the CIN is a deterministic function of time, so once time the presentation took place is known, then it is known when the physician became a member of the CIN. Becoming a member of the CIN is also a discontinuous function in time, in that once the month where the presentation took place is reached the physician essentially becomes "treated" by becoming a member of the CIN.

4.7 DEPENDENT VARIABLES

The dependent variable is a process quality metric associated with CVD.

Patients with AMI diagnosis and received aspirin within 90 minutes of arrival (AMI): This process metric is a hospital-care metric for physicians within the cardiothoracic surgery and cardiology specialties and is specific to the disease state of AMI under the CVD umbrella. Giving patients aspirin during the early stages of a heart attack is shown to slow the risk of clotting and decrease the size of any blood clots have already formed.[119] This metric is defined as an indication of whether the patient received a delivery of aspirin within the first 90 minutes of the selected encounter. Specifically, principal AMI diagnosis is defined according to the National Hospital Quality Measure standard as patients (encounters) who received an ICD-9 diagnosis code of 410.*0 or 410.*1, or equivalent ICD-10 diagnosis code. Only inpatients who have been discharged are available for reporting.

The dependent variable metric is considered to be a rolling metric; meaning the metric is reported on a rolling 12-month basis. For example, if a patient is not prescribed aspirin within the 90-minute window, the particular CVD patient will be counted as a part

of this total metric for 12 months until the encounter drops out of the calculation. The reason a rolling metric is utilized for measurement of performance is it allows physicians who may go on vacation or who are not on call for a particular month to consistently have data reported across the time they are affiliated with the CIN. The data analytics platform from which MPact gathers their quality metric data is only available to pull data from physicians who have a total patient count of at least 30 over a specified period of time. This minimum count is of great concern when looking at a physicians' performance on CVD, as sub-specialists such as cardiologists and cardiothoracic surgeons may have small patients counts in any given month as compared to a primary care physician. Couple this with specialists and surgeons who serve rural communities or go on vacation for several weeks and the total patient count drops dramatically. The 12-month rolling reporting system is put in place to counteract these possible fluctuations and ensure data is being recorded for all physicians on a monthly basis.

4.8 EMPIRICAL STRATEGY

To determine the effect of physicians becoming participating members of the CIN on physician performance, this dissertation employs a regression discontinuity (RD) design on physician-level panel data to estimate a local average treatment effect (LATE). When the assumptions of RD are fully met, this methodology has almost the same causal force as those from a randomized controlled trial.[84] RD designs are of growing importance within economics,[82,83] a handful of applications are being used to understand how changes in health insurance policies affect utilization and cost.[85-88] However, these designs are still underutilized within medicine and public health.[89,90]

This dissertation follows an application of the RD design by using time as the assignment variable to identify the effects of CIN membership; referred to as RDiT.[82,91-94]. To apply RDiT in this dissertation, panel data on physician performance is needed. With this data structure, following the individual physician's performance over each month in time from 2016 to 2018 allows for the use of time-invariant aspects associated with the physician that might affect their performance to be controlled for using "fixed" effects.

In this RDiT design, the month acts as the assignment variable determining when a physician became a member in the CIN ($CIN_{i,c,t}$). In sharp RD designs, the treatment switches on as the assignment variable passes a cutoff. Applied to this context, when *t* passes October 2017 (or November or December 2017 depending on when the chapter received the presentation) then the physician becomes "treated" by becoming a member of the CIN. A linear regression estimating equation with this variable of interest is:

$$y_{i,c,t} = \propto_0 + \delta_1 CIN_{i,c,t} + \theta_i + X'_t\lambda_t + Y'_{ic}\beta_{ic} + \varepsilon_{i,c,t}.$$

Where, $y_{i,c,t}$ is the CVD quality metric (AMI) for each physician (cardiothoracic surgeon or cardiologist), *i*, in chapter, *c*, during month, *t.* The parameter, δ_1, captures the effect of the physician becoming a member of the CIN on the CVD quality metric (physician performance). The equation includes, θ_i, which represents physician fixed effects mentioned above, $X'_t\lambda_t$, which is a time fixed effect including months 1-36 and $Y'_{ic}\beta_{ic}$, which captures a chapter fixed effect for eight chapters. The error term, $\varepsilon_{i,c,t}$, represents the remaining unobserved variation in physician attributes.

The key assumption for identification in an RD is physicians are unable to precisely manipulate the assignment variable (month in which their chapter joined the

CIN) then the variation in the quality metric near the time of joining is randomized. This assumption holds because MPact determined the date of the roadshow within each chapter, not the individual physician. Descriptive summary statistics were conducted to characterize the data, identify outliers, and address any misreported data. All descriptive and inferential statistics were conducted using Stata/MP 15.1 (StataCorp LP; College Station, TX).

4.9 VALIDATING THE USE OF REGRESSION DISCONTINUITY

Guidance to researchers in applying and validating the RD and RDiT designs has been evolving since 2010.[82,90,95,96] Keys to validation of the design lie in a graphical inspection of the data and conducting careful sensitivity analyses. In applying this guidance, I first graphed the quality metrics that represent the dependent variable against the individual months from 2016 to 2018 and visually looked for breaks in trend around the time of the roadshow. It has become standard to summarize the effect of RD and RDiT designs by showing the relationship between the dependent variable and the assignment variable.[90] Visualization of the quality metrics against time should show whether a change in performance occurred around the time of the road show. It also helps to elucidate whether the relationship between physician performance and time is linear, or if other non-linear specifications are needed.

My estimation accounts for the presence of time-varying confounders by running specifications that include controls for other major supply and demand factors that might affect physician performance. A description of these variables and their sources is outlined in Section 4.10.

4.10 IMPORTANCE OF CONTROLS AND TIME-VARYING COVARIATES

Since this study uses panel data that follows each individual physicians' monthly performance on CVD quality metrics, I am primarily relying on the within physician variation to control for some of the unmeasured physician characteristics. The assumption is the physician is serving as his or her own control and that the unmeasured physician characteristics that are fixed will not confound the estimate of the roadshow. In this context, a "fixed" effect means the variable has the same effect on the physician performance prior to and after the roadshow. For example, the gender or race of the physician does not change from 2016 to 2018; therefore, they do not have an effect on the dependent variables of interest, when panel data is used to estimate the effect. However, aspects about the physician or their environment that can affect performance must be controlled for.

Table 4.2 Covariate Data Sources

Variable	*Year(s)*	*Geographic Level*	*Source*
Number of Primary Care Providers (Supply-Side)	2015-2018	Metropolitan and Non-Metropolitan Areas	Occupational Employment Statistics, Bureau of Labor Statistics
Total Population (Demand-Side)	2015-2017 2018*	County	American Community Survey, 1-year estimates, Census Bureau
Percent Insurance (Demand-Side)	2015-2017 2018*	County	American Community Survey, 1-year estimates, Census Bureau
Percent Non-White or Hispanic (Demand-Side)	2015-2017 2018*	County	American Community Survey, 1-year estimates, Census Bureau

*2018 data to be released in October 2019

Additional time varying physician level data is not available; however, examples of time-varying county-level variables from the macro level that might affect a physicians' performance are found in Table 4.2. These variables change over time and might affect CVD quality metrics because they affect the demand and supply of patients with CVD. They are measured at the county level and vary annually because this is the smallest geographic level that allows for the most variation over time. Searches of publicly available data at the county-level did not reveal monthly measures. The variables found in Table 4.2 were also used in similar studies evaluating the impact of PCMHs and ACOs on quality. [24,30,36,40]

4.11 RESULTS

Table 4.3 present descriptive statistics for the dependent variable (quality measure) and covariates by year (2016-2018). In Table 4.3, aspirin was being prescribed to patients within 90 minutes of an AMI diagnosis across the sample on average 33% of the time (Column 4). Also, AMI showed a slight decrease in performance of this metric when comparing averages from year to year. The AMI metric dropped from 35% in 2016 to 32% in 2018; while the minimum and maximum held constant at zero and 100%, respectively (Columns 1-3). The covariates also demonstrated little change in their averages when comparing them across the individual years. Number of primary care physicians showed a slight decrease year over year (Columns 1-3); following literature of this national trend.[97,98] Total population slightly increased as well as percent uninsured. Lastly, percent of the population that is white slightly decreased while percent black had a sizable increase.

Table 4.3 Descriptive Characteristics of AMI Quality Metric

Dependent Variable	*2016 (1)*	*2017 (2)*	*2018 (3)*	*2016-2018 (4)*
AMI				
n	648	648	648	1,944
Mean	0.353	0.339	0.326	0.339
Standard Deviation	0.174	0.201	0.209	0.196
Min	0	0	0	0
Max	1	1	1	1
Covariates				
Physician				
n	1,656	1,800	1,656	
Mean	739.13	682.60	701.09	
Standard Deviation	993.92	953.07	872.15	
Min	90	50	100	
Max	2,610	2,570	2,340	
Total Population				
n	1,692	1,692		
Mean	293,538.20	294,829.10		
Standard Deviation	274,255.70	273,346.30		
Min	85,928	85,774		
Max	986,410	984,505		
Percent Uninsured				
n	1,692	1,692		
Mean	8.289	9.111		
Standard Deviation	1.574	1.579		
Min	6.50	6.40		
Max	11.0	12.20		
White				
n	1,692	1,692		
Mean	235,081.50	235,887.10		
Standard Deviation	184,026.20	181,038.90		
Min	77,933	76,775		
Max	684,030	674,608		
Black				
n	900	504		
Mean	66,881.56	111,368.10		
Standard Deviation	96,595.07	112,396		
Min	10,029	14,127		
Max	238,612	241,023		

In Figure 4.2, a scatter plot shows the relationship of the AMI performance metric over time. This was examined for visible breaks or discontinuity in trend around the time of the roadshow to see if the CINs formation may have an impact on physician performance. The AMI metric showed a higher degree of variation because the values of the observation ranged from 10% to 65%.[14]

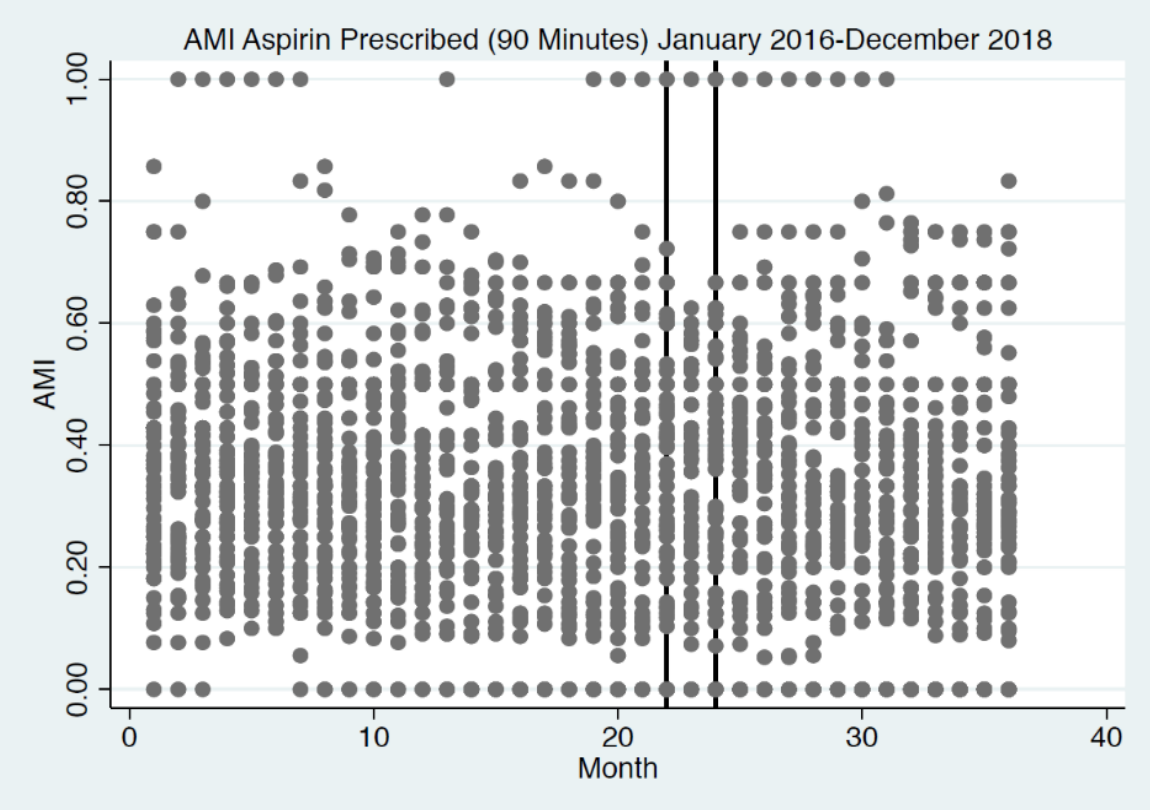

Figure 4.2 Scatter Plot of Dependent Variable CVD Metric Over Time

[14] To further investigate the data graphically, four physicians were selected to demonstrate what the data looks like at an individual level for the AMI metric. No obvious breaks in trend were found at this individual level.

In Table 4.4, estimates are presented demonstrating the impact of physicians becoming participating members of a CIN (MPact) on physicians' performance in CVD. I employed three models consisting of different specifications. The first model exploits the variation in the CVD metrics over time and controls for physician-fixed effects. In the second model, chapter and time fixed effects are added to the first model's specification. In the third model, time-varying county-level controls are added to the specifications of the second model.

Table 4.4 The Effect of Physicians Becoming Members of a CIN on the AMI Quality Metric

Dependent Variable	$\delta_1 CIN_{i,c,t}$	*Physician Fixed Effect*	*Chapter & Time Fixed Effect*	*Time-Varying Controls*
AMI	-0.019 (0.017)	X		
	-0.039 (0.025)	X	X	
	-0.0002 (0.041)	X	X	X

Overall, there were no discernable statistically significant findings for the impact of physicians becoming participating members of the CIN on physician CVD performance metrics (aspirin prescribed within 90-minutes of an AMI diagnosis). For the AMI variable, all three models showed a decrease in prescribing and none were found to be statistically significant.

4.12 DISCUSSION

Across specifications, there were no meaningful statistically significant findings of the effect of physicians becoming members of a CIN (MPact) across both CVD quality metrics. These findings are consistent with previous literature on VBCM quality outcomes.[34,36,39,40,99] There are key explanations for these findings. First, looking at the

presence of the treatment (the CIN formation through the roadshow) and expecting there to be a comprehensive impact on physician-level CVD outcome metrics may be too indirect. Physicians were not required to attend the CIN roadshow presentation by MPact in person. This lack of required attendance is understandable, as requiring all cardiothoracic surgeons or cardiologists to leave their work to attend a presentation would almost certainly result in adverse patient events. Furthermore, while the roadshow presentation was made available to physicians through internal channels such as human resources and shared network drives, there is no way to know precisely which physicians viewed the presentation or the timing of when it was viewed. The lack of effect of the roadshow on CVD quality metrics is consistent with the face there was no requirement to either attend the presentation or view the presentation via internal channels.

Furthermore, the variation and low average prescribing patterns shown in the AMI metric may be attributed to three prevailing factors associated with the measurement of the actual metric itself. First, many patients presenting with an AMI are already on a previously established aspirin regimen and therefore should not receive aspirin within the 90-minute window that the AMI metric requires. Second, often times AMI patients arrive via ambulance where an emergency medical technician (EMT) has administered aspirin before the attending physician has seen the patient. Therefore, the physician cannot claim they prescribed the aspirin. Third, physicians do not always consistently report this metric in the EMR. Most times this is due to aspirin being administered by the EMT and what transpires in the ambulance is seldom transferred and captured within the EMR patient encounter. And sometimes, the sheer urgency surrounding an AMI does not promote careful data capture on the part of the physician.[120,121] For these three scenarios,

there is no room for explanation within the components of the metric itself. For each patient, measure of the metric is simply a binary yes or no response; the attending physician cannot justify the medical decision to not prescribe aspirin within 90-minutes of an AMI and therefore receives the negative count for this quality metric regardless of the medical necessity.

MPact could benefit from a more rigorous and accurate reporting process. As mentioned above, physicians may feel the AMI metric is not an accurate depiction of performance due to inaccurate or incomplete data capture. Furthermore, physicians have noted this metric may be more impactful if targeted toward emergency medicine physicians instead of cardiothoracic surgeons and cardiologists. For example, it was stated many AMI patients who present to the ED never receive a cardiology consult because the patient is simply not severe enough to need one. Therefore, the emergency medicine physician presumes responsibility for all diagnoses and action taken during the AMI encounter without any guidance from a cardiologist. Similarly, if an AMI case is extremely emergent and serious, the emergency medicine physician has little time to call for a cardiology consult and instead becomes the aspirin prescriber, not the cardiologist. In both scenarios, which are common, a cardiologist is not the physician prescribing aspirin within 90-minutes of an AMI; an emergency medicine physician is. Therefore, linking cardiologists to this metric is likely to portray an inaccurate result and should instead tie emergency medicine physicians to the metric as well.

The findings from this chapter suggest that a strategy targeted directly towards physicians within MPact could more clearly improve readmission metrics. Per the Donabedian model, the next logical step would be to make the conceptual framework

tighter by conducting a more impactful structural change targeted toward dissemination of metrics. Such as strategy would involve dissemination of each individual physicians' CVD metric outcomes being given directly to each cardiothoracic surgeon and cardiologist. Furthermore, taking an additional step to unblind these results so physicians can not only see their own performance but the performance of their peers, would potentially have an even greater effect on quality. Behavioral economic literature has shown those physicians who have a true sense of ownership will exhibit the strongest response to performance-based incentives as they claim any residual affects realized to the organization along with the stake of their own reputations.[101-103] Another possible targeted strategy could be the implementation of financial incentives tied to each CVD metric. While MPact's current incentive is increased market share with risk of being removed from the network for underperformance, these may not be strong enough to elucidate an effect. There is a multitude of literature regarding positive physician response through outcomes and performance through the usage of financial motivation.[14,104-107]

These findings should be interpreted within the limitations of the study. First, this analysis did not compare this CIN to other VBCMs such as ACOs and PCMHs but instead compared physicians within this one CIN over time. Thus, these findings cannot make conclusions about quality outcomes in the CIN model versus other models. Likewise, this study cannot assert findings on any other established CINs. Instead, the goal was to evaluate physician performance both within individual physicians and across physicians over time through the use of CVD quality metrics. Second, these CVD metrics, while evaluated monthly for each physician, are aggregated and reported on for a

rolling 12-months. MPact's reasoning for this is twofold. One, by using a rolling 12 months it eliminates small sample sizes on a monthly basis and two, this is the standard way the data analytics platform reports data. Unfortunately, this method of reporting thwarts variation whereas using the raw monthly performance per physician maintains greater variation both within and amongst physicians for a more accurate measure. Third, although the quality metrics in the database encompass all payers (private, self-insured, Medicare, Medicaid, Tricare, etc.), I do not know if certain physicians have a predominant payer mix, which could influence results. This was somewhat adjusted for using covariates, but this method was imperfect as many physicians could not be matched to a specific zip code.

4.13 CONCLUSION

This dissertation provides the first early evaluation of the effect that a CIN can have on the quality of physician performance through outcome metrics. Furthermore, this study adds to the growing body of knowledge on VBCM's impact on health care quality outcomes. Overall, the findings of this chapter suggest little impact on CVD outcomes after physicians became participating members of the CIN. However, because the CIN model is one of the newest VBCMs in the health care landscape, it is likely its impact will increase over time. Therefore, future research should incorporate additional years of data to evaluate any effects along with any forthcoming strategies MPact adopts to improve quality outcomes.

REFERENCES

1. Whittington JW, Nolan K, Lewis N, Torres T. Pursuing the Triple Aim: The First 7 Years. *Milbank Quarterly.* 2015;93(2):263-300.
2. Beasley C. The Triple Aim. Optimizing health, care and cost. *Healthc Exec.* 2009;24(1):64-66.
3. System TCFoaHPH. *A High Performance Health System for the United States: An Ambitious Agenda for the Next President.* The Commonwealth Fund on a High Performance Health System;2007.
4. Berwick DM, Nolan TW, Whittington J. The Triple Aim: Care, health, and cost. *Health Affairs.* 2008;27(3):759-769.
5. Davis K, Stremikis K, Squires D, Schoen C. *Mirror, Mirror on the Wall, 2014 Update: How the U.S. Health Care System Compares Internationally.* Commonwealth Fund;2014.
6. Squires DA. The U.S. health system in perspective: a comparison of twelve industrialized nations. *Issue brief (Commonwealth Fund).* 2011;16:1-14.
7. Magnon S, Fisher E, Kindig D, et al. Achieving Accountability for Health and Health Care2012.
8. LaPointe J. What is Value-Based Care, What it Means for Providers? In: Intelligence R, ed2018.
9. Chee TT, Ryan AM, Wasfy JH, Borden WB. Current State of Value-Based Purchasing Programs. *Circulation.* 2016;133(22):2197-2205.
10. Porter ME. What is value in health care? *N Engl J Med.* 2010;363(26):2477-2481.
11. Greene J. Fee For Service is Dead. Long Live Fee For Service? In. *Managed Care*2017.
12. Catalyst N. What is Value-Based Healthcare? *NEJM Catalyst.* 2017.
13. Burwell SM. Setting value-based payment goals--HHS efforts to improve U.S. health care. *N Engl J Med.* 2015;372(10):897-899.
14. Kronick R, Casalino LP, Bindman AB. Apple Pickers or Federal Judges: Strong versus Weak Incentives in Physician Payment. *Health Services Research.* 2015;50:2049-2056.
15. Paustian ML, Alexander JA, El Reda DK, Wise CG, Green LA, Fetters MD. Partial and incremental PCMH practice transformation: implications for quality and costs. *Health Serv Res.* 2014;49(1):52-74.
16. Joint Principles of the Patient-Centered Medical Home. 2007. http://www.acponline.org/advocacy/where_we_stand/medical_home/approve_jp.pdf.
17. Friedberg MW, Schneider EC, Rosenthal MB, Volpp KG, Werner RM. Association between participation in a multipayer medical home intervention and changes in quality, utilization, and costs of care. *Jama.* 2014;311(8):815-825.

18. Friedberg MW, Lai DJ, Hussey PS, Schneider EC. A guide to the medical home as a practice-level intervention. *Am J Manag Care.* 2009;15(10 Suppl):S291-299.
19. Bleser WK, Saunders RS, Muhlestein DB, Morrison SQ, Pham HH, McClellan MB. ACO Quality Over Time: The MSSP Experience and Opportunities for System-Wide Improvement. *The American Journal of Accountable Care.* 2018;6(I):1-15.
20. Shortell SM, Colla CH, Lewis VA, Fisher E, Kessell E, Ramsay P. Accountable Care Organizations: The National Landscape. *J Health Polit Policy Law.* 2015;40(4):647-668.
21. O'Hara S. The Care Transformation Alphabet: What's the Difference Between CI, ACO and PCMH? In. *Care Transformation Center Blog*: The Advisory Board; 2014.
22. Sokolov JJ. What Physician Leaders Need to Know About Clinically Integrated Organizations, Networks and Medicare Shared Savings Programs. *Physician Executive.* 2013;39(2):14-24.
23. Grauman D, Harris J, Elizondo I, Looby S. Developing a CIN for strategic value: having a clinically integrated network allows a health system to align with independent physicians as a single entity that can build or retain valuable market share.(FEATURE STORY)(clinically integrated network). *FEATURE STORY.* 2014;68(7):52(57).
24. David G, Saynisch PA, Smith-McLallen A. The Inner Workings of the Patient Centered Medical Home Model2016, Cambridge, MA.
25. Peikes D, Zutshi A, Genevro JL, Parchman ML, Meyers DS. Early evaluations of the medical home: building on a promising start. *Am J Manag Care.* 2012;18(2):105-116.
26. Hearld LR, Alexander JA. Patient-centered care and emergency department utilization: a path analysis of the mediating effects of care coordination and delays in care. *Medical care research and review : MCRR.* 2012;69(5):560-580.
27. Chatterjee R, Jackson G, Bettger J, et al. THE PATIENT-CENTERED MEDICAL HOME, A SYSTEMATIC REVIEW. *Journal of General Internal Medicine.* 2012;27:S325-S326.
28. DeVries A, Li CH, Sridhar G, Hummel JR, Breidbart S, Barron JJ. Impact of medical homes on quality, healthcare utilization, and costs. *Am J Manag Care.* 2012;18(9):534-544.
29. Reid RJ, Coleman K, Johnson EA, et al. The Group Health medical home at year two: cost savings, higher patient satisfaction, and less burnout for providers. *Health affairs (Project Hope).* 2010;29(5):835-843.
30. David G, Gunnarsson C, Saynisch PA, Chawla R, Nigam S. Do patient-centered medical homes reduce emergency department visits? *Health Serv Res.* 2015;50(2):418-439.
31. *The Impact of Primary Care Practice Transformation on Cost, Quality and Utilization.* Patient-Centered Primary Care Collaborative - Millbank Memorial Fund;2017.
32. Sinaiko AD, Landrum MB, Meyers DJ, et al. Synthesis Of Research On Patient-Centered Medical Homes Brings Systematic Differences Into Relief. *Health affairs (Project Hope).* 2017;36(3):500-508.

33. Rosenthal MB, Alidina S, Friedberg MW, et al. Impact of the Cincinnati Aligning Forces for Quality Multi-Payer Patient Centered Medical Home Pilot on Health Care Quality, Utilization, and Costs. *Medical care research and review : MCRR.* 2016;73(5):532-545.
34. Flieger SP. Impact of a Patient-Centered Medical Home Pilot on Utilization, Quality, and Costs and Variation in Medical Homeness. *The Journal of ambulatory care management.* 2017;40(3):228-237.
35. Muhlestein DB, Saunders RS, McClellan M. Medicare Accountable Care Organization Results For 2015: The Journey to Better Quality and Lower Costs Continue. In: Blog HA, ed2016.
36. McWilliams J, Landon BE, Chernew ME. Changes in health care spending and quality for medicare beneficiaries associated with a commercial aco contract. *JAMA.* 2013;310(8):829-836.
37. Office of Inspector General H. *Medicare Shared Savings Program Accountable Care Organizations Have Shown Potential for Reducing Spending and Improving Quality.* HHS;2017.
38. Borza T, Oerline MK, Skolarus TA, et al. Association Between Hospital Participation in Medicare Shared Savings Program Accountable Care Organizations and Readmission Following Major Surgery. *Annals of surgery.* 2018.
39. Chukmaitov A, Harless DW, Bazzoli GJ, Muhlestein DB. Preventable Hospital Admissions and 30-Day All-Cause Readmissions: Does Hospital Participation in Accountable Care Organizations Improve Quality of Care? *American journal of medical quality : the official journal of the American College of Medical Quality.* 2018:1062860618778786.
40. McWilliams JM, Hatfield LA, Chernew ME, Landon BE, Schwartz AL. Early Performance of Accountable Care Organizations in Medicare. *N Engl J Med.* 2016;374(24):2357-2366.
41. Ali NJ, McWilliams JM, Epstein SK, Smulowitz PB. Emergency Department Involvement in Accountable Care Organizations in Massachusetts: A Survey Study. *Annals of emergency medicine.* 2017;70(5):615-620.e612.
42. Herrel LA, Norton EC, Hawken SR, Ye Z, Hollenbeck BK, Miller DC. Early impact of Medicare accountable care organizations on cancer surgery outcomes. *Cancer.* 2016;122(17):2739-2746.
43. Mask A, Adepoju OE. Relationship Between Accountable Care Organization Status and 30-Day Hospital-wide Readmissions. Are All Accountable Care Organizations Created Equal? *Journal for healthcare quality : official publication of the National Association for Healthcare Quality.* 2018.
44. Schoenfeld AJ, Sturgeon DJ, Blucher JA, Haider AH, Kang JD. Alterations in 90-Day Morbidity, Mortality and Readmission Rates Following Spine Surgery in Medicare Accountable Care Organizations (2009-2014). *The spine journal : official journal of the North American Spine Society.* 2018.
45. Borza T, Kaufman SR, Yan P, et al. Early effect of Medicare Shared Savings Program accountable care organization participation on prostate cancer care. *Cancer.* 2018;124(3):563-570.

46. Sullivan K. The Verdit is in: All Three of CMS' "Medical Home" Demonstrations Have Failed. http://thehealthcareblog.com/blog/2018/06/07/the-verdict-is-in-all-three-of-cmss-medical-home-demonstrations-have-failed/. Published 2018. Accessed.
47. Burns LR, Pauly M. Accountable Care Organizations May Have Difficulty Avoiding The Failures Of Integrated Delivery Networks Of The 1990s. 2012;31(11):2407-2416.
48. Jencks SF, Williams MV, Coleman EA. Rehospitalizations among patients in the Medicare fee-for-service program. *N Engl J Med.* 2009;360(14):1418-1428.
49. Benbassat J, Taragin M. Hospital Readmissions as a Measure of Quality of Health Care: Advantages and Limitations. *Archives of Internal Medicine.* 2000;160(8):1074-1081.
50. Mechanic RE, Galvin RS. Self-Insured Employers - The Payment-Reform Wild Card. *N Engl J Med.* 2018;379(4):308-310.
51. Taylor M. PHO Model Endures. *Modern Healthcare.* 2007.
52. Nicholson S, Pauly MV, Polsky D, et al. How to present the business case for healthcare quality to employers. *Applied health economics and health policy.* 2005;4(4):209-218.
53. Kaplan A, Guest B. Clinically Integrated Networks: Vision, Purpose and Development. *Physician Executive.* 2012;38(2):60-66.
54. Walker J. Health Costs Get a Rethink. *The Wall Street Journal.* March 8, 2017, 2017;Business News: B8.
55. Chappell B, Dwyer C. Amazon, Berkshire Hathaway and JPMorgan Chase Launch New Health Care Company. https://www.npr.org/sections/thetwo-way/2018/01/30/581804474/amazon-berkshire-hathaway-and-jpmorgan-chase-launch-new-healthcare-company. Published 2018. Accessed.
56. Pham HH, Schrag D, O'Malley AS, Wu B, Bach PB. Care patterns in Medicare and their implications for pay for performance. *N Engl J Med.* 2007;356(11):1130-1139.
57. Blackford N. Legal Formation of CIN. In: Crosby K, ed2018.
58. Statement of Antitrust Enforcement Policy in Health Care. In: Justice USDo, Commission FT, eds1996.
59. Babbo TJ, Marren JP. Clinical Integration: Collective PPO Contracting as a Catalyst for Quality Medicine. In: Group AHLAPOP, ed. *Physician Organizations.* Vol 92006.
60. Kumar P, Levine E. *Clinically Integrated Networks: Can They Create Value?* : McKinsey & Company;2018.
61. Butcher L. *Case Studies in Clinical Integration.* 2016.
62. Blackford N. Clinical Integration of CINs. In: Crosby K, ed2018.
63. Kelsay E, Landers-Nelson D, Smith A, Verstegen C. The Next Wave of Value Generation in Commercial ACOs. Oliver Wyman Health. Maximize Value Web site. https://health.oliverwyman.com/2018/08/committing_to_value.html. Published 2018. Accessed.
64. Clark D. CIN Cost Containment. In: Crosby K, ed2018.
65. Blackford N. Mpact Cost Containment Strategy. In: Crosby K, ed2018.

66. D'Aunno T, Broffman L, Sparer M, Kumar SR. Factors That Distinguish High-Performing Accountable Care Organizations in the Medicare Shared Savings Program. *Health Serv Res.* 2018;53(1):120-137.
67. Conger W. Mpact Quality Improvement. In: Crosby K, ed2018.
68. Blackford N. Quality Component of CIN. In: Crosby K, ed2018.
69. Blackford N. Data Platform of a CIN. In: Crosby K, ed2018.
70. Blackford N. Mpact History and Organizational Structure. In: Crosby K, ed2018.
71. Clark D. Mpact Example of Success: Springfield School District. In: Crosby K, ed2019.
72. Network HCPLA. Alternative payment model (apm) framework: refreshed for 2017. HCPLAN Website. http://hcp-lan.org/workproducts/apm-refresh-whitepaper-final.pdf. Published 2017. Accessed.
73. Boccuti C, Casillas G. *Aiming for Fewer Hospital U-Turns: The Medicare Hospital Readmission Reduction Program.* 2017.
74. Maniar H. Hospital readmissions after cardiac surgery: is it a game worth playing? *The Journal of thoracic and cardiovascular surgery.* 2015;149(3):858.
75. McIlvennan CK, Eapen ZJ, Allen LA. Hospital readmissions reduction program. *Circulation.* 2015;131(20):1796-1803.
76. Nowicki S, Zembroski D, Pickering L, Nobel J. *Reducing Preventable Hospital Readmissions: A Multistakeholder Perspective* New York, NY2012.
77. Commission MPA. Report to Congress: Promoting Greater Efficiency in Medicare. 2007.
78. McHugh M, Ma C. Hospital nursing and 30-day readmissions among Medicare patients with heart failure, acute myocardial infarction, and pneumonia. *The Journal of nursing administration.* 2013;43(10 Suppl):S11-18.
79. Ayanian JZ, Markel H. Donabedian's Lasting Framework for Health Care Quality. *N Engl J Med.* 2016;375(3):205-207.
80. BERWICK D, FOX DM. "Evaluating the Quality of Medical Care": Donabedian's Classic Article 50 Years Later. *The Milbank Quarterly.* 2016;94(2):237-241.
81. Hyder O, Dodson RM, Nathan H, et al. Influence of patient, physician, and hospital factors on 30-day readmission following pancreatoduodenectomy in the United States. *JAMA surgery.* 2013;148(12):1095-1102.
82. Hausman C, Rapson DS. Regression Discontinuity in Time: Considerations for Empirical Applications. In: Rausser GC, Zilberman D, eds. *Annual Review of Resource Economics, Vol 10.* Vol 10. Palo Alto: Annual Reviews; 2018:533-552.
83. Ito K. Asymmetric Incentives in Subsidies: Evidence from a Large-Scale Electricity Rebate Program. *American Economic Journal-Economic Policy.* 2015;7(3):209-237.
84. Angrist JD, Pischke J-S. *Mastering Metrics: The Path from Cause to Effect.* Princeton, NJ: Princeton University Press; 2015.
85. Sood N, Bendavid E, Mukherji A, Wagner Z, Nagpal S, Mullen P. Government health insurance for people below poverty line in India: quasi-experimental evaluation of insurance and health outcomes. *BMJ (Clinical research ed).* 2014;349:g5114.

86. De La Mata D. The effect of Medicaid eligibility on coverage, utilization, and children's health. *Health economics.* 2012;21(9):1061-1079.
87. Card D, Dobkin C, Maestas N. DOES MEDICARE SAVE LIVES? *The quarterly journal of economics.* 2009;124(2):597-636.
88. Venkataramani AS, Bor J, Jena AB. Regression discontinuity designs in healthcare research. *BMJ (Clinical research ed).* 2016;352:i1216.
89. Moscoe E, Bor J, Barnighausen T. Regression discontinuity designs are underutilized in medicine, epidemiology, and public health: a review of current and best practice. *Journal of clinical epidemiology.* 2015;68(2):122-133.
90. Lee DS, Lemieux T. Regression Discontinuity Designs in Economics. *J Econ Lit.* 2010;48(2):281-355.
91. Anderson ML. Subways, Strikes, and Slowdowns: The Impacts of Public Transit on Traffic Congestion. *American Economic Review.* 2014;104(9):2763-2796.
92. Gallego F, Montero JP, Salas C. The effect of transport policies on car use: Evidence from Latin American cities. *J Public Econ.* 2013;107:47-62.
93. Grainger CA, Costello CJ. Capitalizing property rights insecurity in natural resource assets. *JEnvironEconManage.* 2014;67(2):224-240.
94. Lang C, Siler M. Engineering estimates versus impact evaluation of energy efficiency. projects: Regression discontinuity evidence from a case study. *Energy Policy.* 2013;61:360-370.
95. Van Der Klaauw W. Regression–Discontinuity Analysis: A Survey of Recent Developments in Economics. *LABOUR.* 2008;22(2):219-245.
96. Imbens GW, Lemieux T. Regression discontinuity designs: A guide to practice. *J Econom.* 2008;142(2):615-635.
97. Green LV, Savin S, Lu Y. Primary care physician shortages could be eliminated through use of teams, nonphysicians, and electronic communication. *Health affairs (Project Hope).* 2013;32(1):11-19.
98. Hackey RB, Grasso V, LaRochelle M, Seaver K. Rethinking the shortage of primary care physicians. *Jaapa.* 2018;31(6):47-50.
99. Duggal R, Zhang Y, Diana ML. The Association Between Hospital ACO Participation and Readmission Rates. *Journal of healthcare management / American College of Healthcare Executives.* 2018;63(5):e100-e114.
100. Bailey MK, Weiss AJ, Barrett ML, Jiang HJ. *Statistical Brief #248: Characteristics of 30-Day All-Cause Hospital Readmissions, 2010-2016.* Healthcare Cost and Utilization Project;2019.
101. Berenson RA, Rice T. Beyond Measurement and Reward: Methods of Motivating Quality Improvement and Accountability. *Health Services Research.* 2015;50:2155-2186.
102. Judson TJ, Volpp KG, Detsky AS. Harnessing the Right Combination of Extrinsic and Intrinsic Motivation to Change Physician Behavior. *Jama-Journal of the American Medical Association.* 2015;314(21):2233-2234.
103. Kao AC. Driven to Care: Aligning External Motivators with Intrinsic Motivation. *Health Services Research.* 2015;50:2216-2222.
104. Doran T, Maurer KA, Ryan AM. Impact of Provider Incentives on Quality and Value of Health Care. In: Fielding JE, ed. *Annual Review of Public Health, Vol 38.* Vol 38. Palo Alto: Annual Reviews; 2017:449-465.

105. Conrad DA. The Theory of Value-Based Payment Incentives and Their Application to Health Care. *Health Services Research.* 2015;50:2057-2089.
106. Conrad DA, Perry L. Quality-Based Financial Incentives in Health Care: Can We Improve Quality by Paying for It? *Annual Review of Public Health.* 2009;30:357-371.
107. Conrad DA, Vaughn M, Grembowski D, Marcus-Smith M. Implementing Value-Based Payment Reform: A Conceptual Framework and Case Examples. *Medical Care Research and Review.* 2016;73(4):437-457.
108. Cotton P. Patient-Centered Medical Home Evidence Increases with Time. In: Affairs H, ed. *Health Affairs Blog*2018.
109. Schwenk TL. The Patient-Centered Medical Home: One Size Does Not Fit AllThe Patient-Centered Medical HomeEditorial. *JAMA.* 2014;311(8):802-803.
110. Clinic M. Cardiovascular Disease: Definition, Symptoms and Treatments. https://www.mayoclinic.org/diseases-conditions/heart-disease/symptoms-causes/syc-20353118. Published 2018. Accessed.
111. Gordois AL, Toth PP, Quek RG, Proudfoot EM, Paoli CJ, Gandra SR. Productivity losses associated with cardiovascular disease: a systematic review. *Expert review of pharmacoeconomics & outcomes research.* 2016;16(6):759-769.
112. Lang K, Korn JR, Simko RJ, et al. Development of an interactive model of the burden of future coronary heart disease from an employer perspective. *Journal of occupational and environmental medicine.* 2010;52(9):851-857.
113. Gupta A, Allen LA, Bhatt DL, et al. Association of the Hospital Readmissions Reduction Program Implementation With Readmission and Mortality Outcomes in Heart Failure. *JAMA cardiology.* 2018;3(1):44-53.
114. Vidic A, Chibnall JT, Hauptman PJ. Heart failure is a major contributor to hospital readmission penalties. *Journal of cardiac failure.* 2015;21(2):134-137.
115. Johnston SS, Curkendall S, Makenbaeva D, et al. The direct and indirect cost burden of acute coronary syndrome. *Journal of occupational and environmental medicine.* 2011;53(1):2-7.
116. Asay GR, Roy K, Lang JE, Payne RL, Howard DH. Absenteeism and Employer Costs Associated With Chronic Diseases and Health Risk Factors in the US Workforce. *Preventing chronic disease.* 2016;13:E141.
117. DONABEDIAN A. Evaluating the Quality of Medical Care. *The Milbank Quarterly.* 2005;83(4):691-729.
118. Donabedian A. The quality of care. How can it be assessed? *Jama.* 1988;260(12):1743-1748.
119. Bucholz EM, Butala NM, Normand S-LT, Wang Y, Krumholz HM. Association of Guideline-Based Admission Treatments and Life Expectancy After Myocardial Infarction in Elderly Medicare Beneficiaries. *Journal of the American College of Cardiology.* 2016;67(20):2378-2391.
120. Thornton B. AMI Metric with Byron Thornton, MD. In: Crosby K, ed2019.
121. Green B. AMI Metric with Bryan Green, MD. In: Crosby K, ed2019.