EXPLORING THE USE OF SOCIAL NETWORK ANALYSIS IN IDENTIFYING PHYSICIAN ENGAGEMENT IN QUALITY IMPROVEMENT IN THE HOSPITAL SETTING

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Dedicated to my husband Jeff and our three wonderful daughters Kara, Lauren, and Brooke. Thank you for believing in me, for supporting me, and for reminding me daily that all things are possible.

In dedication to my brother-in-law Jeff Korotnayi, who we lost during the course of my studies. The experience yet another reminder of what matters most in life

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Faith, Family & Friends.

Lastly, to all the patients and families that I have had the opportunity to serve over the span of my nursing career. You have taught me what I could never learn from a textbook

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Humbleness, Humility, and Hope.

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ABSTRACT

EXPLORING THE USE OF SOCIAL NETWORK ANALYSIS IN IDENTIFYING PHYSICIAN ENGAGEMENT IN QUALITY IMPROVEMENT IN THE HOSPITAL SETTING

by Kay M. Wagner

Physicians are an integral component in the performance of clinical process of care and patient experience measures in the hospital setting. A deeper understanding of physician influence in quality improvement by hospital leaders will be key to a hospital's success in the various programs set into motion by the Affordable Care Act (ACA) of 2010. The law, intended to put into place health insurance reforms, has an implementation timeline of four years and beyond. Many healthcare leaders across the country have been preparing for the changes in the way of services, programs, and incentives which are intended to improve quality and lower costs. One such program is the Centers for Medicare & Medicaid Services (CMS) Hospital Value Based Purchasing (VBP) program. This pay for performance program differentiates hospital inpatient payment rates based on performance in process, outcome, and patient satisfaction measures. Beginning in 2013, 1% of a hospitals inpatient Medicare payment is at risk with a 0.25% increase each year thereafter, capping at 2% in 2017. The program holds providers accountable for their success or improvement in clinical process of care and patient experience measures via a withhold/payback structure.

This research sought to explore the use of social network analysis (SNA) in identifying physician engagement in quality improvement in a hospital setting. The study involved SNA in determining level of physician prominence within a defined network to answer the following research questions: 1) How can healthcare leaders identify

physicians within their organization as quality improvement “champions” in order to increase the effectiveness of their group in modeling and/or disseminating behavior change within a hospital to improve the overall quality of care outcomes? 2) How do self-perspectives on physician knowledge regarding CMS quality core measures align with other physician's perspectives on seeking out that physician's input on quality? The objective of the study was to map the relationships and communications of a network of physicians in a 265 acute care bed hospital as a means of evaluating influential discussions surrounding quality improvement initiatives. Analysis was performed and physician prominence within the network was identified and quantified mathematically by defining centrality by degree, closeness, and betweenness. Statistical inferences could not be made from the additional level of analysis in determining if relationships existed between the variables of specialty, years of service, and familiarity with CMS core measures and the VBP program. The utilization of SNA in this study provided valuable empirical information that can be utilized by healthcare leaders in identifying physician quality improvement “champions” within their organizations. The information serves as a valuable tool in assisting healthcare leaders in strategizing their approach to improve the overall quality outcomes in their organization by ensuring a more effective and engaged physician network. Future action research is recommended to identify whether or not clinical quality outcomes improve as a result of identifying physician “champions” based on network information. Physician involvement in quality improvement initiatives will be crucial to the success of hospitals in CMS at risk programs such as the VBP program and can position an organization for a more financially stable future and a sustainable culture of quality.

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INTRODUCTION

The landscape of healthcare is changing rapidly, making it more difficult for healthcare leaders to navigate their way through unfamiliar terrain. Several variables are contributing to these changes making the course uncertain, uneven, and unpredictable. One major variable that is the driving force behind many of the changes is healthcare reform, an attempt to address a less than efficient and unsustainable national healthcare system. Healthcare reform resurfaced when President Obama signed into law the Patient Protection and Affordable Care Act (ACA) on March 23, 2010. The law is intended to address the cost, quality and access of healthcare in America by mandating comprehensive health insurance reforms. According to Johnson and Stoskopf (2010), analyzing a health system through the lens of cost, quality, and access is a widely accepted way of measuring its overall function. These same three variables must be consistently addressed by healthcare leaders if they wish to have a sustainable organization in the future. Unlike cost and access, quality has historically been difficult to define and measure. In the Institute of Medicine's (IOM, 2001) report *Crossing the Quality Chasm: A New Health System for the 21st Century*, quality is defined as "The degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge." In addition to the difficulty in defining quality, the progress in these areas has been challenging to measure (Goeschel, Wachter, & Pronovost, 2010).

In an attempt to bring standardization and clarity to the issue, the Hospital Quality Initiative (HQI) was launched in 2003 by the Centers for Medicare & Medicaid Services (CMS) in which quality measures were established:

> …to gauge how well an entity provides care to its patients. Measures are based on scientific evidence and can reflect guidelines, standards of care, or practice parameters. In this instance, a quality measure converts medical information from patient records into a rate or percentage that allows facilities to assess their performance. (CMS, Roadmap for Implementing Value Driven Healthcare in the Traditional Medicare Fee-for-Service Program, n.d.b., p.5)

As part of the HQI, the Hospital Inpatient Quality Reporting (HIQR) program was developed under the Medicare Prescription Drug, Improvement, and Modernization Act (MMA) authorizing CMS to pay hospitals who successfully reported designated quality measures a higher annual update to their payment rates (CMS, Hospital Inpatient Quality Reporting Program, n.d.a.). The measures are made available to the public via the Hospital Compare website. The hospital inpatient measures include 27 quality measures from the domains of process of care and outcomes, and ten patient experience measures:

- Process of care measures show, in percentage form or as a rate, whether or not a health care provider gives recommended care; that is, the treatment known to give the best results for most patients with a particular condition

- Outcome measures are designed to reflect the results of care, rather than whether or not a specific treatment or intervention was performed.
- Patient experience of care is measured by a national, standardized survey of hospital patients about their experiences during a recent inpatient hospital stay referred to as Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS).

Since 2003, the HQI has gained momentum from simply reporting quality measures to CMS to mandatory reporting that is tied to reimbursement through the Value-Based Purchasing (VBP) program. Section 3001(a)(1) of the ACA required the CMS to implement a hospital VBP program that rewards hospitals for the quality of care they provide versus the quantity of care (CMS, 2011). The VBP program is intended to improve quality and lower costs by offering financial incentives to hospitals who improve the quality of care they deliver (U.S. Department of Health & Human Services, 2012). The CMS issued the final rule for the pay-for-performance hospital VBP program under section 1886(o) on April 28, 2011. According to a news release by the U.S. Department of Health & Human Services (2011), for the first time ever:

> Medicare will reward hospitals that provide high quality care for their patients through the new Hospital VBP program…hospitals across the country will be paid for inpatient acute care services based on care quality, not just the quantity of the services they provide.

The purpose of the VBP program, according to CMS, is to move towards "…revamping how care and services are paid for, moving increasingly toward rewarding better value, outcomes, and innovations instead of merely volume" (Medicare Program, 2011).

This force is adding complexity to an already complex system. Independent healthcare organizations are becoming a part of larger healthcare systems as a means of dealing with these additional burdens. Electronic health-record (EHR) systems are becoming common place in organizations changing the way practitioners and providers document the delivery of their care with the percentage of hospitals utilizing EHR systems more than doubling from 2009 to 2011 (Modern Healthcare, 2012). Fiduciary responsible parties within organizations are closely scrutinizing resources for efficiencies and effectiveness from a people, product, time, and money perspective. While leaders are trying to sort through the plethora of change, healthcare reform is coming full force with reimbursements tied to quality versus quantity of care in a variety of settings (hospitals, long term care facilities, and physician practices). How well an organization is prepared for such change is crucial to its success and sustainability.

In preparation, healthcare leaders must understand systems at both a macro and micro level. They must be knowledgeable of what is happening in healthcare at a state, national, and even international level. A comprehension of how their organization will be scored in the VBP program will be crucial in projecting incentive payments. A deep understanding of their organizational infrastructure and the inter-organizational relationships and communications that exist within that infrastructure is crucial. Knowledge of physician engagement surrounding quality initiatives is vital to an organization's ability to meet the future challenges that lie ahead in the VBP program. According to O'Connor and Fiol (2006), "Physician behaviors and attitudes significantly affect the cost, quality and appropriateness of health services…There is tremendous opportunity for your physicians to create a united front as they lead the way to clinical

quality improvements" (p. 50). In order for a healthcare organization to survive and thrive in the VBP payment system, it will require a comprehensive approach to sustaining excellent service performance from physicians and allied health staff (Kennedy, Caselli & Berry, 2011). A comprehensive knowledge of the aforementioned requires systems thinking and is a fundamental skill set of any leader. Without this basic understanding, it will be difficult to overcome the challenges that lie ahead.

National Healthcare Challenges

The structural changes of healthcare as a means of reducing costs, reducing duplication, and improving efficiencies begins at a national level. First (2005) identified the inefficiencies of our national health care system in relation to high and rapidly rising health care costs, increasing populations of uninsured, chasms in quality, and health care disparities. First's identification of such inefficiencies is supported by the Organization for Economic Co-operation and Development (OECD, 2011) which indicated that the United States:

- Spent the most on health than any other country as a share of its economy, with 17.4% of its Gross Domestic Product (GDP) allocated to health in 2008. A percentage that is trending upward close to double the OECD yearly averages since 1980 with no signs of a decrease.
- Fell below the OECD life expectancy at birth average of 79.1 with an average of 78.1.
- In 2007 alone, spent approximately 116 billion to treat diabetes along with the complications and excess expenses that often accompany the disease.

- Had a prevalence of diabetes of 10.3 % of the population age 20-79.
- Ranked highest in childhood obesity, 30% of all children age 11-15 are overweight or obese (the OECD average is 13.8%).
- Led in obesity rates among adults with 34.3% of its adult population in 2007 overweight or obese (OECD average 15.4%).
- Added 5-7% to the total health spending from obesity alone in the late 1990's due to the higher risks of chronic illnesses that is associated with obesity—diabetes, heart disease, and hypertension.

The United States allocates the most on healthcare spending than any other developed country, yet its health outcomes are not reflective of this fact. According to Davis, Schoen, and Stremikis (as cited in Kaufman, 2011), "The US health system is the most expensive in the world, but comparative analyses consistently show the United States underperforms relative to other countries on most dimensions of performance" (p. 300). Shi, Singh, and Tsai (2010, p. 381), summarized the main characteristics of the United States healthcare system, indicating that:

- There is no central governing agency and little integration and coordination
- There is a technology-driven delivery system focusing on acute care
- It is high on costs and unequal access, but average on outcomes
- Delivery of health care is under imperfect market conditions
- The government is subsidiary to the private sector
- Market justice versus social justice is pervasive throughout health care

- There are multiple players and balances of power
- There is a quest for integration and accountability

Despite the fact that the United States is the leader when it comes to healthcare spending, it fails to maintain such a position in the areas of wellness, safety, and quality. According to Jones (2010), the high rate of Gross Domestic Product (GDP) devoted to health care and cost inflation, is generally recognized as unsustainable and has led to the resurfacing of health reform on the policy agenda. Jones (2010) stated the following:

> In the United States, any reasonably balanced investigation of the numbers – rising demand for more (and often more technologically intensive) health care, an aging population, declining employer-based insurance, increasing number of uninsured individuals, and above all, a healthcare cost inflation rate that outruns economic growth by a significant margin – will reveal that, sometime between the years 2015 and 2025, when the "baby boomers" will retire and expect to get all of the health care they want and "deserve" from Medicare and Medicaid (the primary government vehicle for long-term care spending), the numbers for financing the U.S. healthcare system as currently structured will not add up or balance. Something will have to give (p. 51).

Competition

Porter and Teisberg (2004) argued that the root of the problem with U.S. health care performance is the nature of competition. Competition according to the authors is a

double-edged sword in that competition can also be the solution. Porter and Teisberg (2004) indicated:

> Our research shows that competition in the health care system occurs at the wrong level, over the wrong things, in the wrong geographic markets, and at the wrong time. Competition has actually been all but eliminated just where and when it is most important (p. 66)

It is a well-known fact that attempts to reform the United States' health care system has failed in the past of which the authors argued is due to the fact that there was a wrong diagnosis of the problem to begin with. The future focus should be on the nature of competition with the objective to increase value which can be accomplished by transitioning from a zero-sum competition to a positive-sum competition. In zero-sum competition "…the system participants divide value instead of increasing it. In some cases, they may even erode value by creating unnecessary costs" (Porter & Teisberg, 2004, p. 66).In health care, zero-sum competition is manifested in the following four ways: cost shifting versus cost reduction, focus on greater bargaining power versus efforts to provide better care, restricts access and choice of services versus more efficient care, and a dependency on court systems to settle disputes which again raises costs and does not increase value.

According to Porter and Teisberg (2004), a shift to positive-sum competition requires the locus of competition to shift from "Who pays?" to "Who provides the best value?" Many of the features of the positive-sum competition model recommended by the authors can be seen in the reform model recommended today. Changes hospitals can make to move towards a positive-sum competition include:

- Develop clear strategies around unique service lines and become distinctive for those services rather than being all things to everyone.
- Make pricing transparent – made available to patients in advance to enable comparisons.
- Simplify billing (one bill per hospitalization or per period of chronic care).
- Share accessible, standardized information at a national level to drive improvements in quality and efficiency.

Value-Based Purchasing

Many Americans agree that our National healthcare system is in dire need of change, yet defining what that change should look like has been the topic of debate for many years among many politicians. The IOM 2001 quality report, established from the committee on the Quality of Health Care in America, also recommends changes to the American healthcare system as a means of closing the "quality gap" that exists in the current system. The report provides principles and performance expectations for specific direction for policymakers, health care leaders, clinicians, regulators, purchasers, and others. Included is a "…framework to better align incentives inherent in payment and accountability with improvement in quality, and key steps to promote evidence-based practice and strengthen clinical information systems." A decade later, this same approach is being adopted in an attempt to reduce costs and promote the delivery of higher quality of care by rewarding hospitals that do so in the VBP program. The need for change in hospitals is evident in the facts provided by CMS (2011):

- Hospital payments account for the largest share of Medicare spending.

- In 2009, more than 7 million Medicare beneficiaries experienced more than 12.4 million inpatient hospitalizations. One of seven Medicare patients will experience some "adverse" event such as preventable illness or injury while hospitalized.
- One in three Medicare beneficiaries who leave the hospital today will be back in the hospital within a month.

The United States is unique from other countries in that it is financed through a variety of public and private insurance programs by purchasers versus a publicly administered universal insurance program. The primary purchasers include Medicare, Medicaid, and employers. The VBP program is specific to reimbursements made to hospitals from Medicare. Meyer, Rybowski, and Eichler (as cited by the Agency for Healthcare Research and Quality [AHRQ], n.d.) defined VBP purchasing in the following manner:

> The concept of value-based health care purchasing is that buyers should hold providers of health care accountable for both cost and quality of care. Value-based purchasing brings together information on the quality of health care, including patient outcomes and health status, with data on the dollar outlays going towards health. It focuses on managing the use of the health care system to reduce inappropriate care and to identify and reward the best-performing providers. This strategy can be contrasted with more limited efforts to negotiate price discounts, which reduce costs but do little to ensure that quality of care is improved.

Funding

According to the U.S. Department of Health & Human Services (2012), CMS plans to fund the aggregate Hospital VBP incentive payments by reducing the base operating diagnosis-related group (DRG) payment amounts that determine the Medicare payment for each hospital inpatient discharge. The law sets the reduction at 1% in FY 2013, rising to 2% by FY 2017. Hospitals will continue to receive payments for care provided to Medicare patients based on the Medicare Inpatient Prospective Payment System (IPPS), but those payments will be reduced across the board by one percent starting FY 2013 to create the funding for the new VB payments. In federal FY 2013, this amount is estimated to be $850 million, which will then be used for incentive payments.

Hospital Performance and Payment

The reporting of quality of care measures by hospitals is not new. The performance measures adopted by CMS under the VBP program have been taken from the measure set from which hospitals have been reporting under the HIQR program developed in 2003. The difference is that Medicare will now:

> make incentive payments to hospitals beginning in FY 2013 based on how well they perform on each measure or how much they improve their performance on each measure compared to their performance on the measure during a baseline performing period. The hospital VBP program is designed to promote better clinical outcomes for hospital patients as well as improve their experience of care during hospital stays (CMS, 2011)

The VBP program became effective for IPPS discharges on or after October 1, 2012 marking the baseline data collection period for the identified measures. CMS will measure hospital performance using two domains: the clinical process, which is comprised of 12 clinical process of care measures (weighted at 70% of the total performance score) and the patient experience of care domain, which is comprised of Hospital Consumer Assessment of Healthcare Provider and Systems (HCAHPS) survey measure (weighted at 30% of total performance score).

The clinical process of care measures include 12 measures specific to acute myocardial infarction (AMI), pneumonia (PN), heart failure (HF), and surgical care improvement project (SCIP) measures. The HCAHPS measures are specific to nurse communication, doctor communication, hospital staff responsiveness, pain management, medicine communication, hospital cleanliness and quietness, discharge information, and overall hospital rating (CMS, 2011).

Beginning 2013, a Total Performance Score (TPS) will be calculated combining the greater of its achievement or improvement points on each measure to determine a score for each domain, multiplying each domain score by the proposed domain weight and adding the weighted scores together. Hospitals scoring higher TPSs will receive higher incentive payments than those that received lower TPSs. In essence, because the hospital VBP program is budget-neutral, there will be winners and losers. Hospitals whose TPSs are above the national median will see an increase in their payments while those who are on the bottom half will see a loss (McKinney, 2012). The year 2014 will include payment determination on three mortality outcome measures, eight Hospital Acquired Condition (HAC) measures, and two Agency for Healthcare Research and

Quality (AHRQ) composite measures. By 2015, hospitals with certain hospital acquired conditions will receive additional payment reductions from Medicare (CMS, 2012). Details of the VBP program are described in the final rule, 76 Fed. Reg. 88 (6 May 2011). According to Shoemaker (2011), "The new VBP will accelerate the development of measurements and will result in further public scrutiny as well as payment penalties inflicted for substandard performance as defined by the measurement" (p. 68).

Organizational Level Challenges

In 2006, hospital care represented $648 billion accounting for 37% of the total patient-related U.S. health care expenditure hence the focus on value versus volume in the hospital settings (Conway, 2009). Channing and DeVore (2009) indicated, "Considering the rising bill for health care and our current economic crisis, we can't afford to tolerate a status quo that rewards quantity of procedures rather than the quality of the outcomes" (p. 42). Although many healthcare leaders across the country would echo the statement made by the aforementioned authors, it's becoming more and more difficult for them to strike a balance between reducing costs and improving the quality of care that is delivered by the providers and practitioners in their organization. The American Hospital Association (AHA, 2011) Committee on Performance Improvement (CPI) has identified four major priorities for hospitals to focus on as first steps for being successful in the future:

1. Aligning hospitals, physicians, and other providers across the continuum of care.
2. Utilizing evidenced-based practices to improve quality and patient safety.

3. Improving efficiency through productivity and financial management.
4. Developing integrated information systems.

The uniqueness of healthcare organizations make these focus areas somewhat challenging for healthcare leaders to maximize. Shortell and Kaluzny (1997) identified such differences:

- Defining and measuring output are more difficult.
- The work involved is more highly variable and complex.
- More of the work is of an emergency and non-deferrable nature.
- The work permits little tolerance for ambiguity or error.
- The work activities are highly interdependent, requiring a high degree of coordination among diverse professional groups.
- The work involves an extremely high degree of specialization.
- Organizational participants are highly professionalized, and their primary loyalty belongs to the profession rather than to the organization.
- Little effective organizational or managerial control exists over the group most responsible for generating work and expenditures: physicians.
- Dual lines of authority exist in many health care organizations, particularly hospitals, which create problems of coordination and accountability and confusion roles.

According to Bankowitz (as cited in Morrissey, 2011):

We've got to switch the culture from the focus on volume…to a focus on value. And that's going to require a specific focus on leadership skills, it's going to require change-management skills, it's going to require that we have a physician

> engagement in a way that maybe we haven't had before… the Medicare value-based purchasing program marks the beginning of a long goodbye to health care's volume-based business model. Accordingly, it will require a different set of leadership priorities and actions to change the shared practices, behaviors and beliefs and the culture of a health care institution (p. 13)

Healthcare leaders must be aware of the challenges they face within their own organizations if they plan to be successful in transitioning their hospitals from a volume to value based culture.

Physician Engagement

The IOM 2001 report also recognized organizational problems related to quality of care across the continuum. These problems were most evident in the chronic conditions population however:

> the fact that more than 40 percent of people with chronic conditions have more than one such condition argues strongly for more sophisticated mechanisms to coordinate care. Yet health care organizations, hospitals, and physician groups typically operate as separate "silos," acting without the benefit of complete information about the patient's condition, medical history, services provided in other settings, or medications provided by other clinicians (Morrisey, 2011, p.13).

The kind of process improvement one needs to engage in improving the clinical process "…requires the engagement of every single person in your organization" (Edgman-Levitan, as cited in Morrissey, 2011, p. 14). According to Haywood, "The communication, coordination and information demands of meeting these value-based

challenges require hospitals to develop a data-driven culture. It's a knowledge-based game…it's about who has the knowledge and can quickly diffuse it throughout their organization" (as cited in Morrissey, 2011, p. 19).

Organizational Preparation

Kaufman (2011) recognized the need for organizations to move from a culture of entitlement to one of accountability if they wish to be sustainable in the world of VBP and reduced reimbursements. Kaugman (2011) identified nine practical steps that a health system can implement to prepare for the challenges that lie ahead. The following are four steps representative of the need for leaders to make a conscious effort in engaging the front line leaders in quality, the physicians:

- Leaders should analyze the market and conduct regular briefings for board members, physicians, employees, and the community on the structural changes in healthcare occurring at the local, state, and federal level.
- Leaders should designate a group of physician leaders to be the clinical transformation task force. Use this group as a sounding board and to lead implementation efforts to establish an unambiguous course for change with straightforward targets.

- The chief medical officer or his designee should be held accountable for the performance of all hospital-based physicians and medical directors and should routinely measure and manage their performance.
- Base compensation for employed physicians should be modified to include patient satisfaction, system performance, and cooperation with system initiatives.

Statement of the Problem

As much as $700 billion per year in health care services are delivered in the United States that do not improve health outcomes making it imperative for the stakeholders involved (physicians, patients, payers, and purchasers) to explore new models of healthcare delivery and reimbursement to address some of these challenges (Harbaugh, 2009). Fundamentally, healthcare organizations exist for the patients they serve who are entitled to quality care. The term "quality" has been loosely and inconsistently defined by patients, family members, care givers, clinicians, providers, and leaders. The guidelines set by CMS in the form of clinical outcomes, is an attempt to bring consistency and measurability to how quality is defined. The consequences of below standard quality outcomes will not be limited to public opinion which can lead patients to a better performing organization for future care; it will also lead to less reimbursements and possible penalties which puts an organization's sustainability at risk.

Healthcare leaders are being faced with some very unique challenges by way of reform. The changes occurring with our healthcare system at a national level, coupled with the changes occurring at an organizational level, has heightened the need for

healthcare leaders to understand systems. It is within these systems that the quality of care delivered by an organization is defined and measured. Hospitals will no longer be reimbursed in relation to quantity but rather quality. This paradigm shift will require a change in linear, vertical, or horizontal thinking to a systems thinking approach that encompasses national, state, regional, organizational, and discipline perspectives. It will require healthcare leaders to stay abreast of the ever changing outcome measurements, how they are benchmarked, and how they will be utilized in the performance scoring associated with VBP.

Healthcare leaders must transition their organizations from volume-based to value-based systems. This transition will require the involvement, engagement, and accountability of the physicians delivering the majority of the care being provided. Leaders must work collaboratively with physicians while integrating them into quality leadership roles that drive quality improvement initiatives. Physicians must have an awareness of the national and state initiatives that influence the care they provide in the hospital setting. This awareness provides physicians with the tools necessary to follow the guidelines and properly document as a means of capturing the required data to optimize reimbursements in the program. The quality risks of poor documentation have magnified and central to all document improvement strategies is the engagement of physicians. Inadequate and inaccurate clinical documentation has been cited as a key contributor of reduced reimbursements and poor publicly reported quality outcomes. In a study performed by researchers at Boston University of Public Health Physician (as cited in The Advisory Board, 2012), it was found that physicians are the main "agent required

to elevate performance on 46%" of publicly reported indicators. Physician engagement in quality improvement initiatives is crucial to enhancing the quality of patient care provided in the hospital setting which in turn has a positive influence in an organization's overall survival in the era of reform.

The statement of the problem is best summarized by the Clinical Advisory Board of The Advisory Board Company (2012):

> Physician leadership and support is widely recognized as critical to advancing performance goals; however over the years, many hospitals have had to rely on an ever shrinking pool of engaged physicians to support quality improvement initiatives. While this challenge is not new, the implications carry new weight in the shifting market dynamics. . . As the industry shifts to a more performance-based environment, cost and quality performance will become two of the most critical variables for future success.

Research Objective

The objective of this study is to explore the utilization of social network analysis (SNA) to map the relationships and communications of a network of physicians in a hospital setting as a means of evaluating influential discussions surrounding quality improvement initiatives.

Research Questions

1. How can social network analysis (SNA) be utilized to identify communication patterns between physicians who are engaged in quality improvement that can increase the effectiveness of disseminating behavior change within the hospital setting and improving overall quality of care outcomes?
2. How do self-perspectives on physician knowledge regarding CMS quality core measures align with other physician's perspectives on seeking out that physician's input on quality?

Expected Benefits of Study

While leaders may think they understand the networks within their systems, studies show that they can vary widely in the accuracy of their network perceptions. A SNA can be an invaluable tool for leaders to systematically assess their organization by providing data that can both serve to focus executive attention on the networks studied and allow for appropriate interventions at critical points within the network, critical to organizational effectiveness (Cross, Borgatti & Parker, 2002). According to Knoke and Yang (2008), "because network structures affect both the individual and systematic levels of analysis, network analysis can explain the variation in structural relations and their consequences" (p. 9).

Identifying physicians within an organization who engage in quality improvement dialogue and are recognized by others as influential is valuable information for healthcare leaders who wish to improve their overall performance in quality and maximize their payments in the VBP program. Moreover, information provided by the study identifying physicians within an organization who are recognized by their colleagues as influential

can prove useful to healthcare leaders beyond improving quality outcomes for a hospital. The information can be useful in decision making for selecting physician participation in committees, on teams, and or for positions of leadership. Such a study can be utilized to identify the same characteristics among networks that exist in other aspects of the organization such as in nursing, information technology, and supply chain management. The application of SNA can be narrow or broad in scope, depending on a researcher's objective, and because it simultaneously encompasses both structures and entities, it provides conceptual and methodological tools for linking changes in micro-level choices to macro-level structural alterations (Knoke& Yang, 2008). Its methods have been applied to identify relationships among peer groups, families, animals, communities, and even countries (Wasserman & Faust, 1994).

CHAPTER II

REVIEW OF LITERATURE

Chapter I provided an overview of the current state of healthcare in relation to cost and quality and the government's attempt to reform the current system specific to the hospital VBP program which is meant to incentivize organizations to provide improved quality of care. According to Folland, Goodman, and Stano (2010), hospitals are key players in the health care sector. They are at the center of an evolving health economy and have the most visible component of health care spending. The hospital industry will continue to experience rapid change in the areas of number of beds, inpatient utilization, and outpatient services. Competition will persist, putting pressure on hospitals to restructure through mergers, acquisitions and partnerships. Federal and state regulations over quality, costs, and reimbursements will continue to require hospitals to meet the regulations and standards of business and practice. These multifaceted variables influence a hospital's sustainability, and ultimately, the care that consumers experience. It is imperative that healthcare leaders understand their organization from a systems perspective and the interorganizational relationships that exist within those systems if they are to overcome the challenges that lie ahead. Physician engagement in quality improvement initiatives is crucial to the quality of care delivered to patients in their hospitals as well as to their success and sustainability in the VBP program. As healthcare organizations grow in complexity, interorganizational relationships are key to becoming part of a vertically integrated health system (Shortell & Kaluzny, 1997). The literature will be reviewed to establish the contextual framework of quality, systems, physician engagement in quality initiatives, and social network theory.

Quality

According to the American Society for Quality (n.d.), the quality movement can be traced as far back as the late 13th century, initiated by the formation of unions by craftsmen called guilds. This craftsmanship model existed up until the start of the factory system that began in Great Britain in the 1750s and eventually grew into what is known as the Industrial Revolution of the 1800s. Manufacturers began to implement quality processes in practice in the early 20th century and heightened during World War II as a means of ensuring the consistency, safety, and speed in the manufacturing of military products. Walter Shewhart, known as the father of modern quality control, aided the military in providing sampling techniques for inspection with his publication of military-specification standards. Post war, the term total quality surfaced in the United States in response to the works of Juran and Deming who changed the focus from simple inspection to the improvement of processes. By the 1970s Japan was leading the quality competition in the automotive and electronic arenas and the United States reciprocated with the total quality management (TQM) as a means of emphasizing organizational approaches to quality rather than solely a statistical approach. The quality movement has since infiltrated other industries outside of manufacturing and include but is not limited to service, healthcare, education, and government.

Quality Pioneers

The pioneers of quality improvement come from various time periods and diverse disciplines. All have been recognized in the literature as contributors in reforming and influencing quality and their roots run deeply in what we recognize as quality in

healthcare yet today. They are physicists, statisticians, leaders, doctors, nurses, and academicians who span the continuum from industry to providers of care at the bedside, each contributing to the overall advancement of quality from a global perspective. All have faced the resistance and struggles of challenging the status quo yet through their tireless efforts to make a difference, indeed they have succeeded.

Sir Thomas Percival (1740-1804)

Thomas was an English physician who worked to improve clinical practice and public health through his writings in stimulating reform. It was in 1803 that Thomas began presenting the notion of establishing and using a hospital register treatment and results of care to help physicians improve the quality of care. This was met with great trepidation by his colleagues and lack of interest in the concept was the end result. His writings however were influential in establishing the American Medical Association's (AMA) first Principles of Medical Ethics in 1847 (Darr, 2007).

Ignaz Semmelweis (1818-1865)

According to Darr (2007), in 1847 Semmelweis was an Austro-Hungarian physician who focused on reducing the incidence of puerperal (childbed) fever (an often fatal bacterial infection in women post delivery). He utilized mortality statistics in a Vienna hospital by observing hand washing by residents with carbolic acid after participating in autopsies and before performing examinations on live patients. The implementation of hand washing virtually eliminated the infections, yet Semmelweis

faced criticism from his colleagues forcing him out of practicing in Vienna. In 1861, he wrote of his findings and recommendations in The Etiology, Concept, and Prophylaxis of Childbed Fever, which is believed to have influenced the works of Louis Pasteur and the germ theory of disease.

Florence Nightingale (1820-1910)

Nightingale is not only recognized as the most influential pioneer of nursing in making it a respected profession, but she is also remembered as a reformer of hospitals. As the chief nurse during the Crimean War, she learned through statistical analysis that improving the sanitary conditions in the military hospitals led to a reduction in overall death rates. Nightingale faced the challenge of convincing men in power of her findings at a time when social restraints on women were prevalent and the utilization of social statistics was uncommon. One measure of her accomplishments came in 1855 after her arrival at a British Hospital in Scutari with a team of nurses serving in the Crimean War. Upon her arrival, the mortality rate at the hospital was 42.7% of the cases treated, six months later under Nightingale's leadership, mortality in the hospital dropped to 2.2%. Upon returning from the war in 1856, Nightingale worked alongside William Farr, a physician and professional statistician. Her publication of Notes on Matters Affecting the Health; Efficiency and Hospital Administration of the British Army contributed to Farr's final report to the Royal Commission. As a result, four reforms were carried out based on Farr's recommendations:

1. Physical alterations to military barracks and hospitals

2. Improvements in ventilation, heating, sewage disposal, water supply, and kitchens
3. A sanitary code for the army
4. Establishment of a military medical school with a reorganization of the army's procedures for gathering medical statistics (Cohen, 1984).

In 1860, although in poor health leaving her mostly bedridden, Nightingale founded the Nightingale Training School for Nurses based on the following two principles: (1) That nurses should have their technical training in hospitals specially organized for that purpose; (2) That they should live in a home fit to for their moral life and discipline (Cohen, 1984). Cohen (1984) summarized Nightingale's influence on quality, "Her greatest contributions were undoubtedly her efforts to reform the British military health-care system and her establishment, through the founding of training programs and the definition of sound professional standards, of nursing as a respected profession" (p. 128).

William S. Halsted (1852-1922)

Fortunate to have been beginning his career in surgery in 1877, the same time that surgeon Joseph Lister began reporting on the benefits of antiseptic techniques in preventing the spread of microorganisms, Halsted sought to implement antisepsis in a New York City hospital he was employed. He too met much skepticism and opposition from his colleagues to the extent that he was forced to operate from a tent outside the hospital. His outcomes were difficult to refute and surgeons began following his example. Halsted went on to becoming a reputable surgeon at Johns Hopkins Hospital

and was credited with the development of new operations causing him to be known as the "father of surgical subspecialties" and for the donning of rubber gloves during surgery as a means of reducing skin rashes from the repeated use of antiseptic solutions (a practice eventually adopted by surgeons worldwide) (Darr, 2007).

Ernest Amory Codman (1869-1940)

Ernest A. Codman, a Boston surgeon and the founder of the American College of Surgeons (ACS), is considered a pioneer in the advancement of quality with his works in his own private hospital he named "End Result Hospital". His focus was on following his patient's years after their treatment and in monitoring the end result of their care. Codman tracked errors and measured results for patients who were discharged from his hospital. Reasons Codman identified for the errors remain in existence yet today: a lack of knowledge or skill, surgical judgment, lack of care or equipment, and lack of diagnostic skill. In addition, Codman recognized the importance of acknowledging and studying those errors that he termed "calamities" that are unpreventable to advance the practice of medicine. Furthermore, Codman identified the need for transparency; "calamities of surgery or those accidents and complications over which we have known control. These should be acknowledged to ourselves and to the public and study directed to their prevention" (as cited in Neuhauser, 2002, p. 104). Although Codman focused on the role of the surgeon, he was fully aware of the impact hospital processes had on affecting the outcome of treatment. In his own words (as cited by Darr, 2007):

> The end-result idea merely demands that the results shall be constantly analyzed and possible methods of improvement constantly considered. Bad results may be

> due to incorrect diagnoses, to lack of equipment, to errors of care, of judgment, or of skill. The end-result idea implies that the hospital should be conscious of its shortcomings, and constantly on the watch to improve its equipment and method (p. 37).

Codman's efforts to reform medicine to one of scientific management, regulation, and of transparency met great resistance. When Codman met such resistance he became more radical with his approaches. According to Crenner (2007), Codman utilized a public meeting of the medical society "to expose the hypocrisy that he saw behind resistance to his reforms" inviting politicians, hospital trustees, Boston's then mayor, and the president of Harvard University, Lawrence Lowell (who declined the invite). Codman used the stage to convey his message using an eight foot cartoon depicting caricatures of "the residents of Boston's elite Back Bay neighborhood" as an ostrich with its head stuck in the sand. The scene suggested a cozy arrangement among Boston's academic physicians and the city's prominent university and hospitals. The wealthy ostrich laid the "golden eggs" of high medical fees but never looked up to assess the value of its medical services. Only the End Results System could provide such an assessment. Codman paid the price in academic medicine for his radical approach losing his affiliation as a professor at Harvard Medical School and with Massachusetts General Hospital.

Codman is the founder of what is known today as outcomes management in patient care. He is also credited to be the first in organizing morbidity and mortality (M&M) conferences (a forum for physicians to discuss cases openly for the purpose of education related to patient outcomes and how the care provided contributed to such outcomes); instrumental in creating the objective of the ACS's end-result system of hospital standardization when The Hospital Standardization Program was established in 1918 (which later became the Joint Commission on Accreditation of Hospitals in 1951); and organized the first bone tumor registry in the United States (Darr, 2007).

Walter A. Shewhart (1891-1967)

Although many are familiar with the famous study of worker productivity at the Chicago Western Electric Hawthorne Plant in 1924, few are as familiar with the fact that Walter Shewhart worked alongside William Deming and Joseph Juran in the plant as their mentor. Shewhart taught the application of statistics to measure and control process variation. According to Best and Neuhauser (2005), "Shewhart, Deming, and Juran are often considered to be the three founders of the quality improvement movement" (p. 142). In addition to his contribution to the Hawthorne studies, Shewhart developed the first control chart and the Plan, Do, Study, Act (PDSA or the Shewhart Model for Improvement) which focused on product design; both of which continue to be frequently utilized tools in the quality improvement arena yet today. Referred to as the "father of statistical control", Shewhart was concerned with reducing variation which he summarized in his book Economic Control of Quality of Manufactured Product (as cited in Best & Neuhauser, 2005):

> The object of industry is to set up economic ways of satisfying human wants and in so doing to reduce everything possible to routines requiring a minimum amount of human effort. Through the use of the scientific method, extended to take account of modern statistical concepts, it has been found possible to set up limits within which the results of routine efforts must lie if they are to be economical. Deviations in the results of a routine process outside such limits indicate that the routine has broken down and will no longer be economical until the cause of trouble is removed. (p. 142)

W. Edwards Deming (1900-1993)

William Deming earned a doctorate in mathematical physics from Yale in 1928 and later went on to teach, work for the United States Department of Agriculture, and the US Census Bureau. Deming's most well-known work was with the development of courses in aiding industries in war production efforts. In these courses, Deming taught statistical process control methods and Plan, Do, Check, Act (PDCA, or the Deming cycle) cycles as a means of generating new organizational knowledge focusing on problem solving and process improvement versus product design as with Shewhart's PDSA cycle. Combined, the course material led to less waste and improved quality. Japan took note of his works and Deming was invited to teach his methods to Japanese scientists and engineers. His teachings catapulted Japan into becoming the world leader in manufacturing excellence (Neuhauser, 2005). Deming's system of profound knowledge contains four key elements that he believed are vital to quality improvement: appreciation for a system, understanding variation, a theory of knowledge, and

understanding psychology and human behavior. Deming's overall philosophy of quality is best summarized by Neuhauser (2005) who stated:

> This means simultaneously seeing organizations as a set of interrelated processes with a common aim, understanding that processes have common cause and special cause variation, understanding how new knowledge is generated within an organization, and understanding how people are motivated and work in groups or teams in the organization.

Joseph Moses Juran (1904-2008)

A colleague and co-worker of Shewhart & Deming, Joseph Juran was destined to influence the quality movement in the United States. After his work at Western Electric and his contribution to the Hawthorne studies, he went on to publish the Quality Control Handbook in 1951, and like that of his colleague Deming, was invited by Japan to give a series of lectures in 1954. Juran went onto create the Juran Institute, Inc. in 1979 which is still in existence today. Kolesar (2008) examined the actual lectures given by Juran to Japanese executives for both content and impact relative to past and present. The overall theme of Juran's lectures focused on the responsibility of leaders in "controlling" quality and identified 5 primary executive responsibilities:

1. Responsibility for high policy and doctrine on quality – viewed by Juran as a set of ethical issues closely mirrors that of what we identify as transparency today.
2. Responsibility for choice of quality design (grade) – dealing with the issue of quality and cost. Juran stated "that while a higher quality grade usually

costs more, conformance to the design usually costs less" (as cited in Kolesar, 2008, p. 10).

3. Responsibility for the plan of organization of the company with respect to quality – referring to the need for a designated quality department to oversee quality control partnering with a quality committee "whose functions included the identification of unsolved and chronic quality problems, the identification of and recommendation of solutions to these problems, and monitoring the progress on quality" (Kolesar, 2008, p. 11).
4. Responsibility for setting up the measurement of what is actually taking place with respect to quality – identifying the following essential measures of quality: share of market, complaint rates, costs of customer adjustments, direct outgoing quality characteristics and defect rates, costs of quality, scrap, rework and so on, overhead and hidden factory costs, delays and upsets, lost goodwill, and reduced morale.
5. Responsibility for reviewing results against goals and for taking action on significant variations – via a scheduled constructive review (proactive) approach versus when difficulty arises (reactive).

Avedis Donabedien (1919-2000)

After ten years as a practicing physician, Donabedien left his birth country of Beirut to attend the Harvard School of Public Health. It was at that time in 1955 that he began his research career in medical care evaluation. In 1961, Donabedien became a Professor at the University of Michigan where he began his work in defining and

measuring quality. Donabedien identifies two essential parts that comprise quality medical care – the technical components and the interpersonal components (Kelly, 2011). In measuring quality, Donabedien recommends a three part approach including three distinct categories by which quality of care can be classified and inference s can be made about quality of care: structure, process, and outcome. The three categories are defined as such (Donabedien, 1988):

> Structure – denotes the attributes of the settings in which care occurs. This includes the attributes of material resources (such as facilities, equipment, and money), of human resources (such as the number and qualifications of personnel), and of organizational structure (such as medical staff organization, methods of peer review, and methods of reimbursement).
>
> Process – denotes what is actually done in giving and receiving care. It includes the patient's activities in seeking care and carrying it out as well as the practitioner's activities in making a diagnosis and recommending or implementing treatment.
>
> Outcome – denotes the effects of care on the health status of patients and populations. Improvements in the patient's knowledge and salutary changes in the patient's behavior are included under a broad definition of health status, and so is the degree of the patient's satisfaction with care (p. 1745)

Donald M. Berwick (1946 -)

Dr. Donald Berwick, prior to his appointment and departure as the Administrator of CMS, served as the President and Chief Executive Officer of the Institute for Healthcare Improvement (IHI). Berwick's academic experience includes Clinical Professor of Pediatrics and Health Care Policy at the Harvard Medical School and Professor in the Department of Health Policy and Management at the Harvard School of Public Health. He was also an elected member of the Institute of Medicine (IOM) and is recognized as one of the nation's leading authorities on health care quality and improvement. While Berwick was with the IHI, he published a commentary in *The Journal of the American Medical Association* (Berwick, 2008) discussing the science of improvement in health care based on evidence. In order to "accelerate the improvement of systems of care and practice" Berwick identified 4 changes necessary to the then current approach to evidence in healthcare:

1. Embrace a wider range of scientific methodologies – evaluation should include the retaining and sharing of information on both mechanisms and contexts.
2. Reconsider thresholds for action on evidence – make incremental changes and learn from experience while implementing such changes (encourages the utilization of Plan, Do, Study, Act (PDSA) cycles.

3. Rethink views about trust and bias - just as bias can be a threat to valid interference, too vigorous attack on bias can have an unanticipated negative effect. Berwick recommended that an organization equips the workforce to study the effects of their efforts both actively and objectively as part of their everyday work.
4. Be careful about mood, affect, and civility in evaluations – urging practitioners and academicians to respect one another and work collaboratively for the good of our patients.

Physician Engagement

Physician engagement in quality initiatives must be integrated into their education and must begin in medical schools and residency programs. In a systematic review of the literature performed by Patow et al., (2009) the authors were looking to identify the effectiveness of improving patient care through resident involvement in quality improvement (QI) initiatives. Twenty-eight articles met inclusion criteria of residents actively involved in QI in the areas of curriculum change, clinical guideline implementation, or involvement with a clinical QI team. Five of the articles measured patient health as the outcomes in QI while 23 studied process improvement in patient care or resident education as the outcome measure. In half of the articles reviewed, barriers to residents' involvement in QI projects were identified. Many of these same barriers identified for resident engagement are recognized by quality leaders as obstacles in engaging physicians yet today:

- Lack of time, low attendance.

- Difficulty building into already crowded curriculum.
- Time for QI initiatives interrupted.
- Less time for QI initiatives.
- Little previous QI training.
- Clinical leaders presumptions that residents (physicians) have little interest in QI.
- Skepticism.
- Expense.
- Faculty development needed on topics of QI techniques and team dynamics.
- Time and effort spent on complying with government regulations.

In 2002, Shine (President of the IOM from 1992-2001) challenged the medical profession to move from a "20th-century paradigm of the physician who was in solo practice, held autonomy as a central value, prided himself or herself upon continuous learning and the acquisition of new knowledge, and laid claim to infallibility when confronting patients and colleagues" to a 21st-century paradigm (Shine, 2002, p. 92). The new paradigm Shine (2002) argued is one of "physicians who understand teamwork and systems of care in which they can provide leadership. Group practice, both virtual and real, will allow the support of information systems, the collection of evidence about care, and efforts for continuous quality improvement" (p. 92).

Blumenthal's (2012) contribution to *The New England Journal of Medicine* urged physicians to set aside their anger, skepticism, and disinterest in the debate over quality stressing that they are luxuries that physicians can no longer afford in the face of reform and transparency. Blumenthal (2012) pointed to the fact that the medical profession's legal and economic privileges are granted by the public with an expectation that they will have the technical knowledge necessary to provide care in the best interest of their patients. Blumenthal (2012) stated:

> If physicians cannot even understand, much less lead, the current debate about the quality of health care, their claim to technical mastery of their field – and thus, the special rights and responsibilities associated with their professional status – will be open to challenge by contending political and economic groups. Perhaps even more troubling, if physicians lack a full comprehension of the debate over the quality of care, the public may lose confidence in their ability to serve and protect their patients in the fact of the convulsive changes now occurring in our health care system (p. 891).

Quality Stakeholders

The Joint Commission

The Joint Commission (TJC) is an independent, not-for-profit organization which was founded in 1951. It "seeks to continuously improve health care for the public, in collaboration with other stakeholders, by evaluating health care organizations and inspiring them to excel in providing safe and effective care of the highest quality and value" (TJC, 2013). It is the nation's oldest and largest standards-setting and accrediting

body in healthcare and accredits more than 19,000 healthcare organizations and programs across the U.S. In addition to its sentinel event (an unexpected occurrence involving death or serious physical or psychological injury) policy developed in 1996 requiring accredited hospitals to conduct a root cause analysis (RCA), TJC is widely known for the development of the National Patient Safety Goals (NPSGs) program. The program is intended to "compel system change through below-the-waterline questions about core managerial responsibilities and decisions" (Kelly, 2011, p. 112).

The Centers for Medicare & Medicaid Services (CMS)

Medicare and Medicaid programs were signed into law in 1965 by former President Lyndon B. Johnson. Since that time, there have been several changes made to the CMS programs. Chapter I discussed some of those changes in relation to quality reporting and the ACA of 2010. In 1987, CMS was known as the Health Care Financing Agency (HCFA), and it was during this time that the first report related to hospital specific mortality rates for Medicare acute care hospitals was published. This report set the stage for "using federal policy to systematically develop and implement expectations, requirements, methodology, and infrastructure to collect, publish, and disseminate quality performance data measuring beneficiaries' quality of care" (Kelly, 2011, p. 127). From 1997 to 1999, HCFA began collecting quality process measures on acute myocardial infarctions (AMI), breast cancer, diabetes mellitus, congestive heart failure (CHF), pneumonia, and stroke. The difference in this study from the mortality study was that the

data was derived directly from the patients' medical records. Today, the number of mandatory reported CMS hospital quality measures has grown and currently includes clinical process of care measures, outcome indicators, and HCAHPS, all made available to the public as of 2005 on the US Department of Health and Human Services website "Hospital Compare" (Kelly, 2011).

Institute of Medicine (IOM)

Established in 1970, the IOM is an independent, nonprofit organization that works outside of government to provide unbiased and authoritative advice to decision makers and the public. The IOM performs vigorous research as a means of answering the difficult questions of national importance. Reports provided by the IOM are meant to provide the public and decision makers with objective advice and are recognized by leaders in the healthcare industry as a gauge of what an organization should prepare for. IOM's 1999 report To Err is Human: Building a Safer Healthcare System, was another study conducted to look at reducing preventable medical errors with a goal set to reduce by 50% over a span of five years.

As previously mentioned, the most recognized report related to quality has been the 2001 *Crossing the Quality Chasm: A New Health System for the 21st Century* report (IOM, 2001). The IOM report identifies six areas (aims) that the American health care system must make great strides in to meet patient needs: safe, effective, patient-centered, timely, efficient, and equitable. The report also outlines ten rules for redesign:

1. Care is based on continuous healing relationships.
2. Care is customized according to patient needs and values.

3. The patient is the source of control.
4. Knowledge is shared and information flows freely.
5. Decision making is evidence-based.
6. Safety is a system priority.
7. Transparency is necessary.
8. Needs are anticipated.
9. Waste is continuously decreased.
10. Cooperation among clinicians is a priority. (IOM, 2001)

In addition to this report, the IOM publishes a series of reports that focus strictly on quality and patient safety in the United States. Such series include Rewarding Provider Performance: Aligning Incentives in Medicare; Preventing Medication Errors: Quality Chasm Series; Medicare's Quality Improvement Organization Program: Maximizing Potential; Performance Measurement: Accelerating Improvement; Improving the Quality of Health Care for Mental Health and Substance-Use Conditions: Quality Chasm Series; Patient Safety: Achieving a New Standard for Care; Keeping Patients Safe: Transforming the Work Environment of Nurses (IOM, 2013).

The Leapfrog Group

In 1998, a group of large employers collaborated to discuss the purchasing of health care and its influence on cost and quality (The Leapfrog Group, n.d.). The group's initial focus centered on the IOM's 1999 report findings related to medical errors. This original group of employers recognized the need to begin rewarding hospitals who demonstrated improvements in quality and safety, affording the employer an opportunity

to take great "leaps" with their employees, retirees, and families. The official launch of The Leapfrog Group (n.d.) occurred in 2000 with funding from the Business Roundtable (The Leapfrog Group, n.d.). The group today (as cited in Kelly, 2011):

> is a growing consortium of major companies and other large private and public healthcare purchasers that provide health benefits to more than 37 million Americans in all 50 states…Leapfrog members agree to base their purchase of health care on principles that encourage quality improvement among providers and consumer involvement in health care decision making. (p. 112)

Leapfrog participation is voluntary with The Leapfrog Hospital Survey being the "gold standard" for comparing hospitals' performance on the national standards of quality, safety, and efficiency. As of 2009, 1206 hospitals participated in the survey.

The National Quality Forum (NQF)

The NQF was created in 1999 by a coalition of public and private-sector leadership in response to recommendations made by the 1998 Advisory Commission on Consumer Protection and Quality in the Health Care Industry report (2012a). The NQF receives funding from both private and public sources. Two such sources and strong supporters of the NQF include the Robert Wood Johnson Foundation and CMS. The U.S. Department of Health and Human Services (DHHS) contracted the NQF to establish a portfolio of quality and efficiency measures "… that will allow the federal government to more clearly see how and whether healthcare spending is achieving the best results for patients and taxpayers. The contract is part of a provision in the Medicare Improvements

for Patients and Providers Act of 2008." The NQF (2012b) has endorsed over 600 measures with approximately 100 patient-safety focused, an additional 34 safe practices for better health care, and 28 serious reportable events.

Systems

Merriam-Webster defines "system" as a regularly interacting or interdependent group of items forming a unified whole (n.d.). Reed (2006) compared a system to that of a human body that has parts which affect the performance of the whole. Although the term "system" can take on various meanings across disciplines, its application is universal. At an international and national level, The World Health Organization [WHO], as cited in Stopskopf & Johnson, 2010) described a health system as "the sum total of all the organizations, institutions, and resources whose primary purpose is to improve health" (p. 3).

At an organizational level, "A health care system can be defined as a set of connected or interdependent parts or agents--including caregivers and patients--bound by a common purpose and acting on their knowledge" (Trochim, Cabrera, Milstein, Gallagher & Leischow, 2006). Orlikoff (1998) likened an organization to an organic living system. In an organization, "…systems themselves motivate and become the context for governance transformation" and if an organization can be successful in coming together as a whole, one may "…come to realize that what might be good for one part of the organization might not be good for the organization as a whole and that

working together to reach a common goal is the way to achieve results" (p.19). Orlikoff (1998) stated that in order for a true system to exist:

> …neither the hospital, its chief executive officer (CEO), nor a particular group of physician specialists or founding board members are more important than the system itself; and the needs of individuals or specific entities should be eclipsed by the needs of the system.

From a management perspective, Churchman has been studying systems since 1968 and his work has been summarized by Ulrich (1994), who stated that management means more than simply the allocation of resources, "…it means a philosophical challenge to our capabilities of understanding the ethics of the whole system" (p. 26).

Randolph, Esporas, Provost, Massie and Bundy (2009) recognized the concept of a system as the cornerstone of quality improvement (QI) science. The authors recognized the complexity of systems and the effect the nature of a system has on the measurement and feedback of QI projects undertaken within that system. The relationship of system and quality is summarized by Randolph, et al. (2009) in the following manner:

> A system's identification of its common purpose aligns its parts. Those parts are interdependent, meaning that all parts of the system, and all relations between and among those parts, can influence system performance. Thus, QI projects require multiple measures, at multiple levels, to understand the effects of change on the different components of the system, and on the system as a whole. (p. 781)

Systems Thinking

Without a fundamental understanding of systems and systems thinking, it becomes difficult for leaders to develop and design improvement initiatives at any level. A deeper understanding of the linkages, relationships, interactions and behaviors among the elements that characterize the entire system requires systems thinking which is defined as "…an approach to problem solving that views "problems" as part of a wider, dynamic system" (WHO, 2009, p. 33). Additionally, Trochim et al. (2006) indicated, "Systems thinking is a general conceptual orientation concerned with the interrelationships between parts and their relationships to a functioning whole, often understood within the context of an even greater whole" (p. 539). Waldman, Smith and Hood (2003) believed that systems' thinking sheds light in an area that has yet to be fully understood, corporate culture. Orlikoff (1998) described system thinking in the following manner:

> Systems thinking identifies the interdependencies that drive behavior and enables leaders to select high-leverage interventions for lasting results. It is a framework for understanding the world around us that identifies and examines key interrelationships among variables and the patterns these relationships are part of over time. Systems thinkers know that the whole is greater than the sum of its parts and that it can produce an outcome that surpasses any results generated by individual units. Therefore, systems thinkers realize that no one part of the system is more important than any other. This overriding sense of the whole also makes systems thinkers continuously ask how activities conducted by one part of the

> system affect the rest of the system. They know that each entity must act to maximize the good of the system as a whole and that allocation of resources and other decisions that are made for one unit should be evaluated primarily against the effect they will have on the system and not made to maximize the results for that unit alone.

Systems thinking requires a shift from "what's in it for me" to "what's in it for the organization." This is a shift that will be essential if organizations wish to be competitive in the area of quality. Quality must be shared and owned by all members of an organization (clinicians, providers, supply chain, housekeeping, food services, leadership etc…), as all members contribute to the outcomes of patient quality in some manner or another. Boyes-Watson (2005) stated, "Profound organizational change cannot take place unless people within organizations share deep assumptions and values with one another" (p. 370). Senge (1990), is well known for his development of The Fifth Discipline, which is the belief that:

> organizations work the way they work, ultimately, because of how we think and how we interact. Only by changing how we think can we change deeply embedded policies and practices. Only by changing how we interact can shared visions, shared understandings, and new capacities for coordinated action be established. (p. xiv)

In revisiting the IOM report *Crossing the Quality Chasm*, it too supports the need for healthcare organizations to be viewed as complex systems and explores how system approaches can be used to implement change.

Physician Engagement and Quality Improvement

Some might view the need for physician involvement in the VBP as minimal compared to that of a hospital administrator; however, their involvement in the diagnosis and treatment of disease makes them accountable for the supply of medical services and the demand for care, a fundamental driver in controlling Medicare spending (Asplin, 2010). Even though it's a well-known fact that physicians generate significant costs related to patient care, their involvement in efforts to improve cost efficiencies has been unmatched (Goodroe, 2010). The level of physician engagement in quality initiatives is gaining a great deal of attention as a result of pay-for performance programs such as with VBP and the Physicians Quality Reporting Initiative (PQRI). As previously discussed, this attention has been the result of a shift from data reporting only to payments for performance on quality measures. According to Clancy (2009), "The pace of these developments represents an unprecedented opportunity for physician leadership" when it comes to understanding the specifics about measures, data collection, and submission (p. 1396).

Challenges

Few would disagree with the importance of physician engagement in improving the quality of care for patients in the hospital setting; however, engaging physicians in quality improvement (QI) has become a common challenge for hospitals (Gosfield & Reinersten, 2008). While it is recognized that physicians historically have resisted QI initiatives, the extent of such resistance is not well documented (Audet, Doty, Shamasdin, & Schoenbaum, 2005). Utilizing data from the 2003 Commonwealth Fund National

Survey of Physicians and Quality of Care, Audet et al. (2005) found that physicians had not yet embraced QI principles and methods. A recommendation of the study was to engage the medical profession by focusing on capacity, education, and professionalism. System capacity and infrastructure should be addressed by assisting physicians in obtaining and utilizing data for improvement (i.e. optimizing the use of EHRs). Education at the medical school, residency, and postgraduate levels will have to incorporate QI in order to heighten the adoption of QI among physicians. Lastly, the professional organizations of medicine are also getting involved. According to Audet et al. (2005), The Professionalism Charter of 2002 for physicians states that they should participate in the "continuous improvement in the quality of health care" (p. 852).

The challenges associated with early adoption of QI programs in the past have been in defining and measuring the value of healthcare. A definition of value is quality (patient outcomes, safety, and service) divided by cost over time which works well for some clearly defined conditions but is more challenging for complex patients with multiple problems (Asplin, 2010). Although quality patient care is the goal of physician practice, how care is defined as quality by CMS does not always align with physicians. This makes it difficult for healthcare leaders to gain physician "buy-in" and ownership for quality benchmarked outcomes. This issue is likened to the physician as artist metaphor; just as the artist has a unique style and interpretation when sculpting or painting, the physician has unique care delivery methods for his or her patients (Goodroe, 2010).

Shekell (2002) noted that resistance by physicians towards quality assurance and quality improvement efforts are common across all countries and health systems. The

author identified four reasons for the "cognitive dissonance" that exists between the desire of physicians to deliver high quality care and their resistance to organized efforts at quality assurance and improvement. The four reasons include:

1. Physicians may not always agree with the criteria by which quality is being measured.
2. Physicians view quality assurance and improvement programs as opportunities to blame them for anything bad that may or may not happen to the patient.
3. Physicians believe that they are being asked to participate in quality assurance and improvement programs on top of all their other clinical and administrative responsibilities.
4. There are no role models, meaning that until physicians can see how a real program works operationally and can see an improvement in overall quality, resistance to clinical governance will continue (Shekell, 2002, p.6).

The concept of being measured by a form of clinical governance outside the medical discipline as with the VBP is difficult for many physicians to embrace. When measurements are used to evaluate performance, there will always be those that fall below, meet, or exceed the benchmarks. In terms of thinking about clinical quality outcomes in relation to the bell curve, there are always going to be hospitals that perform

below and above the middle, and the majority oftentimes performing in the middle. According to Gawande (2007), a general surgeon, acknowledgement of the bell curve is distressing for most doctors in that it "…contradicts the belief nearly all of us have that we are doing our job as well as it can be done" and such information utilized to compare records of success and failures is difficult for physicians to share with those of peers (p. 207).

Harbaugh (2009) reviewed past, present, and possible future models of physician payment for healthcare delivery. The author identified the need to promote the emergence of regional physician organizations or trusts to help develop measures, aggregate data, and implement QI initiatives as a means of improving quality and efficiency. In addition, the "final solution should be physician driven, patient centered, employer sponsored, and payer administered, with the primary goal of improving the quality of care" (Harbaugh, 2009, p. 1005). Echoing Harbaugh's analysis, Clancy (2009) explained: "In anticipation of an increased focus on quality care, physicians should be thinking right now about how they can engage as individual practitioners as well as through their professional organizations" (p. 1396).

Hospital Leadership Role in Engaging Physicians

In a systematic review of the literature to identify contextual factors that influence QI success, Kaplan et al.(2010) found that physician involvement was important. Physician involvement by way of participation in QI teams was identified in six of the forty-seven articles that were included in the review, as well as a 42% positive association with physicians as project champions and quality improvement success.

Goeschel, Wachter, and Pronovost (2010) reviewed essential responsibilities of physician involvement in quality from both a technical and adaptive perspective. The technical work of QI "…involves identifying known solutions to performance problems, ensuring patients reliably receive evidence-based therapies, and monitoring performance" while the adaptive work "involves changing attitudes, beliefs, and behaviors needed to provide high-quality and safe patient care" (Goeschel, Wachter, & Pronovost, 2010, p. 174). This requires physician engagement in quality initiatives, the primary gatekeepers of a patient's care during hospitalization.

Healthcare leaders must also work at engaging their quality stakeholders, those who can affect or be affected by changes in a system, by working collaboratively. Randolph et al. (2009) supported the need for leadership to supply feedback to the stakeholders on QI efforts to understand how the process helps to achieve the improvement aim. Furthermore, Rice (2012) explained:

> New governance models are needed to engage and align the physician enterprise – and the organization's overall capacity – to deliver on demands for better quality care. Without new governance strategies, systems and staff, quality promises will ring hollow, and pay-for-performance incentives will erode. (p.76)

Moreover, physician leaders or quality "champions" are oftentimes the most effective messengers for delivering performance data to frontline staff and when they provide feedback to other physicians, "…it provides validation that the data came from colleagues with shared interests in promoting, as well as shared barriers to providing, optimal clinical care" (Randolph et al., 2009, p. 792).

Thomas (2009) outlined steps a hospital must consider in developing an alignment approach with physicians. For example, Thomas (2009) indicated that hospitals should take an inventory of their current physician relationships; listen to their key physician leaders, discuss and define their intentions; and communicate their initiatives. Lovrien and Peterson (2011) closely mirrored Thomas's recommendations, and they identified three types of physician alignment that is a must if an organization wishes to "…optimize the delivery system and ensure effective coordination of care while maintaining appropriate financial returns for the hospital" (p. 72):

1. Clinical activity – defined as the correlation of the patient care approach, expectations of quality and service, and consolidation of activity in the diagnosis, treatment, and rehabilitation of patients.
2. Economic – defined as the correlation of physician and hospital financial returns.
3. Alignment of purpose – defined as the correlation of vision, values, and energies and a common culture.

In preparation for VBP, "Surviving and thriving in such a system will require a comprehensive approach to sustaining excellent service performance from physicians and allied health staff" (Kennedy, Caselli, & Berry, 2011, p. 385). According to Asplin (2010), "As stakeholders working in the delivery system, we need to be engaged in the important work of creating a meaningful value-based purchasing system. There is too much at stake to leave this task to others" (p. 259). Physician engagement with QI will be dependent upon their involvement up front when decisions are made regarding opportunities for improvement. Goodroe (2010) stated "Experience has shown that

motivating physicians to share in risk and reward results in better outcomes for patients and cost reductions for the healthcare system" (p. 66). Patmas (2012) also recognized the importance of physician engagement (although specific to physician integration for a sustainable network in an integrated health system):

With the transition from volume-based to value-based purchasing, quality will become an increasingly important determinant of your revenue stream. When building a network from scratch, make sure you have invested in the people and the processes you will need to achieve the highest quality possible. Involving physicians in the quality culture is critical to success. (p. 28)

Social Network Analysis

It's evident by definitions alone how closely related the term social network is to systems. As previously stated, a system is defined as a regularly interacting or interdependent group of items forming a unified whole; whereas a social network refers to the set of actors and the ties among them (Wasserman & Faust, 1994). According to Mitchell (as cited in Tichy, Tushman & Fombrun, 1979), a social network is "a specific set of linkages among a defined set of persons, with the additional property that the characteristics of these linkages as a whole may be used to interpret the social behavior of the persons involved" (p. 507).

Social networks are more formally defined in research as a set of nodes (or network members) that are tied by one or more types of relations. Social network analysis (SNA) focuses on relationships among social entities and on the patterns and implications of these relationships. With SNA, the social environment can be expressed

as patterns or regularities in relationships (structures) among interacting units. Unique to SNA methodology is the fact that the unit of analysis is not the individual but rather an entity consisting of a collection of individuals and the linkages among them. The social network perspective views characteristics of the social units as arising out of structural or relational processes or focuses on properties of the relational systems themselves. Structures, their impact, and their evolution become the primary focus of network analysis. The SNA provides a formal, conceptual means for thinking about the social world by providing "…a precise way to define important social concepts, a theoretical alternative to the assumption of independent social actors, and a framework for testing theories about structural social relationships" (Wasserman & Faust, 1994, p. 17). Additionally, Carrington and Scott (2001) stated, "In the most general terms, social network analysis is a structuralist paradigm: it conceptualises[sic] social life in terms of structures of relationships among actors, rather than in terms of categories of actors" (p. 6).

Historical and Theoretical Perspectives

Social network analysis is a multidisciplinary effort that combines social theory and application with mathematical, statistical, and computing methodology. The earliest works in the field date back to 1954 with the term "social network" credited to the anthropologist Barnes (Wasserman & Faust, 1994). The field of German sociology also contributed to the development of SNA by describing patterns of social relations using the terms points, lines, and connections (Carrington & Scott, 2011). The pioneers of SNA (Moreno, Cartwright, Newcomb, Bavelas, Lewin, and Mitchell) can be traced to the

disciplines of sociology, social psychology, and anthropology. According to Wasserman and Faust (1994), "…network analysis, rather than being an unrelated collection of methods, is grounded in important social phenomena and theoretical concepts. Social network analysis also provides a formal, conceptual means for thinking about the social world" (p. 11). Approximately 20years prior to Barnes beginning his publications on social networks, Moreno (1953) was developing a rare methodological technique he referred to as the sociogram in the 1930's which marked the beginning of sociometry which was the precursor to SNA and social psychology as well as the empirical approach to the measurement of interpersonal relations in small groups (Wasserman & Faust, 1994).

Simmel's work made a noticeable contribution to the empirical findings in network analysis with the premise that social ties are primary and the belief that the social world is found in interactions rather than in an aggregation of individuals. His argument for focusing on the emergent consequences of individual actions versus understanding society as a mass of individuals who react independently to circumstances is summarized in his 1908 publication:

> A collection of human beings does not become a society because each of them has an objectively determined or subjectively impelling life-content. It becomes a society only when the vitality of these contents attains the form of reciprocal influence; only when one individual has an effect, immediate or mediate, upon another, is mere spatial aggregation or temporal succession transformed into society. (as cited in Marin & Wellman, 2011, p. 15)

Several theoretical concepts have shaped the development of various network methodologies and include but are not limited to: social group, isolate, popularity, liaison, prestige, balance, transitivity, clique, subgroup, social cohesion, social role, social position, reciprocity, exchange, mutuality, conformity, and influence dominance (Wasserman & Faust, 1994). From a mathematical perspective, there are three major foundations of network methodology which developed in the 1940's in an attempt to quantify tendencies toward reciprocity: graph theory, statistical and probability theory, and algebraic models. Since that time, researchers utilizing SNA methods have been supporters of quantitative analytical approaches (Wasserman & Faust, 1994). In a search for the key concept "social network" in over 14 social science indexes, Knoke and Yang (2008) saw a drastic increase in the social science literature from an estimated 100 sources in 1975 to over 2650 sources by 2005. The basic concepts and measures of SNA and utilization has expanded from the fields of sociology and anthropology to such disciplines as economics, organization studies, business management, public health, information science, biology, complexity, and chaos theory (Knoke & Yang, 2008).

Assumptions and Principles

There are three underlying assumptions of SNA regarding relations and their effects: structural relations are often more important for understanding observed behaviors than are such attributes as age, gender, values, and ideology; social networks affect perceptions, beliefs, and actions through a variety of structural mechanisms that are socially constructed by relations among entities; and lastly, structural relations should be

viewed as dynamic processes. Networks assume that actors participate in social systems connecting them to other actors, whose relations comprise important influences on one another's behaviors (Knoke & Yang, 2008).

Haythornthwaite (1996) stressed the fundamental maxim for SNA as relationships and describes how SNA identifies ties between pairs and examines the relationships that form and maintain those ties. The author identified five network principles that are used by analysts to explore relational properties of networks:

1. Cohesion – grouping actors according to strong common relationships with each other.
2. Structural equivalence – grouping actors according to similarity in relations with others.
3. Prominence – indicating who is "in charge"
4. Range – indicating the extent of an actor's network
5. Brokerage – indicating bridging connections to other networks. (Haythornthwaite, 1996)

Social Network Research

Informational Perspective

In addition to utilizing SNA approaches to study relationships, the same methodology can be applied to study information exchange. According to Haythornthwaite (1996), information is considered a resource among actors (individuals, groups, or organizations). The SNA approach allows for a focused relationship both in content and patterns as a means of determining how and what resources flow from one

actor to another. According to Haythornthwaite (1996) , "Since information is an important resource, and one that often depends on making and maintaining contact with the right people, a social network approach offers a rich variety of concepts and techniques to describe and explain information access" (p. 325). The study explored the kind of information that is exchanged between pairs, the supplier of the information, and how much information is supplied in relation to the three attributes of relationships: content, direction, and strength. The author supports the utilization of SNA for the study of information exchange and identifies the benefits of such an approach in that it provides tools for the information professional. Such tolls "…can help in the identification, diagnosis, and active modification of information routes…can identify how different types of information flows from one network to another" (Haythornthwaite, 1996, p. 340).

Physician Perspective

To date, there are limited published SNA studies specific to the physician population. In a retrospective, observational cohort study performed by Pollack, Weissman, Bekelman, Liao and Armstrong (2012), a SNA was performed to map the relationships among physicians who treated elderly patients with localized prostate cancer in three U.S. cities. The objective of the study was to examine whether physician social networks were associated with variation in treatment for men with localized prostate cancer. Physicians in the study were considered to have a relationship to one another if they shared in the provision of care for a prostate cancer patient. From a review of prior research, Armstrong, et al. (2012) found that physicians with a higher

number of shared patient claims data were more likely to know and communicate with one another. This information formulated their primary goal: to determine whether provider relationships in the context of the network structure were associated with patterns of prostate cancer treatment. The study population was derived from two years of data from the Surveillance, Epidemiology and End Results (SEER)-Medicare database with a final analytical sample (N = 4,520). Descriptive and multivariable regression analysis was performed. The overall conclusion of the study was that utilizing claims data to identify physician networks may provide insight into observed variation in treatment patterns for men with prostate cancer.

Practice Setting Perspective

Scott et al. (2005) utilized data from two primary care physician practices and detailed "SNA measures that can be used to quantify patterns of decision making and discuss how these measures could be used to facilitate design and measure the outcomes of interventions to change organizational behavior in primary care practices" (p. 444). Matrices were constructed from ethnographic field notes to identify how practice members interact when practice-level decisions are made. Network diagrams and network measurements (density, clustering coefficient, centralization, and hierarchy) were evaluated for utilization. Scott et al. (2005) identified the following applications of SNA: to study observed interactions among agents in a complex social system, to complement and triangulate other quantitative measures of organizational performance that use survey methodology, and to help design interventions to promote practice organizational change.

Based on the premise that physicians often rely on their colleagues for new information and advice about the care of their patients, Keating, Ayanian, Clearly, and Marsden (2007) evaluated the network of influential discussions among physicians in a hospital-based academic practice. The study included a survey about influential discussions among 33 responding physicians with their colleagues. A SNA was performed to describe the network of discussions and examined factors predictive of a physician's location in the network. Graphics software was utilized to construct a diagram of the influential discussions. The unit of analysis for the study was the pair of physicians in which a logistic regression model was performed to analyze statistical patterns of the data. Keating, Ayanian, Clearly, and Marsden's (2007)findings supported their hypotheses about factors important to the network structure within the practice studied which include: physicians seek out colleagues who are able to provide current and useful information, discussions among physician colleagues appeared to be channeled along lines of opportunity and convenience in terms of temporal and spatial proximity, and lastly, physicians were slightly less likely to report having influential discussion with other physicians of different gender (although this finding was of "borderline" statistical significance).

Organizational Perspective

Tichy et al. (1979) provided an overview of the origins, key concepts, and methods of SNA. In addition, the authors provide a case example utilizing a secondary analysis of two organizations to support their claim that "…significant advances can be made in organization theory and research" utilizing the SNA approach (Tichy et al.,

1979). Their method was found useful in facilitating the comparative analysis of organizations as well as the comparison of subunits with the organizations. Tichy et al. (1979) indicated, "Network analysis represents an underutilized framework for analyzing and conceptualizing organizations" (p. 516).

International Perspective

Fattore, Frosini, Salvatore, and Tozzie (2009) utilized the SNA approach to study two "fundamental theoretical strands" underlying the behavioral and attitudinal consequences of networking: the social capital perspective, and the social influence perspective. The authors tested the following two hypotheses utilizing administrative data from a Local Heath Authority (LHA) in Italy to evaluate the effects of general practitioner (GP) network organization on their prescribing behavior:

1. General practitioners who are more central to a collaborative network initiated by an LHA will show better performance.
2. A general practitioner's performance is positively associated with the performance of physicians in the general practitioner's network. (Fattore, Frosini, Salvatore, & Tozzie, 2009)

Hypothesis one was not supported by the data and tested by measuring a GP's centrality using degree of centrality as a variable in regression analysis which had a very small and insignificant effect on the dependent variable (expressed as the difference between an individual GP's per capital pharmaceutical expenditure and the LHA's assigned target). Hypothesis two was tested by calculating the average of the differences between the actual per capita expenditures of connected GPs and the LHA expenditure target. The

variable was equal to the average performance of the individuals with whom a GP had direct relationships. Hypothesis two was supported by the data with a positive coefficient and statistically significant at a 0.05 alpha level in the model which included degree of centrality and at the 0.10 alpha level in the model including degree of centrality.

Centrality, prestige, and clique indicators were found to be highly correlated in a study to describe relationships among healthcare professionals in a French public hospital using SNA with the intent "to improve health service quality by strengthening health service management and leadership" (Boyer et al., 2010, p. 460).

The study was based on a questionnaire designed to describe network membership characteristics and to measure social relations between respondents. Boyer et al.'s findings were measured among physician, administrators, nurses, and managers. Overall, physicians had the highest centrality, prestige, and clique scores underlining their role as leaders in the clinical arena. "The importance of good clinical leadership is becoming increasingly apparent within healthcare because it affects quality in different ways" (p. 467).

The importance of facilitating interactions between leaders and non-leaders regarding mutual expectations was reiterated with two examples in healthcare: as in the case of continuous improvement quality theory and studies by Shortell et al. in 1995 (as cited by Boyer et al., 2010) that show QI is often associated with a participative rather than bureaucratic and hierarchical culture. The authors note that although SNA can provide a systematic way of studying interactions and relationships that exist within complex communication that takes place among healthcare professionals, little has been

performed in the healthcare industry. The overall aim of SNA "…is to improve healthcare quality and staff well-being through better relationships between healthcare professionals" (Boyer et al., 2010, p. 468).

Quality Improvement Team Design

Meltzer et al. (2010) agreed with Boyer et al. in that there is very little research in the healthcare industry specifically to guide the selection of team members for quality improvement teams. SNA tools were utilized to "…derive principles for the design of effective clinical quality improvement teams and explore the implementation of these principles using social network data collected from the inpatient general medical services at a large academic medical center in Chicago" (p. 1119). The authors attempt to answer the following question: "How should team members be selected in order to increase the effectiveness of the group in modeling and/or disseminating behavior change within a larger social environment such as an organization?" (Meltzer et al., 2010) As of publication, the authors were unaware of prior studies that had utilized SNA to improve the design of QI teams in healthcare which was the goal of their study. Fifty-six out of 71 physicians on the general medicine services responded to the survey (79%). Degree, net degree (a new network measure at the group or team level proposed by the authors), and density were examined. Net degree, as conceptualized by the authors, is utilized to characterize the total stock of non-redundant social contacts that are available to a group as a whole as a means of studying the differential advantages of in-group versus out-

group ties in affecting group performance. Future research is recommended to validate net degree as a measure of team-level social capital and to evaluate the usefulness of SNA as a tool for improving care.

CHAPTER III

METHODOLOGY

Background for Design Approach

The introduction and literature review emphasized the need for healthcare leaders to stay abreast of the rapidly changing landscape of healthcare specific to reform. The VBP program puts organizations at risk to lose future CMS reimbursement dollars based on whether or not they show progress or improvement in the clinical process of care and HCAHPS survey measures. The literature supported the need for physician engagement in QI initiatives and recognized the importance of involvement yet also acknowledged the challenges of most organizations in being successful with such an endeavor. It's imperative that leaders maintain a systems perspective which requires systems thinking to prepare strategic initiatives that meet the ever changing CMS requirements. Social network analysis closely complements a systems approach and is a widely utilized and acceptable methodology for studying relationships. Several SNA studies with a focus in healthcare were reviewed at the informational exchange, physician, practice, and organizational levels as well as from an international perspective. One particular study (Meltzer et al., 2010) focused on the utilization of SNA to determine physician leaders for the creation of QI teams. A similar approach was taken with this study as a means of identifying the relationships among physicians in a hospital setting and the communications that occur among these relationships surrounding quality.

Research Objective

To reiterate, the research questions to be answered were: 1) How should physicians be identified by healthcare leaders as quality improvement "champions" in order to increase the effectiveness of their group in modeling and/or disseminating behavior change within a hospital to improve the overall quality of care outcomes; and 2) How do self-perspectives on physician knowledge regarding CMS quality core measures align with other physician's perspectives on seeking out that physician's input on quality? The objective of this study was to explore the utilization of social network analysis (SNA) as a means of mapping the relationships of physicians in a hospital setting to evaluate the network of influential discussions surrounding quality improvement initiatives.

Research Design

According to Knoke and Yang (2008), there were three research design elements specific to network research in which decisions must be made by the researcher prior to fieldwork implementation: sampling units, relational form and content, and level of data analysis. Sampling units describe the social setting and the entities within the setting that make up the network of actors. The setting for this study was a 265–bed, acute care hospital. The network of actors was comprised of employed physicians within this same hospital. Relationships among the sampling unit were evaluated for intensity, frequency, and or strength between the actors (relational form) and the types of communication ties that exist among the actors specific to quality and quality improvement (relational

content). The level of data analysis were the prominence of actors within the group quantified by the measurement of centrality.

Data Collection

Boundary Specification and Population

Prior to any data collection, boundary specifications must be determined to identify the actors to include in the population of the study. According to Wasserman and Faust (1994), the boundary of a set of actors allows a researcher to describe and identify the population under study. In order to study the network, a finite set of actors must be ascertained. The nominalist approach was utilized to specify the network boundaries of this study which "…is based on the theoretical concerns of the researcher" (p. 32). The approach was appropriate for the study in that the researcher was interested in studying the relationships and flow of communications among physicians in a 265–bed, acute care organization. The boundary specifications included all employed physicians within the organization whose leadership role or clinical specialties influenced the majority of care and documentation of patients with diagnoses related to clinical process of care measures. This position-based approach considered actors who hold formally defined positions to be network members and excluded all others. The population under study included employed physicians within the organization with practice specialties in cardiology, family practice, internal medicine, hospitalists, physicians holding leadership roles, and physicians active in chairing or co-chairing quality committees. This categorized the study as a one-mode network defined as a

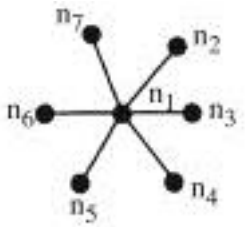
network with a single set of actors. The mode of a network is the number of sets of entities on which structural variables (ties of a specific kind between pairs of actors) were measured.

Data Measurement, Collection, and Processing

Differentiating SNA from other social and behavioral science data is that SNA data consists of one or more relations measured among a set of actors. A network can be observed at various levels. For the purpose of this study, the unit of observation was the actor (a physician) from whom the researcher elicited information about ties. In addition to observation, SNA data can be studied at different levels (modeling unit). The modeling unit consisted of the network as a whole by which the researcher used the entire network to summarize the relationships that existed within the network. The unit of analysis was the employed physician group in its entirety which is unique to network analysis in that the unit of analysis was the entity consisting of a collection of individuals and the linkages among them rather than the individual.

The most common method for SNA data collection when the actors are people is the questionnaire. The survey questionnaire consisted of a roster format by which each actor was presented with a complete list of the members of the network being studied. The survey was made available electronically to all 60 employed physicians who met the population boundary specifications as previously mentioned. According to Knoke and Yang (2008), UCINET is the most widely used software package that facilitates network analysis and provides comprehensive solutions and implementation of many network methods. UCINET was the software utilized to analyze the data received from the survey

responses for this study. The graph theory was applied as a means of identifying the most influential actors (physicians) in the social network. The notation for the data collected was viewed as a graph which consists of nodes joined by lines. The set of actors were identified as N, a symbol commonly used to stand for the set, "…since graph theory literature frequently refers to this set as a collection of nodes of a graph" by which the set N contains g actors in number which will be denoted by $N = \{n_{1,} n_{2,} \ldots\ldots, n_g\}$, depicted in the star graph illustration in Figure 1 (Wasserman & Faust, 1994, p. 71).



(a) Star Graph

Figure 1. Star Graph: An Illustrative Network for the Study of Centrality

There are several measures that attempt to describe and measure properties of "actor location" in a social network and their level of importance (prominence) in which case those actors that are most prominent "…are usually located in strategic locations within the network" (Wasserman & Faust, 1994, p.169). For the purpose of this study, physicians were measured in relation to their prominence within the network and quantified mathematically by defining centrality. Centrality is a concept and measurement that seeks "…to quantify graph theoretic ideas about an actor's prominence within a complete network by summarizing the structural relations among all nodes…where a prominent actor has high involvement in many relations, regardless of whether sending or receiving ties" (Knoke & Yang, 2008, p. 62). Centrality is a class of prominence which allows the researcher to "…define better the important actors as those

with more visibility and to understand better the meaning of the concept" (Wasserman & Faust, p. 173, 1994). According to Borgatti & Halgin (2011), centrality referred to a family of properties of node positions. More specifically, actor centrality identifies the involvement of an actor with other actors in the network. The centrality concepts that were measured in this study include degree, closeness, and betweenness.

Degree Centrality

Degree centrality measures the extent to which a node connects to all other nodes in a social network (Knoke & Yang, 2008). In graphs, degree centrality (d_i) is defined as the number of ties incident upon a node i (Borgatti & Halgin, 2011). According to Wasserman & Faust (1994), degree centrality focuses on the most visible actors in the network by which an actor having a large degree is in direct contact or is adjacent to many other actors, one who "…should then begin to be recognized by others as a major channel of relational information, indeed, a crucial cog in the network, occupying a central location" (p. 179). The same holds true for an actor with low degree centrality in that they would be considered peripheral to the network and less active in the relational process. Degree centrality was an important measurement for this study in that it identified those physicians most influential in the network based on the number of direct connections they had with other physicians. This information can prove valuable to hospital leaders in the sharing of quality information within the physician network.

Closeness Centrality

The concept of closeness centrality was developed to reflect how near a node is to the other nodes in a social network and mathematically is expressed as a function of its geodesic distance to all other nodes (Knoke & Yang, 2008). The idea of the measure is that an actor is central if it can quickly interact with all others and therefore can rely less on other actors for sharing of information. This was an important concept to explore for this study in that "actors occupying central locations with respect to closeness can be very productive in communicating information to other actors" (Wasserman & Faust, 1994, p. 183). Closeness centrality differs from degree in that it not only recognizes the reach a physician might have with other physicians within the network, it measures the distance of the reach indicating the speed at which the quality information might be disseminated. To illustrate how the concept of closeness equates with minimum distance whereas centrality is inversely related to distance, Wasserman & Faust (1994) provided the following scenario:

> Examine the star network in Figure 1. The node at the center of this star is adjacent to all the other nodes, has the shortest possible paths to all the other actors, and hence has maximum closeness. There is exactly one actor who can reach all the other actors in a minimum number of steps. This actor need not rely on the other actors for its interactions, since it is tied to all other actors. (p. 184)

Betweenness Centrality

In graph terminology, betweenness centrality (b_i) refers to the share of shortest paths in a network that pass through a node i (Borgatti & Halgin, 2011). Knoke & Yang

(2008) described the concept as concern for how other actors control or mediate the relations between dyads that are not directly connected. Knoke and Yang (2008) explained, "Actor betweenness centrality measures the extent to which actors lie on the geodesic path (shortest distance) between pairs of actors in the network. Betweenness centrality is an important indicator of control over information exchange or resource flows within a network"(p. 67).Providing the measurement for betweenness centrality identified those physicians that hospital leaders needed to rely on to ensure that quality information gets from point A to point B.

Physician Self Perspectives

In addition to identifying the general communication patterns of physicians within the network, physician responses to familiarity with CMS core measures and the VBP program were analyzed. The information provided by the additional research questions was utilized to determine whether or not self-perspectives on physician knowledge regarding CMS quality core measures align with other physician's perspectives on seeking out that physician's input.

Data Source

An email request was sent to the 60 physicians identified in the network boundary. The email contained consent for non-anonymous participation, and a summary of the study (see Appendix A). A direct link to the survey, which can be seen in document format in Appendix B, was contained within the text of the email for ease of participation. The survey was administered using the online tool Survey Monkey

(www.surveymonkey.com). The survey was open for a period of three weeks to accommodate physician schedules and allow adequate time for completion with two additional follow up reminder emails sent following the first request.

Data Collection and Processing

As noted in the survey (Appendix B), respondents were asked a total of eight questions which were divided into three parts. Part I contained basic demographic questions requesting respondents to provide their name, identify their specialty, and identify their years of service. Part II contained two general questions related to the respondent's familiarity with CMS core measures and CMS's Hospital VBP program with not at all familiar, familiar, and very familiar as response choices. The last section of the survey, Part III, contained the following three questions:

1. In general, how often do you communicate with this person?
2. In general, how often do have discussions with this person specific to quality issues within the organization?
3. How often do you seek input from this person before making key decisions?

The respondents were given the names of all 60 physicians and were instructed to respond to the above questions by rating frequency in the following manner: rarely, monthly, bi-weekly, weekly, or daily.

CHAPTER IV

SURVEY RESULTS AND ANALYSIS

Operational Data of Survey Respondents

A total of 60 surveys were administered to physicians in the population boundary; however, in reviewing final response data, it was identified that 12 of the 60 physicians were no longer employed, and six were transferred to other affiliates within the organization. This brought the final request for participation number to 42. Of the 42, four were returned incomplete and could not be used in analysis but were counted in the response rate calculation. There were a total of 25 respondents who completed the survey in its entirety for a 60% response rate. According to Instructional Assessment Resources (IAR, n.d.) a publication from the University of Texas Austin, an acceptable response rate for an online survey on average is 30%. Although a60% response rate for an online survey would be considered satisfactory in most cases, 100% participation is desired for SNA. The responses to the survey questions provided the raw data for analysis which required conversion into specialized Microsoft Excel working files that could be exported into Predictive Analytics SoftWare Version 18.0 (formerly Statistical Package for the Social Sciences, or SPSS) and UCINET6 Software for Social Network Analysis (Borgatti, Everett, & Freeman, 2002).

Responses were edited, coded, and entered for analysis. A total of 25 surveys were utilized for analysis and were coded by alphabetizing respondent names to protect confidentiality. Specialty and years of service were coded in the following manner: hospitalist (1), family practice (2), cardiology (3), and leader (4). Note that internal

medicine was removed from analysis as there were zero responses from this specialty as demonstrated in the frequency calculations that follow. Years of service was coded as 0-5 years (1), 6-10 years (2), 11-15 years (3), 16-20 years (4), 21-25 years (5), 26-30 years (6), and 30+ years (7). The respondents were asked to rate their familiarity with two government programs. Coding was applied in the following manner: not at all familiar (1), familiar (2), and very familiar (3) with the highest level of familiarity given the highest number. Lastly, communication among physicians was coded as rarely (0), monthly (1), bi-weekly (2), weekly (3), and daily (4) with zero representing the least communication frequency. There were no missing data at the node level and only missing data at the tie level due to the fact that respondents were instructed to not evaluate themselves.

Participation rates were calculated and frequency analysis was performed in SPSS with the results provided in Tables 1 and 2. Survey response by specialty (see Table 1) demonstrates that physician leaders accounted for the highest participation rate while Family Practice provided 52% of total responses. Internal Medicine is represented in this table to account for all data in calculating frequencies and participation rates yet as aforementioned, was removed from further data analysis as there were zero participants from this specialty.

Table 1. Survey Responses by Specialty

Specialty	Number of Respondents (Frequency)	Possible	Participation Rate	Percentage of Total Respondents
Hospitalist	4	7	57	16
Family Practice	13	18	72	52
Internal Medicine	0	7	0	0
Cardiology	3	4	75	12
Physician Leader	5	6	83	20

The frequency and percent of respondents by physician years of service is depicted in Table 2. Note that 24% of the respondents were physicians who had been employed by the organization for the least amount of time, 0-5 years. Years of service was not known of the participants prior to the survey; therefore, participation rates could not be calculated.

Table 2. Survey Responses by Years of Service

Years	Number of Respondents (Frequency)	Percentage of Total Respondents
0-5	6	24
6-10	2	8
11-15	5	20
16-20	2	8
21-25	4	16
26-30	4	16
30+	2	8

Descriptive Statistical Analysis

Two of the survey questions were exploratory in nature to gain insight into the familiarity of physicians with two of the most influential government programs measuring quality in hospitals today: core measures and the VBP program. The questions, “How familiar are you with CMS’s quality core measures?” and “How familiar are you with the CMS VBP program?” elicited responses categorical in nature

which allowed for further frequency analysis. According to Field (2009), when measuring categorical variables, one analyzes frequencies, which is the number of things that fall into each combination of categories and identifies the mode for each variable which is the score that occurs most frequently in the data set. The frequency distribution identifying physician familiarity with CMS core measures is provided in Table 3. The majority of the physicians in the network (72%) responded that they are familiar with this program.

Table 3. Frequency Distribution of Physician Familiarity with CMS Core Measures

Familiarity	Frequency	Percent
Not at all Familiar	3	12
Familiar	18	72
Very Familiar	4	16

The frequency distribution identifying physician familiarity with CMS Value Based Purchasing program is depicted in Table 4. Physician familiarity with VBP is far less evident with 60% of respondents stating that they are not at all familiar with the program.

Table 4. Frequency Distribution of Physician Familiarity with CMS VBP Program

Familiarity	Frequency	Percent
Not at all familiar	15	60
Familiar	8	32
Very Familiar	2	8

Crosstabulation was performed in SPSS to further examine the responses as a means of comparing the categorical data and to identify if any relationships exist between the variables of specialty, years of service, and familiarity with the two government programs. Chi-Square results could not be utilized for interpreting statistical differences in the data as the expected count was less than five for 20% or more of the cells.

Crosstabulation output provided additional information related to familiarity with the programs by specialty and years of service as well as the difference between the expected familiarity and actual. Appendix C provides the crosstabulation of physician familiarity with core measures by specialty. Fifty percent of the Hospitalists had no familiarity with core measures. Family Practice had the highest response to being familiar at 84.6% while Cardiology had the highest level of being very familiar at 33.3%.

Familiarity with the VBP program was analyzed in the same manner with the crosstabulation output painting somewhat of a different picture (see Appendix D). All three cardiologists that responded to the survey had no familiarity with the VBP program. Nine out of 13 Family Practice physicians were also not at all familiar with the program making up 69.2% of their responses. The Hospitalists had identical responses with half not at all familiar. Another notable difference in the output was the not at all familiar response by one of the five physician leaders. Appendix E displays the crosstabulation of familiarity with core measures based on years of service. Of the physicians with 0-5 years of service, 33.3% were not at all familiar with core measures while 50% of physicians with 11-15 and 30+ years of service were very familiar. In analyzing the output for familiarity with the VBP program (see Appendix F), 100% of physicians with 16-20 years of service were not at all familiar and the most familiar were physicians with 11-1 years of service at only 40%. Table 5 is a summary of the descriptive data in relation to physician specialties, years of service, and familiarity with the CMS core measures and VBP program.

Table 5. Summary of Descriptive Data

Physician	Specialty	Years of Service	Familiarity with CMS Core Measures	Familiarity with CMS VBP Program
A	Leader	26 – 30	Familiar	Familiar
B	Cardiology	16 -20	Familiar	Not at all Familiar
C	Hospitalist	11 -15	Very Familiar	Very familiar
D	Cardiology	16 – 20	Very Familiar	Not at all Familiar
E	Cardiology	21 -25	Familiar	Not at all Familiar
F	Family Practice	0 – 5	Familiar	Not at all Familiar
G	Family Practice	21 – 25	Familiar	Not at all Familiar
H	Family Practice	30 +	Very Familiar	Familiar
I	Leader	11 – 15	Very Familiar	Very Familiar
J	Family Practice	26 – 30	Familiar	Not at all Familiar
K	Family Practice	0 – 5	Familiar	Not at all Familiar
L	Leader	21 – 25	Familiar	Familiar
M	Hospitalist	0 – 5	Not at all Familiar	Not at all Familiar
N	Hospitalist	6 – 10	Familiar	Familiar
O	Family Practice	30 +	Familiar	Not at all Familiar
P	Leader	26 – 30	Familiar	Not at all Familiar
Q	Family Practice	11 – 15	Not at all Familiar	Not at all Familiar
R	Family Practice	6 – 10	Familiar	Familiar
S	Hospitalist	0 – 5	Not at all Familiar	Not at all Familiar
T	Family Practice	26 – 30	Familiar	Not at all Familiar
U	Family Practice	0 – 5	Familiar	Not at all Familiar
V	Family Practice	11 – 15	Familiar	Familiar
W	Family Practice	11 – 15	Familiar	Not at all Familiar
X	Family Practice	0 – 5	Familiar	Familiar
Y	Leader	21 – 25	Familiar	Familiar

Social Network Analysis

To examine the predominant research questions below, social network methodology was applied utilizing UCINET 6 and Netdraw Network Visualization Software (Borgatti, 2002) to measure degree centrality, closeness centrality, and betweenness centrality:

1. How can social network analysis (SNA) be utilized to identify communication patterns between physicians who are engaged in quality

improvement that can increase the effectiveness of disseminating behavior change within the hospital setting and improving overall quality of care outcomes?

2. How do self-perspectives on physician knowledge regarding CMS quality core measures align with other physician's perspectives on seeking out that physician's input on quality?

Sociomatrices were constructed from the data provided from the three social network questions of the survey: “How often do you communicate?”, “How often do you have discussions specific to quality issues within the organization?”, and “How often do you seek input from this person before making key decisions?” The responses produced a 25 row by 25 column sociomatrix with the highest possible cell value of 12 and the lowest cell value of zero. The sociomatrix was utilized for analysis and produced the sociogram in Figure 2 depicting the physician network.

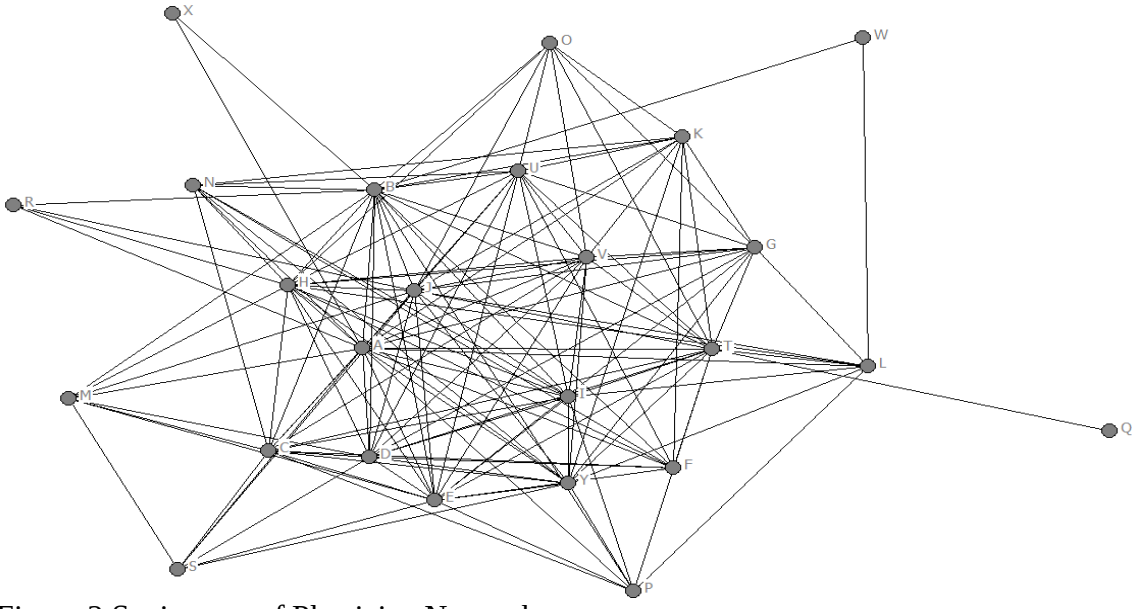


Figure 2.Sociogram of Physician Network

The sociogram is a two-dimensional diagram for displaying the relations among actors within the boundary specifications identified and included points and lines which permits applications of concepts and theorems from graph theory (Knoke & Yang, 2008). The physician network sociogram depicts a fairly equally connected network with identifiable central clustering and three individuals (physicians Q, W, and X, all Family Practice physicians) located on the periphery of the network who are connected by only one or two people. As a means of understanding the patterns of interactions among physicians within the network, attribution was applied distinguishing the nodes by shapes according to specialty (see Figure 3). There is no apparent distinct clustering by specialty in that there is a combination of specialties located centrally in the graph with again the three family practice physicians who remain on the periphery of the network with few relationship connections. As one would expect, those physicians in leadership roles were more connected with leaders A, I, and Y in the central clustering of the network and leaders L and P with fewer connections yet still relatively connected.

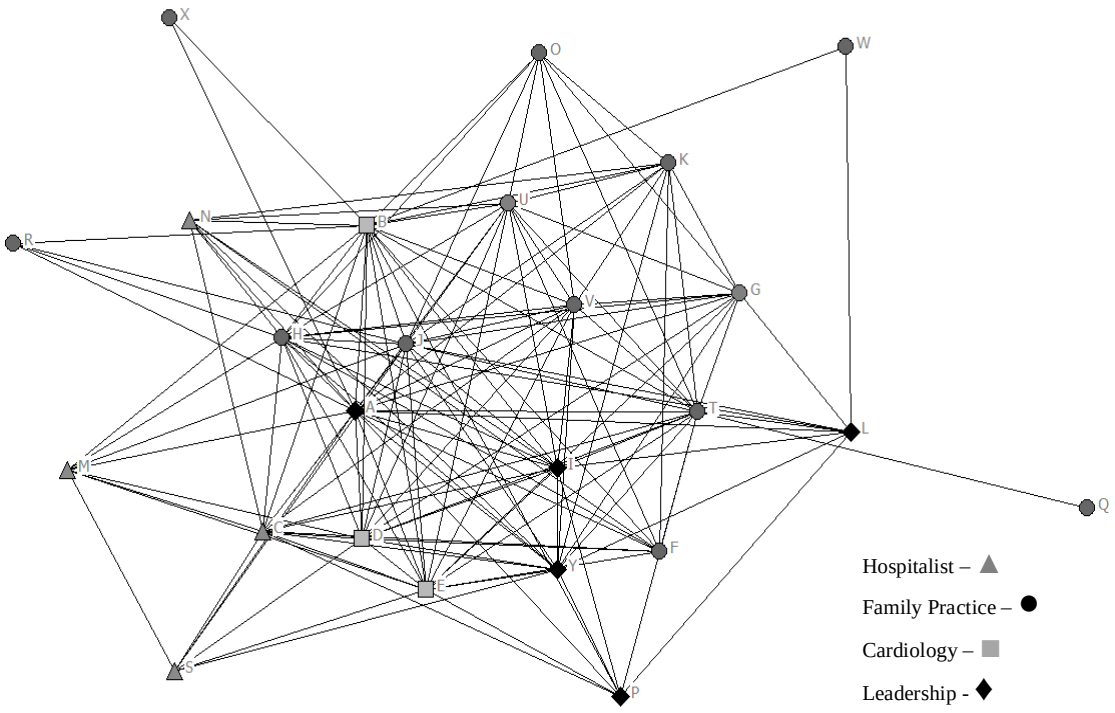


Figure 3.Network Attribution by Specialty

Attribution by years of service was also applied to the social network to identify any distinct patterns that may exist. Figure 4 depicts the same sociogram of the physician network attributed by years of service: circle (0-5 years) includes physicians F, K, M, S, U, and X, upward triangle (6-10 years) includes physicians N and R, grey square (11-15 years) includes physicians C, I, Q, V, and W, downward triangle (6-20 years) includes physicians B and D, plus square (21-25 years) includes physicians E, G, L, and Y, black square (26-30 years) and includes physicians A, J, P, and T, and diamond (30+ years) representing physicians H and O.

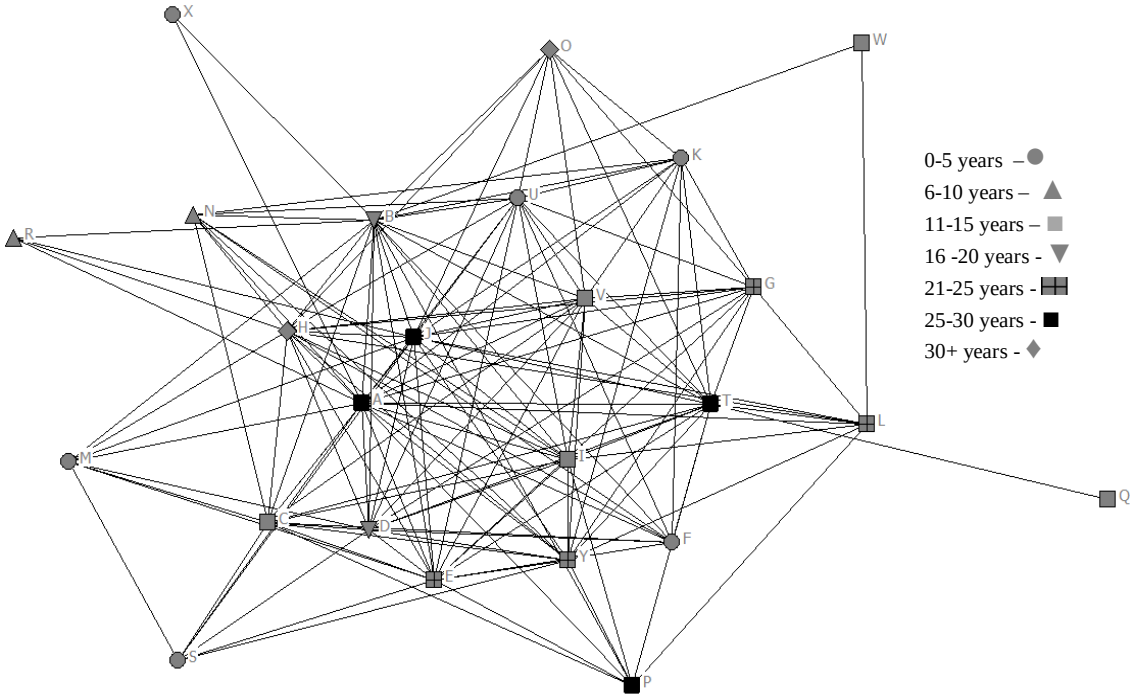


Figure 4. Network Attribution by Years of Service

Physicians H and O both had 30+ years with the organization. One could easily make the assumption that based on this fact alone; they would tend to have the greatest amount of connections. This is not the case, in fact, physician H had more relations with others than O while physicians M and S had similar relations with only 0-5 years of service. Years of service alone did not have an impact on relations as can be seen with physicians F, K, and U who all represented the specialty of Family Practice with 0-5 years with the organization and were more closely integrated within the network graph.

Centrality

Analysis was performed to further examine the research questions specific to centrality. Degree, closeness, and betweenness will each be discussed, detailing the quantitative output produced by UCINET.

Degree

Degree centrality answers the question of how many people can this person reach directly? Activity by actors can be measured by degree centrality. Simply put, "an actor with a high centrality level, as measured by its degree, is 'where the action is' in the network" (Wasserman & Faust, 1994, p. 179). Degree accounts for the immediate ties an actor has or the ties of the actor's neighbors (Hanneman & Riddle, 2005). Appendix G provides the Freeman's Degree Centrality measures. The output produced for this measure gave values at the micro or nodal level (physician out-degree and in-degree centrality values) and at the macro level looking at the network as a whole and its variability (out-degree and in-degree network centralization). Physicians A, C, and Y had the highest out-degree centrality values (in order of highest to next highest value) and should be regarded as the most influential in the network. According to Hanneman and Riddle (2011), actors who have high out-degrees are actors who are able to exchange with many others or to make many others aware of their views and are often said to be influential actors. Physicians A and Y were identified as leaders within the network, and although physician C identified himself/herself as being a hospitalist in his/her primary role, they held an appointed "leadership" role in the organization.

In-degree examination again showed physicians Y, C, and A (in order of highest to next highest value) which indicated that information sharing is most prominent among these three physicians. As previously mentioned, measures were also provided in the output that describe the network at the macro level which expressed the degree of inequality or variance in the network as a percentage defined as Freeman's graph centralization measures (Hanneman & Riddle, 2005). The out-degree centralization was

21.3% and in-degree 17.1% drawing the conclusion that there was less variability with regards to the prominence of the physicians than there is for influence. Taking into account the low percentage of variability at the network level and the in-degree and out-degree values at the nodal level, physicians A, C, and Y were influential in the network.

Closeness

Closeness centrality answers the question how fast can this person reach everyone in the network? Closeness centrality measures how close (distance) an actor is to all other actors in the set of actors with the idea that an actor is central if he/she can quickly interact with others (Wasserman & Faust, 1994). Unlike degree measures, closeness centrality accounts for indirect ties, emphasizing the distance of an actor to all other actors by focusing on the distance from each actor to all others (Hanneman & Riddle, 2005). Appendix H provides the output measuring the average reciprocal distances among actors. The network data is directed thereby calculating separate measures for in-closeness and out-closeness. In essence, closeness measures how many steps one actor is from others in the network therefore, a higher degree of closeness would suggest a greater reach with the least distance. As with degree centrality, the output produced for this measure gave values at the micro or nodal level (physician in-closeness and out-closeness centrality values) and at the macro level looking at the network as a whole and its variability (network in-centralization and out-centralization).

Physician C had the highest degree of in-closeness at 18.0 followed by physicians A and E with 17.5. This would indicate that these three physicians were more likely to receive information within the network. Physician A had the greatest degree of out-closeness at 21.83 followed by physician J at 21.0 and physicians B and T with 20.5

inferring that these four physicians had the greatest capacity for disseminating information in the network. Out-distances were more un-equally distributed with an out-centralization of 61.6% and less variability for in-distances with a centralization of 27.6% concluding that the network was currently stronger in receiving information than it was for disseminating information.

Betweenness

Betweenness centrality answers the question how likely is this person to be the most direct route between two people in the network? The idea of betweenness "… is that an actor is central if it lies between other actors on their geodesics, implying that to have a large 'betweenness' centrality, the actor must be *between* many of the actors via their geodesics" (Wasserman & Faust, 1995, p. 189). In other words, the actor that falls within the line of communication of other actors most frequently (falls on the geodesic paths between other pairs of actors) more people are dependent on these individuals to make connections with others in the network (Hanneman& Riddle, 2005). The output from the combined data set (see Appendix I) demonstrated a great deal of variation in actor betweenness (from 0 – 62.3) and a standard deviation of 15.2 relative to a mean betweenness of 13.5. Unlike the outputs produced for degree and closeness at the macro level, betweenness measures the network centralization index. A lower percentage represents less betweenness within the network. The network centralization index for the physician network under study was relatively low at 9.21% which would indicate minimal betweenness implying that the majority of connections within the network could

be made without the aid of an intermediary. Physicians B, A, and T appear to have had the greatest degree of betweenness; and although the network itself lacked betweenness power, these three physicians representing cardiology, leadership, and family practice, could be key in the formation of groups.

Table 6 provides a summary of the findings listing centrality values for degree, closeness, and betweenness for all physicians in the network. The top three values for each measure have been highlighted.

Table 6. Physician Centrality Values

Physician	In-degree	Out-degree	In-closeness	Out-closeness	Betweenness
A	67.000	88.000	17.500	21.833	43.581
B	28.000	41.000	16.500	20.500	62.311
C	64.000	69.000	18.000	17.833	26.024
D	40.000	43.000	17.000	18.500	21.061
E	43.000	23.000	17.500	17.333	13.867
F	9.000	15.000	15.000	14.500	5.144
G	40.000	34.000	16.333	16.333	8.660
H	34.000	46.000	14.333	20.333	12.478
I	53.000	56.000	16.833	18.000	12.422
J	38.000	40.000	16.000	21.000	26.201
K	37.000	41.000	14.833	15.333	6.690
L	22.000	18.000	14.000	15.333	8.956
M	25.000	10.000	13.833	13.667	1.608
N	14.000	13.000	13.333	14.667	3.544
O	35.000	14.000	14.167	13.833	0.902
P	26.000	17.000	14.333	20.333	1.840
Q	1.000	0.000	9.667	0.000	0.000
R	7.000	1.000	12.000	11.333	0.000
S	20.000	20.000	12.833	12.167	0.372
T	22.000	43.000	15.500	20.500	35.791
U	37.000	37.000	16.500	18.000	14.730
V	46.000	60.000	17.000	18.000	10.816
W	3.000	0.000	11.167	0.000	0.000
X	3.000	0.000	11.167	0.000	0.000
Y	77.000	62.000	16.833	19.000	19.993

CHAPTER V

DISCUSSION

Summary of Findings

The objective of this study was to explore the utilization of SNA to map the relationships of physicians in a 265–bed, acute care hospital by determining prominence within the network, quantifying their position mathematically by defining centrality. The study attempted to apply the principles and methods of SNA to assist healthcare leaders in identifying physicians within the network as quality improvement "champions" as a means of increasing the effectiveness of their group in modeling and/or disseminating behavior change within a hospital to improve quality outcomes. Furthermore, how physician self-perspectives who had with familiarity of CMS core measures aligned with other physician's perspective in the network about seeking out that physician's input on quality was evaluated. The results of the analysis in addition to the demographic and descriptive information provided by the physician responses to the survey questions are found in Table 7: Summary of Findings. Quantitative findings are depicted by physician ranking in each of the five centrality measurements (in-degree, out-degree, in-closeness, out-closeness, and betweenness) with the top three values in each category highlighted. The summary information in addition to nodal positions within the network illustrated in the sociogram will be discussed in more detail later in the chapter.

Table 7. Summary of Findings

Physician	Specialty	Years of Service	Familiarity with CMS	Familiarity with CMS VBP	In-degree ranking	Out-degree ranking	In-closeness ranking	Out-closeness ranking	Betweenness
A	Leader	26–30	Familiar	Familiar	***2***	***1***	***2***	***1***	***2***
B	Cardiology	16 -20	Familiar	Not at all	12	8	5	***3***	***1***
C	Hosp/Leader	11-15	Very	Very	***3***	***2***	***1***	8	5
D	Cardiology	16–20	Very	Not at all	7	7	3	6	6
E	Cardiology	21 -25	Familiar	Not at all	6	12	***2***	9	9
F	Family Prac	0–5	Familiar	Not at all	18	16	9	13	16
G	Family Prac	21–25	Familiar	Not at all	7	11	6	10	14
H	Family Prac	30 +	Very	Familiar	11	6	11	4	10
I	Leader	11–15	Very	Very	44	5	4	7	11
J	Family Prac	26–30	Familiar	Not at all	8	9	7	***2***	4
K	Family Prac	0–5	Familiar	Not at all	9	8	10	11	15
L	Leader	21–25	Familiar	Familiar	15	14	13	11	13
M	Hospitalist	0–5	Not at all	Not at all	14	19	14	15	19
N	Hospitalist	6–10	Familiar	Familiar	17	18	15	12	17
O	Family Prac	30 +	Familiar	Not at all	10	17	12	14	20
P	Leader	26–30	Familiar	Not at all	13	15	11	4	18
Q	Family Prac	11–15	Not at all	Not at all	21	21	19	18	22
R	Family Prac	6–10	Familiar	Familiar	19	20	17	17	22
S	Hospitalist	0–5	Not at all	Not at all	16	13	16	16	21
T	Family Prac	26–30	Familiar	Not at all	15	7	8	***3***	***3***
U	Family Prac	0–5	Familiar	Not at all	9	10	5	7	8
V	Family Prac	11–15	Familiar	Familiar	55	4	3	7	12
W	Family Prac	11–15	Familiar	Not at all	20	21	18	18	22
X	Family Prac	0–5	Familiar	Familiar	20	21	18	18	22
Y	Leader	21–25	Familiar	Familiar	***1***	***3***	4	5	7

Physician A stood out as the most prominent in the network with the greatest capability of influencing and disseminating information, having a value in the top three for all five categories. Physician C followed physician A's prominence in having values in the top three for in-degree, out-degree, and in-closeness implying that he/she was not only prominent in the network but was influential and was most likely to receive information. Physicians B, T, and Y had the highest centrality values in two of the three categories. Physicians B and T had higher than average values in centrality out-closeness and betweenness which implies that their positions in the network lay between many of the other actors and were key in the formation of teams and for dissemination of information in the network. Physician Y had high values in both degree centrality measures, indicating that he/she was influential and prominent in the network. Lastly, in relation to the quantitative values, physician E was noted as having a high degree of in-closeness and was most likely to receive information in the network, while physician J had a high degree of out-closeness and had the capacity to disseminate information in the network.

Table 7 also helps to address the research question of how self-perspectives on physician knowledge regarding CMS quality core measures align with other physician's perspectives on seeking out that physician's input on quality. Physician J, for example, identified him/herself as being very familiar with both the CMS core measures and the VBP program; and although a leader by title, others in the network were not reaching out

to this physician for information or seeking his/her expertise in this area. Physician C's self-perspective in being very familiar also with the programs aligned with the other physician's perspectives in the network as one they would seek for input on quality as evidence by his/her centrality degree and in-closeness values.

The most prominent physicians within the network are listed in Table 8 providing identification of their specialty, years of service, and familiarity with CMS's core measures and VBP program. Although statistical inferences could not be made in identifying relationships among the aforementioned variables, prominence and familiarity could prove to be extremely valuable information for the healthcare leader to improve the effectiveness of the network in modeling and or disseminating behavior change. For example, even though physician A had the highest degree of prominence in the network, he/she was only familiar with the core measures and the VBP program, while physician C, in addition to being prominent, was very familiar with the programs and should be recognized as a likely "champion" for assisting the administrative team in educating other physicians in the network on these programs.

Table 8. Physician Prominence Identifiers

Physician Program	Specialty	Years of Service	Core Measures	VBP
A	Leader	26-30	Familiar	Familiar
C	Hospitalist/Leader	11-15	Very Familiar	Very Familiar
B	Cardiology	16-20	Family	Not at all Familiar
Y	Leader	21-25	Familiar	Familiar
E	Cardiology	21-25	Familiar	Not at all Familiar
J	Family Practice	26-30	Familiar	Not at all Familiar
T	Family Practice	26-30	Familiar	Not at all Familiar

It is evident that SNA can be utilized to identify communication patterns between physicians who are engaged in quality improvement supported by quantitative data produced from UCINET outputs as well as graph data displayed in a sociogram. Physician attribution by prominence was applied to the same physician sociogram that had been utilized throughout the study which provided a two-dimensional visualization of the seven most prominent physicians in the network represented by size and color of the nodes (see Figure 5).

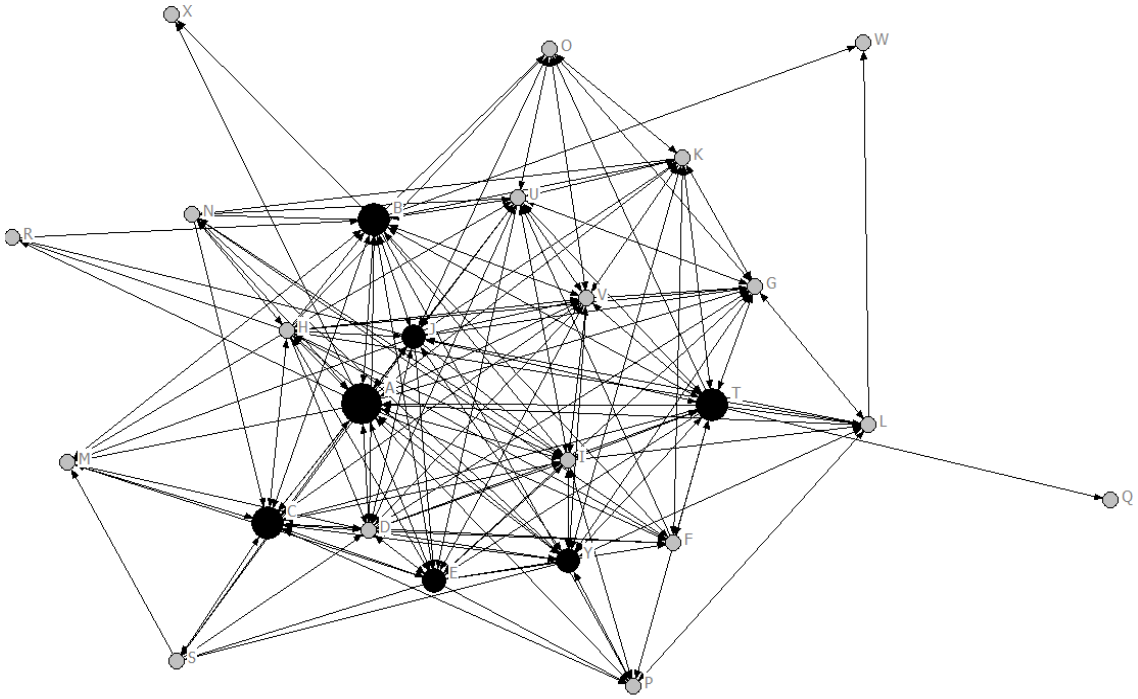


Figure 5.Sociogram of Physician Network by Prominence

Further analysis of the data adds richness to the quantitative information when all aspects under study are summarized. As a means of increasing the effectiveness of disseminating behavior change among physicians within the hospital setting, healthcare leaders can utilize the information provided in Table 7 in combination with the visual

data provided from the sociogram. The data not only identifies quality "champions" based on centrality within the network, it provides useful information that can assist healthcare leaders in strategically engaging physicians who were on the periphery of the network (outliers Q, W and X). An opportunity also present within the network under study would be to encourage communications between physicians J and T with physicians Q, W, and X to engage them in quality dialogue from a Family Practice perspective. In addition, the prospect of Hospitalist C working with Hospitalists M and S to bring them closer into the cluster of the network and provide core measure and VBP education exists. Another extremely important aspect to note, and one that a hospital leader would want to address, is the fact that although hospital settings are moving to a more robust hospitalist staffing model for delivering patient care in the acute care setting, only the hospitalist/leader and one other hospitalist had familiarity with the programs and only four of seven responded to the survey.

This study demonstrates that the principles and methods of SNA can be utilized to identify the most influential physicians in a network by defining centrality in relation to quality in the hospital setting. The practical implications of this study provides mathematical and visual relational information about the physician network that can assist healthcare leaders in identifying physician quality improvement "champions" as a means of increasing the effectiveness of their group in modeling and/or disseminating behavior change within the hospital setting. This in turn can position an organization for success in such programs as VBP and those yet to surface as a result of reform. However, to address the last component of the research question as to whether or not

improvement in quality outcomes are noted as a result would require additional research. This will be discussed in more detail under recommendations for future research.

Limitations of Study

Two forms of bias must be considered as limitations to this study. First researcher bias existed, in that the researcher had existing knowledge of the organization under study, and informant bias which is " …the discrepancy between self-reported and actual behaviors" also existed as a common bias recognized by social researchers in the data collection process of SNA (Knoke & Yang, 2008, p. 35). The researcher guarded against bias as a participant observer by utilizing only coded data from the time analysis began, removing as many identifiers as possible. Informant reliability, which would require test-retests of the survey tool, was not performed thereby preventing the ability to compare level of agreement between responses.

The survey response rate of 60%, although considered satisfactory for an online survey, limited the ability to study the network in its entirety. In addition, the population boundaries established for the study inadvertently eliminated physicians in specialties that are instrumental in many of the process of care measures in the VBP program (i.e. the surgical care improvement project (SCIP) measures in which surgeons are primarily accountable to the outcomes). The researcher would also want to inquire about the best means of communication for requesting participation as it was later noted that the internal medicine team rarely utilized hospital emails as a primary form of communication. In this instance, a hard copy of the survey could have been provided to this physician group that may have increased the survey response rate and provide more comprehensive data

of the network under study for analysis. Lastly, adding an additional component to the demographics of the survey to inquire about what types of quality committees, projects, or initiatives physicians participated in versus identifying leaders by title only could provide additional information of value.

Recommendations for Future Research

Although a large body of social network research exists, at the time of this study, it was noted that none were identified by the researcher as having utilized SN methodology to assist healthcare leaders in identifying prominent physicians within a network to promote dissemination of quality information in the hospital setting. Research conducted by Meltzer et al. (2010) in exploring the use of social network methods in designing healthcare quality improvement teams was the closest parallel to this study and most current found in the literature to date. As previously stated, this study was not able to answer the second component of the primary research question with respect to the improvement of overall quality of care outcomes. A sequential research approach would be more appropriate to evaluate improvement of outcomes as with action research where a baseline of the quality of care outcomes would be measured as a baseline, an intervention would be applied, and the quality of care outcomes would be reevaluated post intervention. Another approach to this particular study would be to perform a baseline physician SNA survey, implement an intervention surrounding quality improvement, and resurvey the same group with the same questions to identify whether or not the intervention had any effect on strengthening the ties of the relationships in the network as a result.

While the utilization of this study in practice was discussed in brief previously, its application into practice goes well beyond identifying physician "champions." The study can be applied in the hospital setting by assisting healthcare leaders in their strategic planning. The analysis provided current state of a network and could serve as the baseline in working towards building the infrastructure of an organization's quality improvement model. A healthcare leader, for example, could identify whether or not physicians holding formalized leadership titles are the right physicians or might there be other physicians recognized by their colleagues as "informal" leaders, who have a greater prominence in the network and are therefore more likely to influence others creating the culture change necessary in driving success in quality programs. A healthcare leader could also evaluate the significance of outliers within the network by asking questions like: Are the positions of the physicians on the periphery of the network explainable or does their nodal position represent disengagement requiring leadership intervention as a means of influencing change at a macro level? Lastly, priorities could be set with a focus on core measure and VBP education, an advantageous approach to increase the familiarity of all physicians in the network with the programs. At a time when hospital resources are scarce, education beginning with the hospitalist group may be the greatest return on investment for a quick win in the acute care setting.

Though the possibilities for research utilizing SN methods are numerous, there are opportunities to extend such studies in the hospital setting. Relationships can be studied at the health system level (macro perspective) down to a specific unit or department (micro perspective) and all levels in between (meso perspective). At the macro level, one could study the physician network across a health system rather than at the hospital level

providing and evaluation of quality improvement across the continuum of care. Research surrounding communications among the hospitalist network alone and the information sharing that exists at this very micro level could be advantageous in the hospital acute care setting. Future studies that address nurse to nurse communication at the bedside could be extremely valuable and can have a positive impact on reducing errors at the bedside. A two-mode study involving actors from more than one set would also be applicable to the hospital setting (i.e. physicians and administration or physicians and nurses) analyzing measurements on which actors from one of the sets have ties to actors in the other set.

Understanding relationships within populations and the information sharing that occurs within networks extend well beyond the methodological and practical benefits in that it can help identify communication gaps in processes and in the case of this study, can have an impact on the quality of care a patient receives and ultimately their health outcome. Embedding SNA at the community, regional, state, and international levels can provide the framework in building sustainable solutions in dealing with a broken healthcare system. Population health management studies, for example, that identify, at a regional level, networks that support the Institute of Healthcare Improvement (IHI) Triple Aim framework for improving the patient experience of care, improving the health of populations, and reducing per capita cost of healthcare (IHI, 2013). Application of SNA at a legislative level to determine who the "movers and shakers" are at a national level and who have an impact on policy as a means of positively changing our healthcare delivery model.

Lastly, the benefits of such research at an international level can prove to be very valuable. Chapter I of this study outlined some of the challenges the United States is facing with its healthcare system; the country that spends the most on healthcare than any other country, yet its health outcomes are not reflective of this fact. Opportunities exist to apply SNA methods to learn from other countries. Japan for example, is the leader in health statistics of all OECD countries yet continues to see a decrease in total expenditure. Research utilizing SN methods has gone viral with a 2010 TED conference by presenter Christakis, a Harvard Professor of Medicine, Health Care Policy, and Sociology, sharing his findings related to how social networks predict epidemics. His work in this field has "shown how phenomena as diverse as obesity, smoking, emotions, ideas, germs, and altruism can spread through our social ties" and it, "also sheds light on how we might take advantage of an understanding of social networks to make the world a better place" (TED, n.d.).

It is evident from the research that SNA methodology can be applied to study relationships in any network. The results of such research are invaluable in that it identifies the most prominent actors within a network who have the greatest influence on information sharing. Whether the methods are applied at a very micro level in a small network or more globally at a macro level, it can help shape our healthcare system and position our country to be the leaders in quality versus the leaders in healthcare spending.

APPENDICES

APPENDIX A

CONSENT FORM FORNON-ANONYMOUSSURVEY

Dear Dr. X,

I am seeking your participation in a study that is described in more detail below. If you find that you have additional questions regarding this study please feel free to contact the research investigator in the manner that best meets your needs.

Study Title: Exlploring the Use of Social Network Analysis in Identifying Physician Engagement in Quality Improvement in the Hospital Setting

Research Investigator's Name:
Kay Wagner, Health Administration Doctoral Candidate, Central Michigan University
Email: wagne1km@cmich.edu
Phone: 989-839-4992

Research Committee Chair:
Dr. James Johnson, Central Michigan University
Email: johns6ja@cmich.edu
Phone: 989-774-1351

What is the purpose of this study? The purpose of this research study is to explore the utilization of social network analysis (SNA) to map the relationships and communications of a network of employed physicians in MidMichigan Medical Center-Midland in the specialty areas of cardiology, family practice, internal medicine, hospitalists, and leadership as a means of evaluating discussions surrounding quality improvement initiatives within the organization.

What will I do in this study? Participation requires the completion of a brief survey which will provide the data needed to complete the study.

How long will it take me to do this? The estimated time for completion of the survey is 20 minutes.

Are there any risks of participating in the study? There are minimal risks associated with participation in this study as in those associated with risks encountered in daily life.

What are the benefits of participating in the study? The participants can gain insight into their position within the network as well as allow for identification of the relationships that exist within the network and the strengths of those relationships. This can be a valuable resource when seeking or sharing information.

Will anyone know what I do or say in this study (Confidentiality)? No. The information you provide will be utilized for the researcher's purpose of analysis only. Your name will be kept confidential and will not be shared with other parties without your permission. The results of the study will be shared as aggregate data only. All identifiable information will be minimized by the researcher.

Will I receive any compensation for participation? There is no compensation for your participation in this study.

Is there a different way for me to receive this compensation or the benefits of this study? Not that the research investigator is aware of.

Who can I contact for information about this study? For questions about this research study feel free to contact the research investigator, Kay Wagner at wagne1km@cmich.edu/ 989-839-4992 or the research investigator Chair, Dr. James Johnson at johns6ja@cmich.edu/ 989-774-1351.

You are free to refuse to participate in this research project or to withdraw your consent and discontinue participation in the project at any time without penalty or loss of benefits to which you are otherwise entitled. Your participation will not affect your relationship with the institution(s) involved in this research project.

The completion of this survey implies my consent to participate in this research.

If you are not satisfied with the manner in which this study is being conducted, you may report (anonymously if you so choose) any complaints to the Institutional Review Board by calling 989-774-6777, or addressing a letter to the Institutional Review Board, 251 Foust Hall Central Michigan University, Mt. Pleasant, MI 48859.

APPENDIX B

PHYSICIAN SOCIAL NETWORK SURVEY

The following survey completion time is estimated to be approximately 20 minutes. For the purpose of this study, it's important that you include your name as it is essential in collecting and identifying information to responses in studying social networks. Please note however that study codes will replace your name to protect your confidentiality and that documentation linking study codes to subjects will be restricted to the researcher and will not be shared with other parties without your permission. Your voluntary participation is appreciated. The following questions examine general demographic information, perspectives related to quality specific to core measures, and social networking experiences with your colleagues in relation to quality initiatives within the organization.

Part One – Demographics

Name (or Survey Code) - _____

Practice Specialty – (Please check one primary practice specialty that applies)

- ☐ Hospitalists
- ☐ Family Practice
- ☐ Internal Medicine
- ☐ Cardiology
- ☐ Physician Leadership

Years of Service - _____

Part Two– General

1. How familiar are you with the Centers for Medicare and Medicaid Services (CMS) quality core measures?
   - ☐ Not at all familiar
   - ☐ Familiar
   - ☐ Very familiar

2. How familiar are you with CMS's Hospital Value Based Purchasing program?
   - Not at all familiar
   - Familiar
   - Very familiar

Part Three–Social Network Survey

For each of the following questions, choose one of the five choices for each person on the list excluding your own name. Each question is different looking at the frequency, type, and quality of communication you are having with other physicians within the organization. Please think specifically about each person listed.

1. In general, how often do you communicate with this person?

Daily Weekly Bi-Weekly Monthly Rarely

Physicians listed in alphabetical order. The names have been removed from this appendix to maintain confidentiality of the participants.

2. In general, how often do have discussions with this person specific to quality issues within the organization?

Daily Weekly Bi-Weekly Monthly Rarely

Physicians listed in alphabetical order. The names have been removed from this appendix to maintain confidentiality of the participants.

3. How often do you seek input from this person before making key decisions?

Daily Weekly Bi-Weekly Monthly Rarely

Physicians listed in alphabetical order. The names have been removed from this appendix to maintain confidentiality of the participants.

APPENDIX C

CROSSTABULATION OF PHYSICIAN FAMILIARITY WITH CMS CORE MEASURES BY SPECIALTY

			Familiarity with core measures			
			not at all familiar	familiar	very familiar	Total
Physician Specialty	Hospitalist	Count	2	1	1	4
		Expected Count	.5	2.9	.6	4.0
		% within Physician Specialty	50.0%	25.0%	25.0%	100.0%
		% within Familiarity with core measures	66.7%	5.6%	25.0%	16.0%
	Family Practice	Count	1	11	1	13
		Expected Count	1.6	9.4	2.1	13.0
		% within Physician Specialty	7.7%	84.6%	7.7%	100.0%
		% within Familiarity with core measures	33.3%	61.1%	25.0%	52.0%
	Cardiology	Count	0	2	1	3
		Expected Count	.4	2.2	.5	3.0
		% within Physician Specialty	.0%	66.7%	33.3%	100.0%
		% within Familiarity with core measures	.0%	11.1%	25.0%	12.0%
	Physician Leadership	Count	0	4	1	5
		Expected Count	.6	3.6	.8	5.0
		% within Physician Specialty	.0%	80.0%	20.0%	100.0%
		% within Familiarity with core measures	.0%	22.2%	25.0%	20.0%
Total		Count	3	18	4	25
		Expected Count	3.0	18.0	4.0	25.0
		% within Physician Specialty	12.0%	72.0%	16.0%	100.0%
		% within Familiarity with core measures	100.0%	100.0%	100.0%	100.0%

APPENDIX D

CROSSTABULATION OF PHYSICIAN FAMILIARITY WITH CMS VBP PROGRAM BY SPECIALTY

			Familiarity with VBP program			
			not at all familiar	familiar	very familiar	Total
Physician Specialty	Hospitalist	Count	2	1	1	4
		Expected Count	2.4	1.3	.3	4.0
		% within Physician Specialty	50.0%	25.0%	25.0%	100.0%
		% within Familiarity with VBP program	13.3%	12.5%	50.0%	16.0%
	Family Practice	Count	9	4	0	13
		Expected Count	7.8	4.2	1.0	13.0
		% within Physician Specialty	69.2%	30.8%	.0%	100.0%
		% within Familiarity with VBP program	60.0%	50.0%	.0%	52.0%
	Cardiology	Count	3	0	0	3
		Expected Count	1.8	1.0	.2	3.0
		% within Physician Specialty	100.0%	.0%	.0%	100.0%
		% within Familiarity with VBP program	20.0%	.0%	.0%	12.0%
	Physician Leadership	Count	1	3	1	5
		Expected Count	3.0	1.6	.4	5.0
		% within Physician Specialty	20.0%	60.0%	20.0%	100.0%
		% within Familiarity with VBP program	6.7%	37.5%	50.0%	20.0%
Total		Count	15	8	2	25
		Expected Count	15.0	8.0	2.0	25.0
		% within Physician Specialty	60.0%	32.0%	8.0%	100.0%
		% within Familiarity with VBP program	100.0%	100.0%	100.0%	100.0%

APPENDIX E

CROSSTABULATION OF PHYSICIAN FAMILIARITY WITH CMS CORE MEASURES BY YEARS OF SERVICE

			Familiarity with core measures			
			Not at all familiar	Familiar	very Familiar	Total
Physician Years of Service	0-5 years	Count	2	4	0	6
		Expected Count	.7	4.3	1.0	6.0
		% within Physician Years of Service	33.3%	66.7%	.0%	100.0%
		% within Familiarity with core measures	66.7%	22.2%	.0%	24.0%
	6-10 years	Count	0	2	0	2
		Expected Count	.2	1.4	.3	2.0
		% within Physician Years of Service	.0%	100.0%	.0%	100.0%
		% within Familiarity with core measures	.0%	11.1%	.0%	8.0%
	11-15 years	Count	1	2	2	5
		Expected Count	.6	3.6	.8	5.0
		% within Physician Years of Service	20.0%	40.0%	40.0%	100.0%
		% within Familiarity with core measures	33.3%	11.1%	50.0%	20.0%
	16-20 years	Count	0	1	1	2
		Expected Count	.2	1.4	.3	2.0
		% within Physician Years of Service	.0%	50.0%	50.0%	100.0%
		% within Familiarity with core measures	.0%	5.6%	25.0%	8.0%
	21-25 years	Count	0	4	0	4
		Expected Count	.5	2.9	.6	4.0
		% within Physician Years of Service	.0%	100.0%	.0%	100.0%
		% within Familiarity with core measures	.0%	22.2%	.0%	16.0%

	26-30 years	Count	0	4	0	4
		Expected Count	.5	2.9	.6	4.0
		% within Physician Years of Service	.0%	100.0%	.0%	100.0%
		% within Familiarity with core measures	.0%	22.2%	.0%	16.0%
	30+ years	Count	0	1	1	2
		Expected Count	.2	1.4	.3	2.0
		% within Physician Years of Service	.0%	50.0%	50.0%	100.0%
		% within Familiarity with core measures	.0%	5.6%	25.0%	8.0%
Total		Count	3	18	4	25
		Expected Count	3.0	18.0	4.0	25.0
		% within Physician Years of Service	12.0%	72.0%	16.0%	100.0%
		% within Familiarity with core measures	100.0%	100.0%	100.0%	100.0%

APPENDIX F

CROSSTABULATION OF PHYSICIAN FAMILIARITY WITH CMS VBP PROGRAM BY YEARS OF SERVICE

			Familiarity with VBP program			
			not at all familiar	familiar	very familiar	Total
Physician Years of Service	0-5 years	Count	5	1	0	6
		Expected Count	3.6	1.9	.5	6.0
		% within Physician Years of Service	83.3%	16.7%	.0%	100.0%
		% within Familiarity with VBP program	33.3%	12.5%	.0%	24.0%
	6-10 years	Count	0	2	0	2
		Expected Count	1.2	.6	.2	2.0
		% within Physician Years of Service	.0%	100.0%	.0%	100.0%
		% within Familiarity with VBP program	.0%	25.0%	.0%	8.0%
	11-15 years	Count	2	1	2	5
		Expected Count	3.0	1.6	.4	5.0
		% within Physician Years of Service	40.0%	20.0%	40.0%	100.0%
		% within Familiarity with VBP program	13.3%	12.5%	100.0%	20.0%
	16-20 years	Count	2	0	0	2
		Expected Count	1.2	.6	.2	2.0
		% within Physician Years of Service	100.0%	.0%	.0%	100.0%
		% within Familiarity with VBP program	13.3%	.0%	.0%	8.0%
	21-25 years	Count	2	2	0	4
		Expected Count	2.4	1.3	.3	4.0
		% within Physician Years of Service	50.0%	50.0%	.0%	100.0%
		% within Familiarity with VBP program	13.3%	25.0%	.0%	16.0%
	26-30 years	Count	3	1	0	4
		Expected Count	2.4	1.3	.3	4.0
		% within Physician Years of Service	75.0%	25.0%	.0%	100.0%
		% within Familiarity with VBP program	20.0%	12.5%	.0%	16.0%

	30+ years	Count	1	1	0	2
		Expected Count	1.2	.6	.2	2.0
		% within Physician Years of Service	50.0%	50.0%	.0%	100.0%
		% within Familiarity with VBP program	6.7%	12.5%	.0%	8.0%
Total		Count	15	8	2	25
		Expected Count	15.0	8.0	2.0	25.0
		% within Physician Years of Service	60.0%	32.0%	8.0%	100.0%
		% within Familiarity with VBP program	100.0%	100.0%	100.0%	100.0%

APPENDIX G

FREEMAN'S DEGREE CENTRALITY OUTPUT

```
Diagonal valid?                    NO
Model:                             ASYMMETRIC
Input dataset:                     Combined Data Set2 (C:\Program Files\Analytic Technologies\Combined Data Set2)
```

		1 OutDegree	2 InDegree	3 NrmOutDeg	4 NrmInDeg
1	A	88.000	67.000	30.556	23.264
3	C	69.000	64.000	23.958	22.222
25	Y	62.000	77.000	21.528	26.736
22	V	60.000	46.000	20.833	15.972
9	I	56.000	53.000	19.444	18.403
8	H	46.000	34.000	15.972	11.806
20	T	43.000	22.000	14.931	7.639
4	D	43.000	40.000	14.931	13.889
11	K	41.000	37.000	14.236	12.847
2	B	41.000	28.000	14.236	9.722
10	J	40.000	38.000	13.889	13.194
21	U	37.000	37.000	12.847	12.847
7	G	34.000	40.000	11.806	13.889
5	E	23.000	43.000	7.986	14.931
19	S	20.000	20.000	6.944	6.944
12	L	18.000	22.000	6.250	7.639
16	P	17.000	26.000	5.903	9.028
6	F	15.000	9.000	5.208	3.125
15	O	14.000	35.000	4.861	12.153
14	N	13.000	14.000	4.514	4.861
13	M	10.000	25.000	3.472	8.681
18	R	1.000	7.000	0.347	2.431
17	Q	0.000	1.000	0.000	0.347
23	W	0.000	3.000	0.000	1.042
24	X	0.000	3.000	0.000	1.042

DESCRIPTIVE STATISTICS

		1 OutDegree	2 InDegree	3 NrmOutDeg	4 NrmInDeg
1	Mean	31.640	31.640	10.986	10.986
2	Std Dev	23.317	19.821	8.096	6.882
3	Sum	791.000	791.000	274.653	274.653
4	Variance	543.670	392.870	65.547	47.366
5	SSQ	38619.000	34849.000	4656.033	4201.509
6	MCSSQ	13591.760	9821.760	1638.667	1184.144
7	Euc Norm	196.517	186.679	68.235	64.819
8	Minimum	0.000	1.000	0.000	0.347
9	Maximum	88.000	77.000	30.556	26.736
10	N of Obs	25.000	25.000	25.000	25.000

```
Network Centralization (Outdegree) = 21.271%
Network Centralization (Indegree) = 17.120%

Note: For valued data, the normalized centrality may be larger than 100.
    Also, the centralization statistic is divided by the maximum value in the input dataset.

Actor-by-centrality matrix saved as dataset Combined Data Set2-deg
```

APPENDIX H

CLOSENESS CENTRALITY OUTPUT

Closeness Centrality Measures

		1 inCloseness	2 outCloseness	3 NinCloseness	4 NoutClosenes
3	C	18.000	17.833	75.000	74.306
1	A	17.500	21.833	72.917	90.972
5	E	17.500	17.333	72.917	72.222
4	D	17.000	18.500	70.833	77.083
22	V	17.000	18.000	70.833	75.000
9	I	16.833	18.000	70.139	75.000
25	Y	16.833	19.000	70.139	79.167
2	B	16.500	20.500	68.750	85.417
21	U	16.500	18.000	68.750	75.000
7	G	16.333	16.333	68.056	68.056
10	J	16.000	21.000	66.667	87.500
20	T	15.500	20.500	64.583	85.417
6	F	15.000	14.500	62.500	60.417
11	K	14.833	15.333	61.806	63.889
8	H	14.333	20.333	59.722	84.722
16	P	14.333	14.167	59.722	59.028
15	O	14.167	13.833	59.028	57.639
12	L	14.000	15.333	58.333	63.889
13	M	13.833	13.667	57.639	56.944
14	N	13.333	14.667	55.556	61.111
19	S	12.833	12.167	53.472	50.694
18	R	12.000	11.333	50.000	47.222
23	W	11.167	0.000	46.528	0.000
24	X	11.167	0.000	46.528	0.000
17	Q	9.667	0.000	40.278	0.000

Statistics

		1 inCloseness	2 outCloseness	3 NinCloseness	4 NoutClosenes
1	Mean	14.887	14.887	62.028	62.028
2	Std Dev	2.206	6.141	9.193	25.586
3	Sum	372.167	372.167	1550.694	1550.694
4	Variance	4.868	37.708	84.519	654.657
5	SSQ	5662.027	6483.027	98299.094	112552.555
6	MCSSQ	121.707	942.707	2112.963	16366.434
7	Euc Norm	75.246	80.517	313.527	335.489
8	Minimum	9.667	0.000	40.278	0.000
9	Maximum	18.000	21.833	75.000	90.972
10	N of Obs	25.000	25.000	25.000	25.000

Network in-Centralization = 27.61%
Network out-Centralization = 61.61%

Output actor-by-centrality measure matrix saved as dataset Combined Data Set2-cloreciprocal (C:\Program Files\Analytic Technologies\Combined Data Set2-cloreciprocal)

Running time: 00:00:01
Output generated: 28 Jan 13 17:14:27
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APPENDIX I

BETWEENNESS CENTRALITY OUTPUT

```
Un-normalized centralization: 1220.785

                     1            2
          Betweenness nBetweenness
         ------------ ------------
  2   B        62.311       11.288
  1   A        43.581        7.895
 20   T        35.791        6.484
 10   J        26.201        4.747
  3   C        26.024        4.715
  4   D        21.061        3.815
 25   Y        19.993        3.622
 21   U        14.730        2.669
  5   E        13.876        2.514
  8   H        12.478        2.261
  9   I        12.422        2.250
 22   V        10.816        1.959
 12   L         8.956        1.623
  7   G         8.660        1.569
 11   K         6.690        1.212
  6   F         5.144        0.932
 14   N         3.544        0.642
 16   P         1.840        0.333
 13   M         1.608        0.291
 15   O         0.902        0.163
 19   S         0.372        0.067
 17   Q         0.000        0.000
 18   R         0.000        0.000
 23   W         0.000        0.000
 24   X         0.000        0.000


DESCRIPTIVE STATISTICS FOR EACH MEASURE

                       1            2
                Betweenness nBetweenness
               ------------ ------------
  1      Mean        13.480        2.442
  2   Std Dev        15.244        2.762
  3       Sum       337.000       61.051
  4  Variance       232.387        7.627
  5       SSQ     10352.444      339.754
  6     MCSSQ      5809.684      190.666
  7  Euc Norm       101.747       18.432
  8   Minimum         0.000        0.000
  9   Maximum        62.311       11.288
 10  N of Obs        25.000       25.000

Network Centralization Index = 9.21%

Output actor-by-centrality measure matrix saved as dataset Combined Data Set2-bet

---------------------------------------
Running time:  00:00:01
Output generated:  27 Jan 13 17:14:41
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```

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