Implementation of Evidence-based Practice Within a Physician-led Quality Improvement Collaborative: A Multimethod Analysis of Facilitators and Barriers to Implementation

by

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Dedication

This dissertation is dedicated to my beautiful wife, Darlene, and our three princesses—Sotiria, Athena, and Persephone

"I charge you to descend upon this world with the full weight of your passion. Collide yourself against this path with the full force of your mighty ambitions. Fall into this calling heavy with purpose and be nothing less than contagious."
– Sekou Andrews

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Abstract

In this dissertation, I have reported on a multimethod study of the barriers and

facilitators to implementation of imaging appropriateness criteria, an evidence-based

practice to improve the use of imaging for prostate cancer patients, within the Michigan

Urological Surgery Improvement Collaborative (MUSIC). I conducted seven months of

field research throughout MUSIC to study the history and organization of the

collaborative. I conducted field site visits and interviews with key members of the

urology practices. I performed a comparative case study assessment of this qualitative

data to explain the barriers and facilitators of the implementation efforts within the

urology practices. I also developed and deployed an instrument to assess and explain

the specific factors affecting the behavioral intentions of the urologists in the

collaborative. Through this extensive assessment, I have shown how the collaborative

can organize in a purposefully way to positively shape the behaviors of the members.

These strategies included: 1) Professional interplay to build trust and professional

relationships; 2) positive reinforcement to strengthen beliefs about legitimacy; and 3)

inclusiveness to shape attitudes about the grassroots efforts. I suggested these

strategies helped influence the collaborative members' to adopt and use the innovation.

Therefore, the collaborative assumed the role as the "collective opinion leader." I have

shown that beliefs related to professional identity, along with patient or resource

constraints, can be barriers to implementation. Additionally, knowing the criteria and its

evidence, as well as having strong beliefs about the consequences, are the strongest

predictors of an urologist's intention to follow the imaging appropriateness criteria.

Furthermore, strong social influences from the practice and positive attitudes towards

the collaborative will facilitate implementation efforts and possibly reduce barriers from

the environment.

Chapter 1. Introduction

1.1 Introduction and Research Problem

Multi-organizational quality improvement collaboratives are an increasingly common strategy for implementing evidence-based practice or health interventions. In this type of boundary spanning activity, a group of teams from multiple sites come together to share knowledge, skills, tools, and resources, to improve the quality of care across the collaborative (Plsek, 1997). Specific implementation strategies are developed to purposefully change the behaviors of targeted individuals. That is, to get the participants to adopt and routinely use the new evidence-based practice or health intervention.

Because of the potentially large investment of resources, such as time and money, there is considerable concern that collaboratives are not effective at changing behavior in care processes or at achieving desired outcomes of care. In fact, the current research on collaborative effectiveness is often mixed or inconclusive. A systematic review by Schouten et al. (2008) reveals that, when compared to control groups, most quality improvement collaboratives are able to achieve only moderately positive effects on outcomes of care. However, the authors report a considerable amount of variance in targeted outcomes. For example, the majority of studies considered by Schouten and colleagues found that collaboratives have a positive effect on some of the health

outcomes they intended to improve, but not all of them. Furthermore, two of the studies showed that the collaborative had no significant effects on the outcomes they were targeting to improve. A recent update to this review also concluded that mixed effectiveness outcomes are still being realized by collaboratives today (Nadeem et al., 2013).

Much of the research on collaborative effectiveness has analyzed factors that influence the effectiveness of teams within the collaborative itself. A recent systematic review by Hulscher, Schouten, Grol, and Buchan (2013) suggests there are major issues within this body of work. Most of the studies considered were excluded because of flawed methods or the study only hypothesized a relationship between collaborative processes and measures of success (Hulscher, Schouten, Grol and Buchan, 2013). More importantly, however, Hulscher and colleagues identified that the majority of factors had no significant effects on effectiveness and the impact of several significant determinants were unclear. Additionally, although not explicitly explained, the preponderance of the studies focused on factors related to team dynamics and the context of the immediate work environment. Few studies have analyzed the wide range of factors that could influence individual behavior change.

It is important to understand that the adoption and routine use of an evidence-based practice involves changes in healthcare professionals' behaviors. These clinical behaviors can be influenced by a wide range of individual, organizational, and social factors (Damschroder et al., 2009; Hulscher, Grol, and Van der Meer, 2010), to include that of the collaborative itself. Yet, few studies have assessed the healthcare

professionals' beliefs and attitudes towards these types of factors. For example, no research has focused on the process of dissemination and what role the opinion leaders or champions play in gaining the support of their colleagues. Additionally no research has assessed the interplay between the individuals and the collaborative leaders, and how this interplay influences the individual behavior change. For instance, how do the leaders of the collaborative influence the participants and what are the participants' beliefs and attitudes towards the leaders and collaborative itself. In fact, these are major gaps in implementation research today (Damschroder et al., 2009).

Implementation of an evidence-base practice will likely require a change in behavior. In the field of behavioral change, the Theory of Planned Behavior (Ajzen, 1991) is the most often used model to explain intention and predict the clinical behavior of health professionals (Godin, Bélanger-Gravel, Eccles and Grimshaw, 2008). This socio-cognitive theory posits that three determinants (attitudes, subjective norms, and perceived behavioral control) shape a person's intention to behave in a specific way. Intention can be thought of as the motivation to behave in a specific manner. Although this theory may be limited in scope, a promising approach would be to use this concept of behavioral determinants to explore the factors that affect the intentions of clinical behaviors of the health professionals within a collaborative. This method and approach would be helpful in gaining a better understanding of the cognitive mechanisms underlying the intentions and behaviors of the collaborative members themselves. It would also help to fill the void in the literature with respect to collaboratives and behavioral determinants.

Before moving on to the research questions I propose for this dissertation, it's important to have a grounded understanding of the structures and processes of a quality improvement collaborative. Therefore, I will now provide an overview of the basic elements of a quality improvement collaborative as described by the Institute for Healthcare Improvement.

1.2 Elements of a Quality Improvement Collaborative

It's important to understand the elements and functions of a quality improvement collaborative in order to conceptualize the wide array of factors that could influence the behaviors of the individuals within the collaborative itself. Most quality improvement collaboratives in today's healthcare industry are modeled after the Breakthrough Series that was developed in 1995 by the Institute for Healthcare Improvement (IHI, 2003; Kilo, 1998). This model organizes a short-term learning system that brings together a large number of teams to seek improvement in a focused topic area. This collaborative effort creates "breakthrough" accomplishments with respect to improved quality and reduced costs.

The model itself has several key elements. Figure 1 provides the schematic presentation of a quality improvement (QI) collaborative. The first is the *topic of focus*. The leaders identify an area of healthcare or an issue that needs addressed. Next, they *recruit experts* in the relevant field of focus. This team develops the collaborative's aims, strategies for measurement, and evidence-based practices to improve the quality of care. They assemble the "Change Package", which consists of the vision and the specific

changes in care, and help to lead and coordinate the efforts of the member organizations.

The leaders *recruit organizations* to join the collaborative. Organizations can join on a voluntary basis by submitting an application. The organization must identify a multidisciplinary team(s) to work together on the specified topic for approximately a year. The selected team(s) attends a series of meetings, called *learning sessions*, where they receive the "Change Package", learn improvement techniques from experts, and share their experiences implementing new practices with one another.
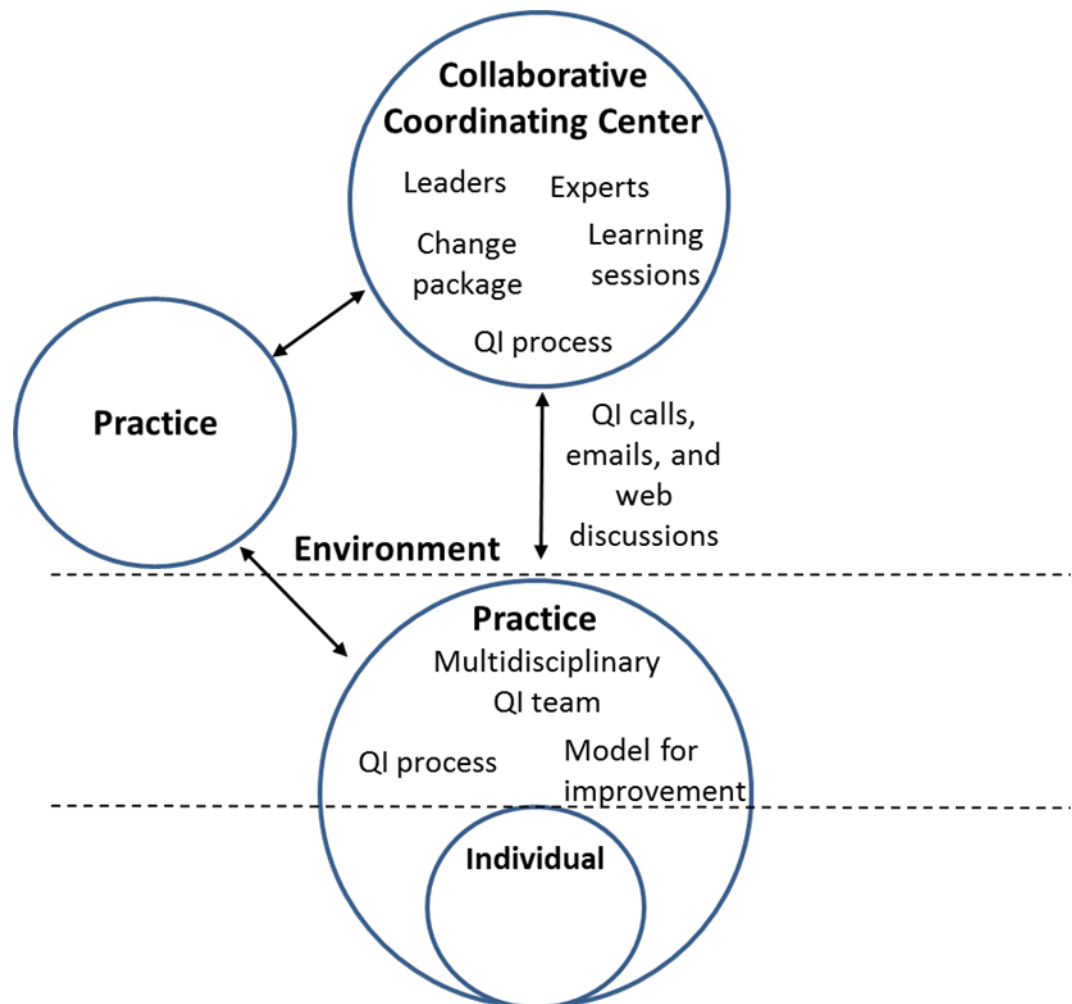
Figure 1. Model depicting the basic elements of a QI collaborative.

During the *action period*—the time between learning sessions—teams implement changes within their own organization. The *model for improvement* is the Plan-Do-Study-Act cycles, which helps systematically develop and implement small-scale changes, measure the effects, and make changes for improvement. The teams collaborate—they submit monthly written reports detailing improvement activities; they learn from one another by participating in monthly conference calls, web-based discussions, and site visits.

Throughout the cycle, the teams track their own *performance measures* and provide reports to the collaborative. The leaders and experts review and evaluate the performance of the collaborative over time. After the collaborative ends, teams *summarize their results* and lessons learned and present them to nonparticipating organizations at conferences. This model of quality improvement is continuously refined from the feedback from the participants (IHI, 2003).

A wide range of factors could affect the behaviors of the individuals and influence the implementation efforts. For example, the collaborative leaders may have existing professional relationships, or social influences, with individuals within the collaborative, which could facilitate or hinder implementation. Conversely, others may have limited knowledge of the collaborative's leadership or the experts leading the charge. Additionally, professional norms or other institutional pressures could negatively influence the adoption and use of an evidence-based innovation. Yet, as described before, no studies have analyzed the effects of these factors on the behaviors of the healthcare professionals within a collaborative setting.

This dissertation research was developed to fill the gap in knowledge. Identifying the key factors that have an influence on a healthcare professional's behavior can provide a basis for developing strategies to help improve implementation efforts and collaborative effectiveness (Michie et al., 2005; Godin, Bélanger-Gravel, Eccles and Grimshaw, 2008). With this in mind, I now turn to my statement of purpose and research questions.

1.3 Statement of Purpose and Research Questions

The purpose of this multimethod study is to gain a better understanding of the multi-level influences within a quality improvement collaborative and provide insights into the determinants of success for implementing an evidence-based practice. It is my intent to provide a detailed characterization of barriers and facilitators of implementation through a careful examination of the individual, organizational, and environmental factors influencing the behavioral intentions of the collaborative participants. To do this, I look specifically at what happens when an evidence-based practice is disseminated and implemented within a quality improvement collaborative.

To address the purpose of this study, I have constructed the following research questions:

1. What factors influence physicians' intentions to follow evidence-based practice?

2. How was the quality improvement collaborative formed and how is it organized?

3. What are the interactions between the collaborative leaders and the individual physicians participating as collaborative members and how do these interactions support the physicians' uptake of the innovation?

4. What are the interactions among physicians from the same practice participating in a collaborative and how do these interactions support physicians' uptake of the innovation?

5. What are the social and environmental factors that influence physicians participating in a collaborative to develop intentions to follow the evidence-based practice?

1.4 The Michigan Urological Surgery Improvement Collaborative

The collaborative under investigation is the Michigan Urological Surgery Improvement Collaborative (MUSIC). This collaborative is comprised of a partnership between Blue Cross Blue Shield of Michigan (who funds the collaborative), the Department of Urology at the University of Michigan (who functions as the Coordinating Center), and over 90% of the urology practices from throughout the State of Michigan. The term urology practice in this sense refers to the group of urologists who are organized together to share resources, rather than the office space they work from (i.e. some urology practices have multiple offices).

Research within this collaborative was opportune for several reasons. First, there were a variety of social contexts the practices were embedded in. For example, the urology practices ranged in size from a single urologist to a large academic medical center with upwards of 18 urologists. Some practices were located in rural areas with limited specialty care support, while others were within major urban cities, such as Detroit, with multiple urology practices and large academic medical centers competing

in the same area. Additionally, in some areas, there was little diversity with respect to patient demographics, while in others they were quite diverse.

Additionally, the timing was impeccable. MUSIC had just developed and disseminated their first major evidence-based practice. This was due in large part because the collaborative had collected over 10,000 prostate cancer patient encounters and their subsequent analysis of the diagnosis and treatment data helped to detect that bone and CT scan imaging was being used inefficiently. Physician leaders within the collaborative also recognized there was ambiguity with respect to the current professional guidelines and recommendations. Thus, this innovation, called the imaging appropriateness criteria, was developed in an effort to improve the urologists' use of bone and CT scans when staging newly diagnosed prostate cancer patients. More specifically, it was developed to improve the quality of care related to the overuse of bone and CT scans when it was not medically necessary and the underuse of bone and CT scans when it was medically necessary. My study was designed to identify which factors influence the urologists' intentions to follow these newly developed imaging appropriateness criteria.

To answer the research questions I proposed, I conducted a multimethod study in the Michigan Urological Surgery Improvement Collaborative between December 2013 and January 2015. Using participant observation, semi-structured interviews, and historical document review, I identified how the collaborative was formed and assessed the primary functions of the collaborative. Using field-site visits and semi-structured interviews, I performed a rigorous assessment of the barriers and facilitators for

implementing evidence-based practice within the urology practices. And finally, using a questionnaire that was developed from the qualitative findings, I assessed the attitudes, beliefs, and intentions of individual physicians with respect to the collaborative, social and environmental factors, and the innovation itself. The study was deemed exempt by the University of Michigan Medical School Institutional Review Board.

1.5 Organization of Dissertation

In this chapter I have provided an overview of quality improvement collaboratives and have briefly identified the need for research that comprehensively examines the determinants of successful implementation within a collaborative. I have also stated my research purpose and questions and identified the methods that I will use to address those questions. In Chapter 2, I discuss the current research on quality improvement collaboratives and the proposed theoretical frameworks I used to guide this research study. Chapter 3 describes the research design and methods I used to address my research questions. In Chapters 4, 5, and 6 I present and discuss my research findings. More specifically, in Chapter 4, I provide an overview of MUSIC and a comprehensive description of the development and dissemination of the evidence-based practice. I also briefly summarize the collaborative's implementation performance. In Chapter 5, I use a comparative case study analysis to describe the barriers and facilitators of implementation efforts within several high and low implementation practices. In Chapter 6 I use survey data from a TDF-based questionnaire that I developed and deployed to assess the factors affecting the urologist's intention to follow the imaging appropriateness criteria. I conclude by

discussing how my findings addressed my questions, implications of these findings, and

provide a summary of my contribution and a way ahead for future research.

Chapter 2. Literature Review: Quality Improvement Collaboratives

In this chapter I discuss the current research on quality improvement collaboratives and the proposed theoretical frameworks I used to guide this research study. I first provide a general overview of why collaborations exist. I then provide an overview of the collaborative effectiveness literature and identify the gaps within this current body of research. Finally, I describe how I can use the Consolidated Framework for Implementation Research and Theoretical Domains Framework to study the collaborative and analyze the factors that can shape the beliefs, attitudes, and behavioral intentions of the individual healthcare providers involved in a collaborative.

2.1 An Overview of Quality Improvement Collaboratives

Quality improvement collaboratives have been a popular way of organizing for decades. Early pioneers of these efforts include the Northern New England Cardiovascular Disease Study Group (O'Conner et al., 1996), the Health Disparities Collaboratives (Chin et al., 2007), and the Vermont Oxford Network (Horbar, 1999). The basic philosophy of these early improvement efforts was to establish a practice-based research network to collect and share detailed clinical data to better understand how to measure and improve the quality of medical and surgical care (Horbar, 1999).

In 1995, the Institute for Healthcare Improvement formalized this way of collaborative learning by developing the Breakthrough Series model (IHI, 2003; Kilo,

1998). This quality improvement model provided a common framework so that a large number of improvement teams from different healthcare organizations could form a short-term learning system (often 12-18 months) in an effort to achieve rapid quality improvement within a specific focus area. The basic elements, which were described in detail in Chapter 1, were designed to weave the quality improvement process into the everyday work of the participants (Kilo 1998). Through the collaborative's structured activities, member organizations would share knowledge, skills, tools, and resources needed to foster action for improvement. The general concept was that improvement teams were likely to be more effective in developing knowledge and implementing quality improvement ideas when working together rather than working in isolation (Lindenauer, 2008).

Most of today's quality improvement collaboratives are modeled after this series (Nadeem et al., 2013). It's important to understand why they are a popular organizational strategy in today's healthcare industry. As briefly mentioned, the basic philosophy of a quality improvement collaborative is to improve the quality of healthcare in a targeted area of focus across multiple organizations. In order to accomplish this overarching goal of improved quality, member organizations share knowledge, skills, tools, and resources necessary to foster action for improvement. This concept centers on the premise that improvement teams are likely to be more effective in developing knowledge and implementing quality improvement ideas when working together rather than working in isolation (Lindenauer, 2008).

Expanding on this thought, most efforts to improve the quality of healthcare are

spearheaded within clinics, hospitals, and health systems, which can be at the local,

regional, and national level. These efforts can often be limited because of small samples

and lack of knowledge about what others are doing in other organizations (Plsek, 2009).

For example, there is little infrastructure for data collection and benchmarking across

healthcare organizations. Because of these limitations, adverse events may be rare,

creating the need to collect data for multiple years to get a statistically significant

sample size. Thus, making significant improvements and inferring study results from a

small sample is often difficult. Additionally, local clinical leaders may not know how or

what to do to improve the healthcare they deliver and smaller practices may not have

the resources to accomplish any tasks outside of their core mission of providing care.

Thus, the boundary spanning activities of quality improvement collaboratives can

break down these barriers and help advance quality improvement efforts in several

ways (Plsek, 1997). First, data collection across the collaborative can help to solve the

problem of small data sets that plague local improvement efforts. This data can help to

establish performance benchmarks and show quality improvement efforts over time.

Additionally, the collaborative can foster improvement efforts by sharing knowledge

and resources, to include best practices, within and outside of the collaborative. For

example, Nembhard's (2009) study suggests the collaborative helped maintain

motivation, provide access to social support, and improve project management skills,

which improved organizational performance. Ultimately, this way of organizing for "real-

time science" plays an important role in building knowledge and capacity to improve quality in healthcare (Berwick, 1996).

2.3 Are Collaboratives Effective at Improving Quality?

Although quality improvement collaboratives are a popular way of organizing to improve healthcare, evidence supporting their effectiveness is mixed or inconclusive. Outcomes in this context generally center on changing processes of care (e.g. routinely following new asthma management guidelines) or improving health and wellness outcomes (e.g. reducing infant mortality). Several recent systematic reviews reveal that quality improvement collaboratives are only able to achieve moderately positive improvements on their targeted outcomes (Schouten et al., 2008 and Nadeem et al., 2013). These reviews also show that the outcomes are often mixed and inconclusive and the effects of collaboratives cannot be predicted with certainty.

There is a considerable amount of research attempting to assess the determinants of collaborative effectiveness. That is, determining which factors within a collaborative are effective at changing processes of care and health outcomes. As with the effectiveness literature, however, this body of work is limited and indeterminate. A recent systematic review by Hulscher, Schouten, Grol, and Buchan (2013) identified the majority of factors under investigation had no significant effects on outcomes of interest and the impact of several significant determinants was unclear. This review also shows the preponderance of studies has narrowly focused on factors related to the quality improvement teams and the model for improvement they employ. A review by Nadeem et al. (2013) also suggests there is a considerable amount of variation in this body of

work and the small number of high quality studies makes it nearly impossible to evaluate which characteristics of collaboratives are associated with success.

There are also limitations to this research. Most studies of collaborative effectiveness assess outcome measures from medical records or administrative data and do not directly assess changes in the individual's attitudes, beliefs, and behaviors (Nadeem et al., 2013). For instance, researchers have studied medical records to infer the collaborative's effect on provider's adherence to treatment guidelines (Carlhed et al., 2006; Landon et al., 2004) and chronic care management (Chin et al., 2007; Landon et al. 2007; Schouten et al., 2010). However, these types of outcomes related to overt behavior make it difficult to determine if and how the collaborative itself was effective at changing the specific beliefs, attitudes, and behaviors in question (Fishbein and Ajzen, 1975). In other words, the methods make it difficult to assess if the collaborative is the true mechanism of change.

Despite these issues, there are a few promising studies that provide a better understanding for how specific components of the collaborative may be linked to positive outcomes. A study by Nembhard (2009) suggests collaborative participants' valued six features related to knowledge acquisition: collaborative faculty, solicitation of their staff's ideas, change package, Plan-Do-Study-Act cycles, Learning Session interactions, and collaborative extranet. She suggests these features provided the participants with motivation, social support, and project management skills. Several other studies she has published have suggested that engagement in interorganizational learning (i.e. conference calls and learning sessions) and deliberate learning activities

(i.e. Plan-Do-Study-Act cycles, solicitation of staff ideas, staff education) may be important to improving performance (Nembhard, 2012; Nembhard and Tucker, 2011).

Although the attitude assessments of these studies are helpful for shedding light on the salient components, there may be issues inferring their effects on improved performance. For instance, these studies assessed the relationship between the participants' attitude of the collaborative components and a subjective assessment of organizational improvement, which was conducted by the IHI director (Nembhard, 2009, 2012; Nembhard and Tucker, 2011). Thus, it is difficult to determine if the collaborative elements were responsible for the improvements.

Other research by Schouten, Grol, and Hulscher (2010) suggests there are three core processes in a Quality Improvement Collaborative that are important for their success: sufficient expert team support, effective multidisciplinary teamwork, and the use of a model for improvement. Although these elements generally align with the findings of the previously mentioned studies, this research was a factor analysis of an instrument and the items were not empirically tested to predict outcomes. While it is informative and reinforcing, it is limited.

Few studies have used a theoretically based approach to get a better understanding for how a collaborative can change healthcare professionals' behaviors. Research in the field of behavioral change often looks towards sociocognitive theories to predict the clinical behavior of health professionals (Godin, Bélanger-Gravel, Eccles and Grimshaw, 2008). In particular, the Theory of Planned Behavior is the most often used theory for this purpose. This theory posits that attitudes about the behavior,

subjective norms, and perceived behavioral control can shape a person's intention to behave in a specific manner (Ajzen, 1991). Thus, efforts to change behaviors should be focused on understanding and addressing the antecedents of behavioral intentions or determinants of behavior.

If this type of assessment is performed, a theoretically-based implementation strategy could be tailored to meet the needs of the collaborative in changing clinical behaviors, which would likely lead to implementation success and collaborative effectiveness. Thus, a theoretically based assessment of implementation efforts would improve our understanding of the multiple factors that can influence the behaviors of the healthcare professionals in a collaborative setting. With this in mind, I now transition to discuss an innovative way to study barriers and facilitators of implementation an evidence-based practice within a quality improvement collaborative.

2.4 An Innovative Way to Study Barriers and Facilitators of Implementation

Implementation science is the study of methods to promote the integration of research findings and evidence into healthcare policy and practice (NIH, 2015). This field of research seeks to understand the behavior of healthcare professionals in the sustainable adoption and routine use of evidence-based innovations. Over the past decade, a plethora of implementation theories have been developed to promote implementation effectiveness.

This body of work has produced a vast array of theories with overlapping constructs, making it difficult to determine which theory or framework to use. Consequently, several theoretical frameworks were developed in an effort to

consolidate these vast arrays of constructs and theories. Two of them will be presented

here for this research.

The first is the Theoretical Domains Framework, which was developed in 2005 by

a collaboration of psychological theorists, health service researchers, and health

psychologists (Michie et al., 2005). This framework was constructed from behavioral

change theories in an effort to guide the theoretical assessment of implementation

problems. It is primarily focused on psychosocial determinants of change.

Similar to the TDF, in 2009, the Consolidated Framework for Implementation

Research (CFIR) was constructed with the intent of consolidating the constructs into

useable theory-based frameworks (Damshroder et al, 2009). This framework was used

to consolidate the theories and constructs related to Implementation Science. As such,

it primarily focused on organizational and social factors affecting implementation.

Although they cover similar concepts, each framework provides a unique lens to

assess implementation efforts. Together, though, these two frameworks provide

taxonomies and menus of constructs to draw upon for assessing barriers and facilitators

of implementation (Brehaut and Eva, 2012). To conceptualize this, the domains for each

framework have been added to model depicting the elements of the quality

improvement collaborative. This shows how the domains for each of the frameworks

map onto the elements and processes (See Figure 2). Each of these frameworks was

developed from different areas of social science. Thus, each has strengths and

weaknesses for assessing implementation efforts. The following subsections will further

describe each framework in more detail and how they both can be used in an innovative way to study implementation efforts within a quality improvement collaborative.

The Theoretical Domains Framework

The Theoretical Domains Framework was originally developed (Michie et al., 2005) to integrate 33 behavioral change theories into a unified 12 domain framework. Cane, O'Connor and Michie (2012) further refined the framework by expanding it to 14 domains and 84 constructs (See Table 1). Each domain consists of a grouping of theoretical constructs and exemplar questions to help guide the theoretical assessment
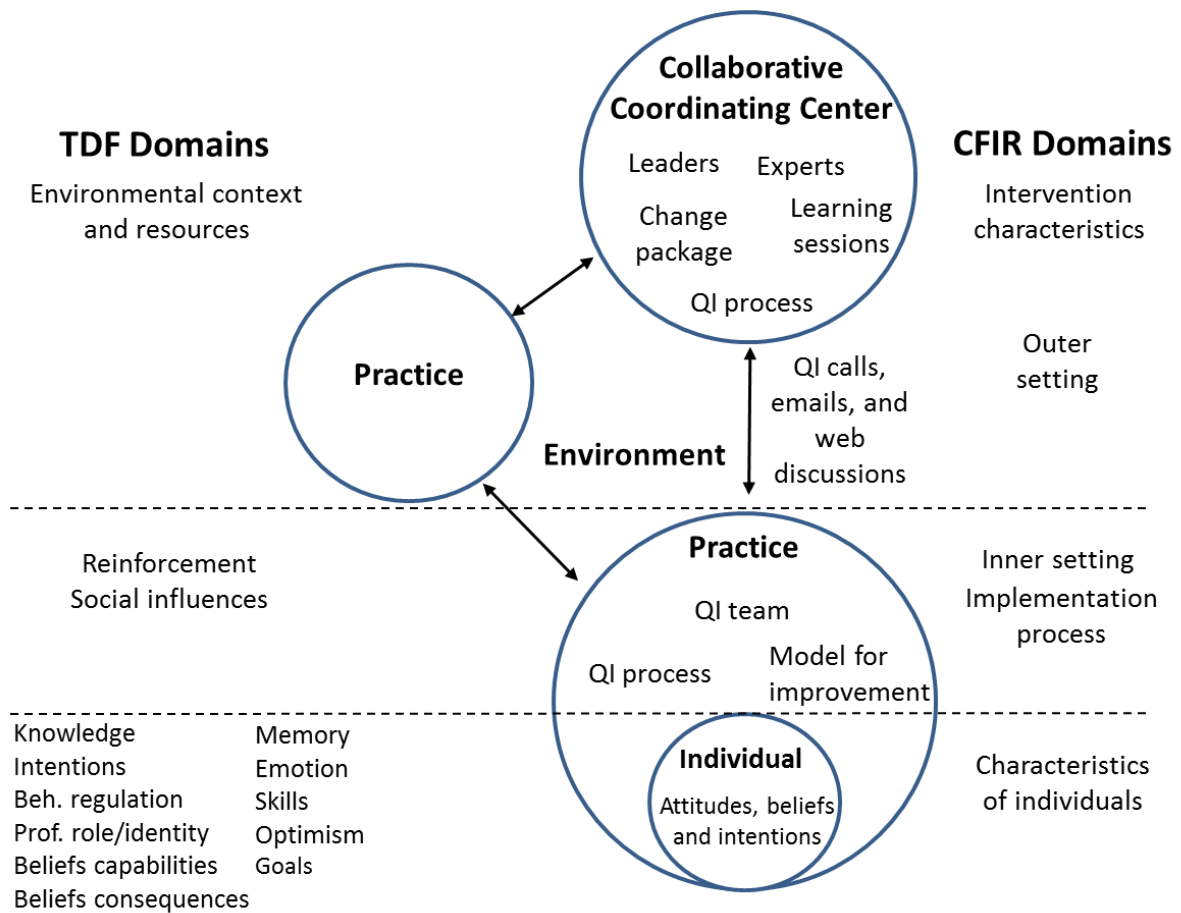
Figure 2. TDF and CFIR mapped to the elements of a QI collaborative.

of implementation problems (Michie et al., 2005). These domains cover a wide range of sociopsychological behavioral determinants.

Since its development, the TDF has been used in a variety of empirical studies to guide the analysis of behavior determinants. The majority of studies have investigated the behavior of health professionals, while a few assessed health-related behaviors of patients (Francis, O'Connor, and Curran, 2012). Over half of the published studies have used the framework in an exploratory interview to identify barriers to uptake of a guideline. A few researchers have also utilized the TDF to develop a questionnaire for assessing determinants of implementation behaviors (Amemori et al., 2011; Beenstock et al., 2012; Taylor et al., 2013). However, the internal consistency reliability of the questionnaires was questionable (Huijg et al., 2014).

Overall, there are several strengths to the TDF. First and foremost, there are 33 behavioral change theories embedded within the domains and constructs. One of these theories of behavioral change is the Theory of Planned Behavior. As seen in Figure 2, this places a heavy focus on factors related to the individual (e.g. beliefs about consequences) and the practice (e.g. social interactions). Thus, this comprehensive framework can provide a method for theoretically assessing determinants or mediators of behavioral change (i.e. factors affecting attitudes, beliefs, and behavioral intentions) and developing evidence-based interventions (Michie, Van Stralen, and West, 2011). Additionally, while it can be used to guide qualitative methods, the newly validated TDF-based questionnaire provides items that can discriminately measure the domains (Huijg et al., 2014).

On the other hand, some of these strengths could also be viewed as weaknesses. For example, while the framework seems to be comprehensive with respect to its coverage of the collaborative, it involves a large number of domains (14) and underlying constructs (89). This requires a large number of items to provide a comprehensive measurement for each domain. However, researchers have overcome this issue by tailoring a subset of items to measure specific domains of interest (Amemori et al., 2011; Huijg et al., 2014). Additionally, because this framework has an existing questionnaire, a qualitative analysis that is guided by the CFIR could help determine what domains are important to assess with a questionnaire (the strengths of the CFIR will be discussed later). This is the proposed method for this study.

Table 1. Domains and Constructs of the Theoretical Domains Framework

Domain	Definition of Domain	Constructs
D1 Knowledge	An awareness of the existence of something	Knowledge (including knowledge of condition /scientific rationale), and Procedural knowledge
D2 Skills	An ability or proficiency acquired through practice	Skills, Skills development, Competence, Ability, Interpersonal skills, Practice, and Skill assessment
D3 Social/ professional role & identity	A coherent set of behaviors and displayed personal qualities of an individual in a social or work setting	Professional identity, Professional role, Social identity, Identity, Professional boundaries, Group identity, Leadership, and Organizational commitment
D4 Beliefs about capabilities	Acceptance of the truth, reality, or validity about an ability, talent, or facility that a person can put to constructive use	Self-confidence, Perceived competence, Self-efficacy, Perceived behavioral control, Beliefs, Self-esteem, Empowerment, and Professional confidence
D5 Optimism	The confidence that things will happen for the best or that desired goals will be attained	Optimism, Pessimism, Unrealistic optimism, and Identity

D6 Beliefs about consequences	Acceptance of the truth, reality, or validity about outcomes of a behavior in a given situation	Beliefs, Outcome expectancies, Characteristics of outcome expectancies, Anticipated regret, Consequents
D7 Reinforcement	Increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and stimulus	Rewards, Incentives, Punishment, Consequents, Reinforcement, Contingencies, and Sanctions
D8 Intentions	A conscious decision to perform a behavior or a resolve to act in a certain way	Stability of intentions, Stages of change model, Transtheoretical model and stages of change
D9 Goals	Mental representations of outcomes or end states that an individual wants to achieve	Goals, Goal priority, Goal / target setting, Goals, Action planning, Implementation intention
D10 Memory, attention & decision process	The ability to retain information, focus selectively on aspects of the environment and choose between two or more alternatives	Memory, Attention, Attention control, Decision making, Cognitive overload / tiredness
D11 Environmental context and resources	Any circumstance of a person's situation or environment that discourages or encourages the development of skills and abilities, independence, social competence, and adaptive behavior	Environmental stressors, Resources / material resources, Organizational culture /climate, Salient events / critical incidents, Person x environment interaction, and Barriers and facilitators
D12 Social influences	Those interpersonal processes that can cause individuals to change their thoughts, feelings, or behaviors	Social pressure, Social norms, Group conformity, Social comparisons, Group norms, Social support, Intergroup conflict, Alienation, Group identity, and Modelling
D13 Emotion	A complex reaction pattern, involving experiential, behavioral, and physiological elements, by which the individual attempts to deal with a personally significant matter or event	Fear, Anxiety, Affect, Stress, Depression, Positive / negative affect, and Burn-out
D14 Behavioral regulation	Anything aimed at managing or changing objectively observed or measured actions	Self-monitoring, Breaking habit, and Action planning

Furthermore, the current version of the TDF focuses heavily on factors related to

the individual adopting the innovation (e.g. skills, optimism, and emotion) and the

practice (e.g. social interactions). It provides only a general assessment of the

healthcare professionals' knowledge of the innovation and provides a weak assessment of the environmental context and resources. However, as Huijg and colleagues (2014) suggest, specific items related to knowledge of the implementation behavior could be added to improve the assessment of the domain *Knowledge.* As well, additional contextually sensitive items could be added to the domain Environmental context and resources. Again, this could be informed by using the CFIR, which is more comprehensive for studying the innovation and the external environment.

The Consolidated Framework for Implementation Research

Similar to the TDF, the Consolidated Framework for Implementation Research (CFIR) was developed by Damschroder and colleagues (2009) to consolidate the myriad of constructs found in published implementation theories. However, the development was not as systematic and drawn out as the TDF, per se. As described by the authors, the framework is a consolidation of constructs to enable a systematic exploration of the contextual factors that influence or predict implementation success (Damschroder et al, 2009). In essence, the framework was primarily developed for qualitative analyses to promote theory development and verification about what works where and why across multiple contexts.

The theories reviewed for the framework were related to dissemination, innovation, organizational change, implementation, knowledge translation, and research uptake. In total, there were 19 implementation theories considered for inclusion. Constructs were selected for inclusion based on strength of evidential support for influencing implementation and potential for operationalization. The resultant menu

of constructs consists of 39 operationally defined constructs organized into five domains

(See Table 2).

Table 2. Domains and Constructs for the CFIR

Domain	Constructs
Intervention Characteristics	Intervention Source, Evidence Strength and Quality , Relative advantage, Adaptability, Trialability, Complexity, Design Quality and Packaging, and Cost
Outer Setting	Patient Needs and Resources, Cosmopolitanism, Peer Pressure, External Policies & Incentives
Inner Setting	Structural Characteristics, Networks and Communications, Culture, Implementation Climate (Tension for Change, Compatibility, Relative Priority, Organizational Incentives and Rewards, Goals and Feedback, Learning Climate), and Readiness for Implementation (Leadership Engagement, Available Resources, Access to knowledge and information)
Characteristics of Individuals	Knowledge and Beliefs, Self-efficacy, Individual Stage of Change, Individual Identification with Organization, and Other Personal Attributes
Process	Planning, Engaging (Opinion Leaders, Formally appointed internal implementation leaders, Champions, and External Change Agents), Executing, and Reflecting and Evaluating

Since its development, the CFIR has been used in a variety of empirical studies. It

has helped with formative evaluations of implementation efforts (English et al., 2011;

Damschroder and Lowery, 2013) and guided mixed-methods assessments of

implementation strategies (Powell et al., 2013). The majority of the studies have been

qualitative in nature, where the CFIR taxonomy has been used to inform the

development of the interview guides and coding frameworks. In line with this,

Damschroder and Lowery (2013) recently provided a step-by-step guide for how to

apply a theory-based framework using qualitative data. Of note, however, research

groups, such as the Seattle Implementation Research Collaborative, have attempted to

map quantitative measures to the constructs and domains of the CFIR in an effort to improve the development and use of CFIR-based instruments (Martinez, Lewis, and Weiner, 2014).

The most obvious strengths to the CFIR are its comprehensiveness and systems approach to studying implementation. Figure 2 shows the domains cover all the elements of the conceptual model (as previously mentioned, the constructs from the Diffusion of Innovations Theory is embedded within the framework). Unlike the TDF, the CFIR is heavily focused on the intervention and the social context the individuals (e.g. inner setting) and organizations (e.g. outer setting) are embedded within. It also assesses the process of implementation, focusing on both the active change process as well as the individuals who promote the implementation efforts (*e.g.*, local champions, external change agents). Thus, this qualitative research could help inform the development of the TDF survey.

There are also several weaknesses to this framework. As with the TDF, there are a lot of constructs to be assessed, which may be problematic in qualitative research. Additionally, the framework and current methods make it difficult to assess the individual-level attitudes, beliefs, and intentions towards the behavior. For example, this framework is mostly used with qualitative work and the constructs provide a thorough assessment of interviewee's perceptions related to the innovation and factors in the environment. However, the domain *Characteristics of the individual* only provides a general assessment of person's knowledge and beliefs, self-efficacy, stages of change, and organizational identity. It's not only difficult to measure these construct, but a small

sample could bias the results considerably. Also, while the framework provides a general description of each construct, there are several that are underdeveloped and ambiguous. This makes it difficult to maintain reliability when coding (e.g. concepts may overlap with multiple domains and constructs).

As described, each of the theoretical frameworks has its strengths and weaknesses. The CFIR was developed to assess a multitude of factors that could affect implementation effectiveness. Its major limitation, however, is assessing the individuals involved in the implementation. The TDF, on the other hand, was developed from a sociopsychological standpoint. It specifically assesses the potential behavioral determinants of the individual, with clear weaknesses in the domains of *Knowledge* and *Environmental context and resources.* Thus, an innovative way to approach this research investigation would be to use both frameworks to assess the gaps and implementation issues (Skolarus and Sales, 2015). The CFIR, which is primarily used in qualitative research, could be used to assess the contextual factors related to implementation effectiveness and the findings could inform a TDF questionnaire to assess the behavioral determinants of healthcare professionals within the collaborative.

2.5 Conclusion

Quality improvement collaboratives can play an important role in fostering improvement efforts and improving healthcare. It's essential for collaborative leaders to determine the factors that effectively change the behaviors of targeted individuals and gain the use of an evidence-based innovation. Research in this area is mixed and there are still major gaps in this literature. There are few theoretically-based studies that have

assessed the factors that can shape the beliefs, attitudes, and intentions of the

individual healthcare provider involved in the collaborative (Nadeem et al., 2013).

     I have proposed an innovative way to use two theoretically based frameworks to

study the barriers and facilitators of implementation with a collaborative. The

Theoretical Domains Framework is primarily focused on the participants within the

collaborative and the antecedents to their behavior—behavioral intentions, attitudes,

and beliefs. The Consolidated Framework for Implementation Research focuses more

broadly on the social and structural patterns and processes that can shape the

provider's attitudes, beliefs and intentions. Together, they provide a comprehensive

assessment of the facilitators and barriers to implementation within the collaborative.

The next chapter will focus more specifically on the research design and methods.

Chapter 3. Research Design and Methods

In this chapter I describe the research design and methods I used to address my research questions. I begin with the rationale for my research design and then describe the research sample. I conclude by providing a detailed description of my multimethod approach and analysis, which includes participant observation, historical document review, semi-structured interviews, and survey research.

3.1 Introduction

The purpose of this multimethod study is to gain a better understanding of the multi-level influences within a quality improvement collaborative and provide insights into the determinants of success for implementing evidence-based practices. Through a careful examination of the individual, organizational, and environmental factors influencing the behavioral intentions of the physicians, it is my intent to provide a detailed characterization of barriers and facilitators of implementation. To do this, I look specifically at what happens when an evidence-based practice is disseminated and implemented within a physician-led quality improvement collaborative. My research questions, as restated from Chapter 1, are:

1. What factors influence physicians' intentions to follow evidence-based practice?

2. How was the quality improvement collaborative formed and how is it organized?

3. What are the interactions between the collaborative leaders and the individual physicians participating as collaborative members and how do these interactions support the physicians' uptake of the innovation?

4. What are the interactions among physicians from the same practice participating in a collaborative and how do these interactions support physicians' uptake of the innovation?

5. What are the social and environmental factors that influence physicians participating in a collaborative to develop intentions to follow the evidence-based practice?

The purpose statement and research questions place emphasis on understanding and characterizing social interactions and contextual factors that shape and influence the behavior of the individuals within the collaborative. The collaborative focus implies a need to study the history, structures, and processes of the organization itself. I therefore designed this study as a multimethod project to gather a variety of qualitative and quantitative data using participant observation, historical document review, semi-structured interviews, and survey research (See Figure 3). These methods were chosen for several reasons.

First, the most appropriate research design for studying the organization and processes of the collaborative was inductively with qualitative data. The participant observation research, semi-structured interviews, and historical document review allowed me to get a better understanding and characterization of the social interactions between the collaborative Coordinating Center and the member practices. As well,

these methods enabled me to gather rich data on the historical perspective of the collaborative, which was useful to understand how the collaborative was formed and organized over time.
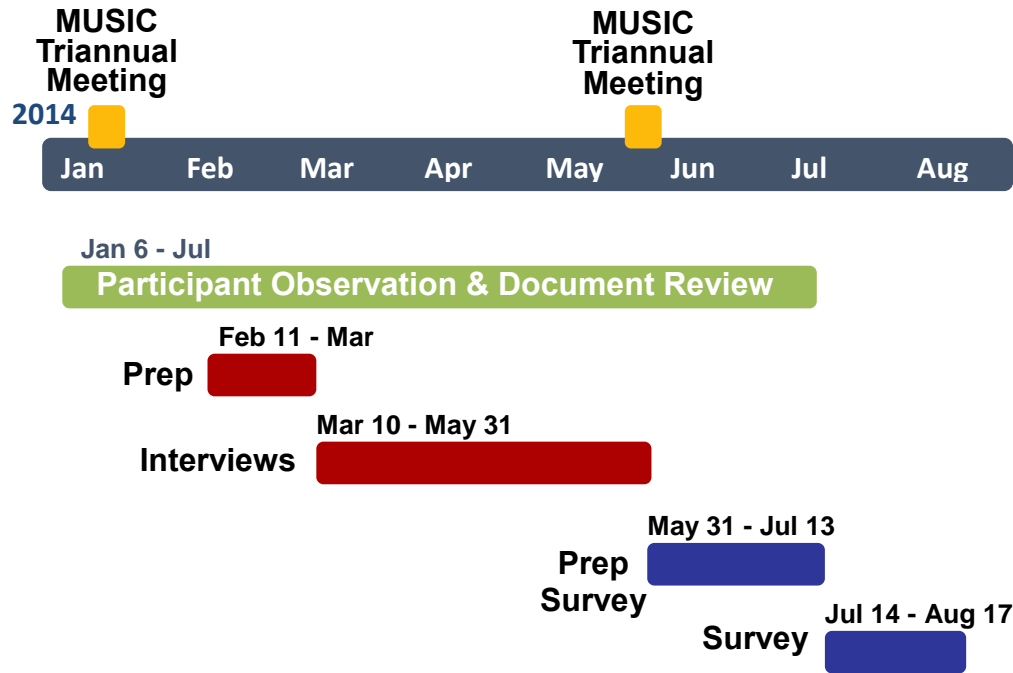
Figure 3. An overview of the dissertation research timeline.

Semi-structured interviews were also used to gather context-sensitive qualitative data at the practice-level. These interviews were conducted with a purposeful sampling of key informants from each practice in order to get a deeper understanding of the context (i.e. patients and resources in the environment) and social interactions (e.g. leader engagement) from a variety of perspectives. After the data was collected, I used a qualitative comparative analysis with high and low implementation practices to help better understand and further characterize the individual, organizational, and environmental factors impacting the uptake and use of the evidence-based practice.

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I also chose to use survey methodology to further examine the factors

influencing the behavioral intentions of the physicians. The Theoretical Domains

Framework questionnaire by Huijg et al. (2014) as well as the findings from the

qualitative research helped to inform the development of this questionnaire. This survey

was helpful as it allowed me to reach all the population of physicians within the

collaborative. It also helped to test the reliability of the qualitative results and

strengthen the robustness of the conceptual model.

3.2 Research Site and Sample

Because my intent was to understand the inner workings of collaborative and

the member practices, it was important to select a study site that would allow maximum

exposure to all aspects of the organization itself. In this case, however, the site and

study sample weren't purposefully selected; rather it was based on opportunity. I was

approached by Dr. David Miller, the co-director of the Michigan Urological Surgery

Improvement Collaborative (MUSIC), to study the implementation efforts within the

collaborative. As Dr. Miller explained, they were interested in studying the

implementation efforts of a recently disseminated evidence-based practice change. This

innovation, called the imaging appropriateness criteria, was developed using the

collaborative's historical imaging data in an effort to improve the quality of care related

to the overuse of bone and CT scans when it was not medically necessary and the

underuse of bone and CT scans when it was medically necessary. This was opportune

time as the collaborative had just disseminated the innovation at the time this research

started.

The Michigan Urological Surgery Improvement Collaborative is a physician-led quality improvement collaborative that is comprised of a partnership between Blue Cross Blue Shield of Michigan, who funds the collaborative, and the Department of Urology at the University of Michigan, who functions as the Coordinating Center. The Coordinating Center is physically located in a research building at the north campus research complex of the University of Michigan. The staff of the Coordinating Center manages the daily operations and coordinates the efforts of the collaborative. The majority of field research was conducted from this site.

In total there were 32 member practices and over 200 physicians in the collaborative when this research was conducted, which comprised over 80% of the urology practices from throughout Michigan (See Figure 4). Practice in this sense consisted of the urologists who organized together to provide urology services. The urology practices in the collaborative ranged in size from a single urologist to a larger practice with upwards of 18 urologists. There were also two larger urology groups that were comprised of multiple urology practices (this is best described as a collaborative within the MUSIC collaborative). However, despite the fact that some of the practices were embedded within a larger organization, the individuals in the practice itself were considered to be the exclusive members of the collaborative. For example, the urologists in the Department of Urology within the University of Michigan were all considered members of the collaborative and not the University of Michigan Health Center.

Although this collaborative spanned across a regional area within the state of

Michigan, it's important to understand there was considerable heterogeneity with

respect to the environmental context the urology practices were embedded within. For

example, the practices in northern Michigan were mostly located in rural areas with

limited specialty care support, while others were within major urban cities, such as

Detroit, with multiple urology practices and large academic medical centers competing

in the same area. Additionally, in some areas there was little diversity with respect to

patient demographics, while in others they were quite diverse. Also, some areas had

Figure 4. Map depicting the urology practices in Michigan

more patients who appeared to have resource constraints, such as a lack of insurance, while other locations had more affluent patients with little resource issues.

The urology practices actively collected patient-level data in the collaborative's data registry. This enabled the collaborative to analyze trends in the diagnosis and treatment of prostate cancer patients. The data revealed there was overuse of bone and CT scans for staging prostate cancer patients when it wasn't clinically necessary and underuse when it was clinically necessary. In addition to this, the urology guidelines and best practices from the leading authorities within the profession were somewhat ambiguous and passive. This provided an opportunity to improve the quality of care for prostate cancer patients.

Consequently, the collaborative developed and disseminated an evidence-based practice known as the imaging appropriateness criteria. These criteria focused on improving the overuse and underuse of bone and CT scans when staging newly diagnosed prostate cancer patients. Although similar in concept, the criteria were a change from the existing professional guidelines and best practices. They were developed based on local patient data and more definitive than the national criteria. This was first major innovation of MUSIC, which provided a tremendous opportunity for studying their implementation efforts.

3.3 Field Research Methods to Study the Collaborative

The first study of this dissertation was focused on the collaborative as a whole and the activities of Coordinating Center. In order to conduct a careful examination of the organization and social interactions, I collected a variety of qualitative data using

multiple methods. Each method provided access of different aspects of the Coordinating

Center and the larger collaborative. Together, they enabled me to assemble a more

complex understanding of history of the collaborative, how it's organized, and the social

interactions and coordination work involved. My data collection methods included:

participant observation, semi-structured and unstructured interviews, and historical

document review.

I used participant observation to immerse myself in the Coordinating Center

activities. More specifically, for seven months I became one of the (non-salary) research

members of the Coordinating Center staff. My role was to study the implementation

efforts of the collaborative and help develop strategies to improve MUSIC's

implementation effectiveness (quality improvement focused). I established an office

location in the Coordinating Center headquarters from January to July of 2014. During

this time I interacted with the Coordinating Center staff on a daily basis and attended

their weekly staff meetings.

I also had a considerable amount of field work outside of the Coordinating

Center. I was tasked to conduct field site visits to each of the 32 urology practices to

assess barriers and facilitators of their implementation efforts (the interviews from this

were used for the comparative case study). These visits were conducted from March

until May of 2014 with Andrew Brachulis, the Quality Coordinator for MUSIC. I also

attended MUSIC's tri-annual meetings in January, May, and October of 2014 to observe

the interactions among the collaborative participants and the Coordinating Center staff.

In addition, I attended several dinners and formal practice visits with the Coordinating Center staff (these visits were purposefully planned to help improve performance and/or onboard new urology practices). Thus, my role as a participant enabled me access to the inner workings of the Coordinating Center and to each of the urology practices, where I otherwise would have had a difficult time.

I also wanted to gain a better understanding of the history of the collaborative and how it was organized. I conducted unstructured interviews with each member of the Coordinating Center staff and two staff representatives for Blue Cross Blue Shield of Michigan (This was in addition to our regular conversations). These interviews were generally focused on the person's role and responsibilities, their historical knowledge of the collaborative, and their recommendations for improvement. These interactions helped to identify previous publications, draft manuscripts, and historical information about the collaborative. As well, I gained access to imaging performance data in the collaborative's data registry. Because of this, I had the opportunity to examine the collaborative's bone and CT scan imaging usage rates over time to determine the collaborative's overall effectiveness at implementing the evidence-based change.

There was an overwhelming amount of data collected during these seven months of time. On a daily basis I took both hand written and typed field notes. I kept all reports, emails, and correspondence from the Coordinating Center staff. I also digitally recorded our formal conversations during the weekly meetings and the tri-annual meetings. However, I did not have all these recordings transcribed, as it was too much information. Rather, I listened to the recordings and used the pertinent information to

strengthen my field notes and memos. On a weekly basis I created an analytic memo to capture my reflections and thoughts of the data. I then used all of this data to paint a comprehensive picture of the collaborative and the Coordinating Center activities.

3.4 Comparative Case Study Analysis of Barriers and Facilitators

Practice Selection and Study Participants

This part of the dissertation was intended to explore the barriers and facilitators to implementation within the urology practice. Thus, the unit of analysis, or case, for this part of the study was determined to be the urology practice. There were 32 practices visited and over 110 interviews conducted during this research. I looked specifically at how the imaging appropriateness criteria was disseminated and implemented within each practice. The amount of data collected during this time was overwhelming (2,139 pages of transcript from the interviews alone). Because of this, and because I wanted to isolate the factors that contributed to implementation success, I used a comparative case study analysis of four urology practices.

The sample of cases was purposefully selected based on their performance in implementing the imaging appropriateness criteria. There were four cases that represented the extreme ends of performance: two of the practices had the highest implementation effectiveness (practice 1 and 2; See Table 3) and two had the lowest implementation effectiveness (practice 3 and 4). Implementation effectiveness was measured by the practice's imaging performance with regards to the criteria. More specifically, this was the percent of imaging studies (both bone and CT scans) that were ordered in accordance with the imaging appropriateness criteria. The pre-innovation

period was assessed with these criteria to get a baseline performance. Additionally, the

cases were further chosen by matching high and low implementing practices by size and

wave of entry into the collaborative. This helped to control for the effects of time and

organizational size for the comparative analysis.

Table 3. High and Low Implementation Practices

Practice	Size	Pre-innovation		Post-innovation	
		# cases (n)	% correct*	# cases (n)	% correct*
1	Medium	270	90.7	177	97.2
2	Small	22	95.5	110	93.6
3	Small	113	73.4	112	68.7
4	Medium	99	65.7	83	66.3

* % correct reflects the percent of the imaging studies that were ordered in accordance
with the imaging appropriateness criteria

Semi-structured interviews were then sought from key informants from each of

the practices, who included the clinical champion, lead nurse or medical assistant,

practice administrator, and data abstractor (See Table 2). There was variation, however,

with respect to the data abstractor position as it did not exist in all four practices. For

example, the data abstractor responsibilities were sometimes covered by the

administrator or medical assistant. Additionally, there was another physician

interviewed at practice 2. In total 14 people were interviewed.

Table 4. Comparison of Interviewees by Practice

Practice	Clinical Champion	Practice Manager	Nurse or Medical Assistant	Data Abstractor	Other
1	Yes	Yes	Yes	Yes	No
2	Yes	Yes	Yes	No	Physician
3	Yes	Yes	Yes	No	No
4	Yes	Yes	Yes	No	No

Participants were assured that responses would be de-identified and aggregated to maintain anonymity. Each person verbally consented at the start of the interview and was asked for permission to record interview. No incentive was offered for the interview. Interviews were conducted in private areas by myself and a member of the central collaborative staff.

Data Collection Procedures

The CFIR was used to inform the development of the semi-structured interview guide. There were 34 of the 37 constructs being assessed. The questions for each construct were developed from a previously validated CFIR interview guide (Damschroeder and Lowery, 2013). Two interview guides were developed. Because most clinical support staff didn't know about the imaging appropriateness criteria or the implementation of the innovation, a shorter interview guide than that used with physicians was created, which dropped items related to the imaging appropriateness criteria. For all interviews, the questions were kept open-ended in nature and respondents were probed for elaboration to facilitate the narrative. Open narrations were encouraged to allow respondents to address information they thought was important.

The first set of questions asked about the respondent's role within the practice. The next set of questions assessed the respondent's knowledge and perceptions of the imaging appropriateness criteria along with the process of implementation within their practice, including a self-rated assessment of the difficulty and success of implementation. Next, questions focused on the process of receiving newly diagnosed

prostate cancer patients and how the urologist identified the imaging requirements. For example, the process generally started from the first patient visit and spanned to placing the order for imaging. This was done in an effort to assess the physician-patient interaction as well as the staff-physician interaction during this process. The final group of questions focused on potential factors of influence from the inner and outer setting. The last few items specifically targeted the respondent's perception of the collaborative. The physician interviews typically lasted one hour and support staff interviews ranged from 10 to 45 minutes. For analysis, interviews were recorded, professionally transcribed verbatim, and checked for accuracy. The 14 interviews produced 190 pages of transcripts for review.

Qualitative Data Coding and Case Memos

Transcripts were imported into NVivo Version 10 and coded using the CFIR framework. Additional codes were added for inductively derived themes. To increase coding validity, a coding guidebook was developed and reviewed by a qualitative expert. In addition, an expert in CFIR qualitative analysis reviewed the coding of the initial transcripts. NVivo reports of the aggregate responses were used to develop case summary memos, which were organized by CFIR domain.

Rating of the CFIR Constructs

Each of the CFIR constructs was provided a rating. This helped to systematically summarize the code and display the information in a matrix in order to perform the comparison across the cases (Ragin, 2009). The rating criteria developed by Damshroder and Lowery (2013) were used to guide assignments of the ratings (see Table 1). The

ratings reflect the valence and strength of each construct. For valence, a positive rating

suggests the construct had a positive influence on the organization or was facilitating

implementation efforts, while a negative rating indicated the construct had a negative

influence or was impeding the implementation efforts. The rating assessment was as

follows: +2 or -2 for explicit examples of how the construct manifested in the practice;

+1 or -1 for general comments about the construct; 0 for neutral statements. Missing

indicated there was no data collected. When the ratings were completed for all five

cases, the rating for each construct was compared across cases to help ensure

consistent application of ratings.

Within the qualitative analyses, I sought to identify differences between high and

low implementation urology practices. A summary matrix was created to facilitate the

comparative analysis. The matrix listed the ratings for each CFIR construct by case,

which allowed for analyzing patterns across the practices. The two urology practices

with high imaging criteria compliance were grouped together to compared with the two

practices with low compliance. This helped to identify distinguishing patterns between

high and low implementation urology practices. In line with the research from

Damshroder and Lowery (2013), the constructs were categorized in the following

manner: missing too much data, not distinguishing between low and high

implementation urology practices, and weakly or strongly distinguishing between low

and high implementation urology practices. The assignment was a judgement based on

the spread and pattern between the high and low implementation practices. For

example, if both high implementation practices were rated as +2 and the low practices

were -2, the construct was determined to be strongly distinguishing. If there was any

variation from this, it was assessed into the other categories.

Table 5. Criteria Used to Assign the Rating to Constructs

Rating	Criteria*
+2	The construct is a positive influence in the organization, a facilitating influence in work processes, and/or a facilitating influence in implementation efforts. The interviewee(s) describes explicit examples of how the key or all aspects of a construct manifests itself in a positive way.
+1	The construct is a positive influence in the organization, a facilitating influence in work processes, and/or a facilitating influence in implementation efforts. The interviewee(s) make general statements about the construct manifesting in a positive way but without concrete examples.
0	A construct has neutral influence if it appears to have neutral effect or is only mentioned generically without valence or there is no evidence of positive or negative influence.
-1	The construct is a negative influence in the organization, an impeding influence in work processes, and/or an impeding influence in implementation efforts. The interviewee(s) makes general statements about the construct manifesting in a negative way but without concrete examples.
-2	The construct is a negative influence in the organization, an impeding influence in work processes, and/or an impeding influence in implementation efforts. The interviewee(s) describes explicit examples of how the key or all aspects of a construct manifests itself in a negative way.
Missing	The Interviewee(s) was not asked about the presence or influence of the construct or if asked about a construct, their responses did not correspond to the intended construct and were instead coded to another construct.

*Adapted from Damschroder and Lowery (2013)

3.5 Survey Methods to Assess Determinants of Behavioral Intention

This project was conducted in four stages: formulation of survey items, survey

administration, psychometric analysis, and testing the behavioral intention.

Formulation of Survey Items

The questionnaire development was guided and informed by the finding from

the semi-structured interviews. First, individual survey items were reviewed and

selected from the TDF questionnaire of Huijg et al. (2014). In total, 18 items were

selected to address the following 10 domains of the TDF (See table 6): Knowledge,

social/professional role and identity, beliefs about capabilities, beliefs about

consequences, reinforcement, intentions, environmental context and resources,

memory/attention and decision processes, social influences, emotion, and behavioral

regulation. Based on the interviews, and feedback from the pilot survey, items from the

domains skills, optimism, goals and emotion were not selected to be measured (an item

measuring goals was in the domain behavioral regulation). Of the 16 items selected, 10

were shown to have discriminant content validity by Huijg et al. (2014).

Next, new items were developed to measure other possible factors of influence

identified in the qualitative analysis. In total there were 16 items covering the following

five domains: Knowledge, beliefs about consequences, environmental context and

resources, social influences, and behavioral regulation. There were three items in the

domain Knowledge developed to measure the urologist's knowledge and beliefs of the

scientific evidence related to the imaging appropriateness criteria (Table 6, items 3-5).

The additional item covering the Beliefs about consequences domain (Table 6, item 14)

was focused on beliefs of legal outcomes. Five additional items were added to measure

the domain of Environmental context and resources, focusing on imaging resources

(Table 6, items 24 and 25) and other potential patient influences from the environment

(Table 6, items 20-22). And finally, an additional item was added to the Behavioral

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regulation domain to measure the respondent's belief that they contributed to the success of the criteria (Table 6, item 34).

There were six items developed to measure the social interactions and other professional role issues within the work environment. The first two items were added to measuring the urologist's view of the clinical staff assisting with identifying imaging requirements (Table 6, items 7 and 8). These items were added to strengthen the measures for domain Social/professional role and identity. Four other items were added to measure the domain Social influences. One item was added to measure social support (Table 6, item 27); that is, if the support staff members could remind the urologist of the criteria when it was ordered contrary to the criteria. The other three items were added to measuring the social influence of the collaborative itself (Table 6, items 28-30).

This process led to a final list of 34 items covering ten domains. Four domains were not used because the interview findings as well as feedback from the urologists indicated they didn't warrant assessment in the questionnaire (i.e. the urologists' felt the domain skills did not need to be assessed). The survey was piloted with five urologists from the collaborative and four PhD researchers from the University of Michigan. Feedback from these experts helped rephrase the items in an effort to increase content validity. A few significant adjustments were recommended on some of the TDF-based items.

The first two TDF items were under the domain Beliefs about consequences. The first item was originally worded "If I follow MUSIC's imaging appropriateness criteria

when ordering bone and CT imaging studies it will benefit public health." It was felt that

public health was too broad of a category. This item was changed to "If I follow MUSIC's

imaging appropriateness criteria it will have a broader impact on prostate cancer care."

This reworded item was believed to still measure the same domain (Table 6, item 12).

The next item under this domain was "If I follow MUSIC's imaging appropriateness

criteria it will disadvantage my relationship with my patients with prostate cancer." The

content of this item was believed to be measured with another item on the

questionnaire. Additionally, there were no other items measuring the influence of other

radiologists (physicians who specialize in imaging). Thus, the item was changed to "If I

follow MUSIC's imaging appropriateness criteria it will disadvantage my relationship

with my radiology colleagues." Although this item originally had discriminant content

validity, the reworded item was now believed to measure the domain Environmental

context and resources, as radiologists would normally influence the behavior of the

urologists from external context of the practice (Table 6, item 22).

The next item was under the domain Environmental context and resources. It

was originally worded as "Within the socio-political context, there is sufficient financial

support (e.g., from local authorities, insurance companies, the government) to order

bone and CT imaging studies for staging patients with prostate cancer in accordance

with MUSIC's imaging appropriateness criteria." This item was believed to be too wordy,

so it was changed to "My patients have sufficient financial resources (e.g. insurance

coverage) to order bone and CT scans in accordance with MUSIC's imaging

appropriateness criteria." This reworded item was believed to still measure the construct of resources under the same domain (Table 6, item 18).

The final item that was adjusted fell under the domain Behavioral regulation. The item was originally worded as "Ordering bone and CT imaging studies for staging patients with prostate cancer is something I do without thinking." The physicians that reviewed the original questionnaire didn't feel this was appropriate. Thus, it was rewritten to say "Ordering a bone and CT scan is something I always do when staging patients with newly-diagnosed prostate cancer." The item was still believed to measure the construct of automaticity under the domain Behavioral regulation (Table 6, item 31).

The items were organized into five sets of questions (See MUSIC Survey). The first set of questions were focused more generally on ordering bone and CT scans when staging newly diagnosed prostate cancer patients. The second set was focused more specifically on beliefs and attitudes towards the imaging appropriateness criteria. The third set of questions was focused on factors that could influence their decision to order imaging and the fourth set covered MUSIC in general.

The final set of questions was added as controls (Table 6, items C1-C5). The controls included a single item to determine if the respondents provided prostate cancer care. If they indicated they didn't provide prostate cancer care, the survey logic jumped to the set of questions at the end related to the collaborative. Three questions were added to control for the individual characteristics of the respondents: the volume of their practice that was prostate cancer care (volume), the number of years since completing their residency (experience), and if they were a clinical champion for the

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collaborative (champion). The final question measured the number of urologists in the

urology practice (practice size). The wave of entry, measuring when the practice joined

the collaborative, was added later to control for the effects of experience or time within

the collaborative.

Table 6. TDF and Interview Items for the MUSIC Questionnaire

	Domain	Item	Response	Source	Discriminant Content Validity
0	Control	Do you provide care related to the diagnosis and/or treatment of patients with prostate cancer?	Yes or No	N/A	N/A
1	D1 Knowledge	I am aware of the content and objectives of MUSIC's imaging appropriateness criteria	(Strongly disagree – strongly agree)	TDF	Yes
2	D1 Knowledge	I know the content and objectives of MUSIC's imaging appropriateness criteria	(Strongly disagree – strongly agree)	TDF	Yes
3	D1 Knowledge	I believe there is enough evidence to justify following MUSIC's imaging appropriateness criteria	(Strongly disagree – strongly agree)	Interviews	N/A
4	D1 Knowledge	I believe MUSIC's imaging appropriateness criteria are equivalent to the imaging guidelines in the American Urological Association's (AUA) PSA Best Practice statement	(Strongly disagree – strongly agree)	Interviews	N/A
5	D1 Knowledge	I believe MUSIC's imaging appropriateness criteria are equivalent to the imaging guidelines in the National Comprehensive Cancer Network's (NCCN) clinical practice guidelines for prostate cancer	(Strongly disagree – strongly agree)	Interviews	N/A
6	D3 Social/ professional role and identity	It is my responsibility as a physician to identify when a patient requires a bone or CT scan when staging newly-diagnosed prostate cancer	(Strongly disagree – strongly agree)	TDF	Yes
7	D3 Social/ professional role and identity	In my established clinic work-flow, midlevel providers (i.e. nurse practitioner or physician assistant) help me identify when a patient requires a bone or CT scan when staging newly-diagnosed prostate cancer	(Strongly disagree – strongly agree)	Interviews	N/A
8	D3 Social/ professional role and identity	In my established clinic work-flow, support staff (i.e. registered nurse or medical assistant) help me identify when a patient requires a bone or CT scan for staging newly-diagnosed prostate cancer	(Strongly disagree – strongly agree)	Interviews	N/A
9	D4 Beliefs about capabilities	How much control do you have when ordering bone scans when staging patients with newly-diagnosed prostate cancer?	(No control at all – a lot of control)	TDF	No
10	D4 Beliefs about capabilities	How much control do you have when ordering CT scans when staging patients with newly-diagnosed prostate cancer?	(No control at all – a lot of control)	TDF	No
11	D6 Beliefs about consequences	For me, MUSIC's imaging appropriateness criteria are…	(Useless – useful)	TDF	No
12	D6 Beliefs about consequences	If I follow MUSIC's imaging appropriateness criteria it will have a broader impact on prostate cancer care	(Strongly disagree – strongly agree)	TDF	Yes

13	D6 Beliefs about consequences	I believe MUSIC's imaging appropriateness criteria will hold up to legal scrutiny	(Strongly disagree – strongly agree)	Interviews	N/A
14	D7 Reinforcement	How often do you get financial reimbursement when ordering bone scans?	(Never – always)	TDF	No
15	D7 Reinforcement	How often do you get financial reimbursement when ordering CT scans?	(Never – always)	TDF	No
16	D8 Intentions	I will definitely follow MUSIC's imaging appropriateness criteria over the next month	(Strongly disagree – strongly agree)	TDF	Yes
17	D10 Memory, attention and decision processes	How often do you remember MUSIC's imaging appropriateness criteria when ordering a bone or CT scan for staging a patient with newly-diagnosed prostate cancer?	(Never – almost always)	TDF	Yes
18	D11 Environmental context and resources	My patients have sufficient financial resources (e.g. insurance coverage) to order bone and CT scans in accordance with MUSIC's imaging appropriateness criteria	(Strongly disagree – strongly agree)	TDF	Yes
19	D11 Environmental context and resources	I would follow MUSIC's imaging appropriateness criteria regardless of patient demographics, such as age, race, ethnicity or socioeconomic status	(Strongly disagree – strongly agree)	Interviews	N/A
20	D11 Environmental context and resources	Even if it's NOT indicated in accordance with the MUSIC's imaging appropriateness criteria, I feel the need to order a bone and CT scan to protect myself legally	(Strongly disagree – strongly agree)	Interviews	N/A
21	D11 Environmental context and resources	Even if it's NOT indicated in accordance with the MUSIC's imaging appropriateness criteria, I feel the need to order a bone and CT scan when a patient requests it	(Strongly disagree – strongly agree)	Interviews	N/A
22	D11 Environmental context and resources	If I follow MUSIC's imaging appropriateness criteria it will disadvantage my relationship with my radiology colleagues	(Strongly disagree – strongly agree)	TDF	Yes
23	D11 Environmental context and resources	Even if it IS indicated in accordance with the MUSIC's imaging appropriateness criteria, I feel that I don't need to order a bone and CT scan because it's a waste of resources	(Strongly disagree – strongly agree)	Interviews	N/A
24	D11 Environmental context and resources	If I order a bone scan to stage a newly diagnosed prostate cancer patient, and the results are negative, I feel that I don't need to order a CT scan because it's a waste of resources	(Strongly disagree – strongly agree)	Interviews	N/A
25	D12 Social influences	Most physicians who are important to me think I should order a bone and CT scan in accordance with MUSIC's imaging appropriateness criteria	(Strongly disagree – strongly agree)	TDF	Yes
26	D12 Social influences	Most physicians whose opinion I value would approve of me ordering a bone and CT scan in accordance with MUSIC's imaging appropriateness criteria	(Strongly disagree – strongly agree)	TDF	Yes
27	D12 Social influences	My clinical support staff can remind me of MUSIC's imaging appropriateness criteria when I order a bone scan or CT scan contrary to the indications	(Strongly disagree – strongly agree)	Interviews	N/A
28	D12 Social influences	I believe that I am a valued member of the MUSIC?	(Strongly agree – strongly disagree)	Interviews	N/A
29	D12 Social influences	What is your overall satisfaction with MUSIC?	(Very satisfied - - very dissatisfied)	Interviews	N/A

30	D12 Social influences	Considering your experience with MUSIC, how likely would you be to recommend MUSIC to other urologists who are not associated with the collaborative?	(Very likely -- very unlikely)	Interviews	N/A
31	D14 Behavioral regulation	Ordering a bone and CT scan is something I always do when staging patients with newly-diagnosed prostate cancer	(Strongly disagree – strongly agree)	TDF	No
32	D14 Behavioral regulation	I keep track of my overall progress towards MUSIC's goals for imaging appropriateness	(Strongly disagree – strongly agree)	TDF	No
33	D14 Behavioral regulation	I have a clear plan of how I will order bone and CT scans in accordance with MUSIC's imaging appropriateness criteria	(Strongly disagree – strongly agree)	TDF	No
34	D14 Behavioral regulation	I believe I have contributed to the success of MUSIC's imaging appropriateness criteria	(Strongly disagree – strongly agree)	Interviews	N/A
C1	Control	What is the estimated percentage of your clinical volume that relates to prostate cancer?	(0-100%)	N/A	N/A
C2	Control	What year did you finish your residency training?	Year	N/A	N/A
C3	Control	Are you the designated clinical champion for MUSIC related activities?	Yes or No	N/A	N/A
C4	Control	How many urologists are in your practice?	(1-4, 5-10, >10)	N/A	N/A
C5	Control	What is the wave of entry into the Michigan Urological Surgery Improvement Collaborative?	1 to 4	N/A	N/A

Survey Administration

There were 153 urologists from 32 urology practices invited to participate in the survey. The inclusion criteria included any urologists in the collaborative who had a single prostate cancer patient in the collaborative's data registry. The survey was conducted using a Qualtrics web-based survey.

Data were collected between July and August 2014. Reminder emails were sent to the non-respondents approximately every 10 days after the initial email invitation was sent. Participants were informed that the questionnaire would take no more than ten minutes to complete and it was entirely voluntary. No personally identifiable information was collected and the respondents were told that their responses would be confidential and anonymous. No incentive was offered for the survey completion.

Psychometric and Statistical Analyses

The individual items were rated using a five-point Likert scale. Estimates of internal consistency were calculated using Cronbach's alpha. The correlation coefficients were calculated using Pearson's correlation and defined as low (0.0 to 0.39), moderate (0.40 to 0.69), or high (0.70 to 1.0).

An exploratory method was used to investigate the factor structure of the items and to determine how the new interview items were associating with the already known items from the TDF questionnaire of Huijg et al. (2014). Using a principal component analysis with a Varimax rotation, the items were fit to the domain based on face validity of the item, the rotated factor loading, and the internal consistency (Cronbach's alpha) of the factor. The extraction criteria consisted of an eigenvalue of 1.0 and a Varimax method for matrix rotation. The resulting factors were labelled based on their component domains.

The final sample was relatively small and there were a large number of items to investigate. Psychometricians suggest that a minimum of 10 respondents per item are needed to produce reliable estimates (Nunnaly, 1978). Thus, the exploratory factor analysis was conducted with fewer items (a sub-sample) in an effort to remove excess "noise" and produce more stable results. In the sub-sample of items, the TDF domain was the unit of analysis for each factor analysis. This meant that a factor analysis was run separately for each domain.

The resultant theoretical domains were further analyzed to gain a better understanding of their underlying domain structure. For each of the domains a mean score was tallied. To do this, a mean value was calculated by summing the individual

item scores and dividing by the number of items in the domain. Additionally, a 95%

confidence interval was calculated for each domain. A low mean value for the domain

suggests that it may be a barrier for implementing the imaging appropriateness criteria,

while a higher mean value suggests that that particular domain may help facilitate the

implementation.

Test of Behavioral Intention

To test the relation between the intentions and the potential behavioral

determinants, I drew upon the Theory of Planned Behavior from the conceptual model

(Ajzen, 1991). This theory posits that attitudes, subjective norms, and perceived

behavioral control shape a person's intention to behave. Behavioral intentions are

assumed to capture the motivational factors that influence a behavior.

A regression model was used to examine the relationships of the attitudes,

subjective norms, and perceived behavior control with the intent to follow the imaging

appropriateness criteria. The dependent variable for the model was the single item

measuring intent to follow the imaging appropriateness criteria (Table 6, item 16): "I will

definitely follow MUSIC's imaging appropriateness criteria over the next month."

The first determinant of behavioral intention is the attitude toward the behavior.

This refers to the degree to which a person has a favorable or unfavorable evaluation of

the imaging appropriateness criteria. For this study, the attitude towards the imaging

appropriateness criteria was measured with the following single item (Table 6, item 11):

"For me, MUSIC's imaging appropriateness criteria are… (useful)." The second predictor

of behavioral intention is subjective norm. This refers to the perceived social pressure to

perform or not to perform the behavior. The newly constructed factor for the domain

Social influence (Subjective Norms) was used to assess the influence of subjective norms

on behavioral intent. The third determinant of intention is the degree of perceived

behavioral control. This refers to the perceived ease or difficulty of performing the

behavior. The newly constructed factor for the domain Beliefs about capabilities was

used to assess perceived behavioral control on behavioral intent.

Subsequent regression models were conducted to explore the newly constructed

factors representing the theoretical domains and their relationship with behavioral

intention. The regression models controlled for volume of prostate cancer care

(volume), years of clinical experience (experience), clinical champion, and practice size.

The standardized beta coefficients and asterisks denoting significant p-values are

reported. All analyses were performed using Stata version 13.1 (Statacorp, 2013).

Chapter 4. The Michigan Urological Quality Improvement Collaborative

In this chapter I focus on the collaborative as a whole and the activities of the leaders and the Coordinating Center. I first provide the history of the collaborative and how it has been organized. I then provide a comprehensive description of the development and dissemination of the evidence-based practice, which helps lay the groundwork for the subsequent analysis of the implementation activities within the practices. All of the qualitative work in this chapter was conducted to answer the following research questions:

2. How was the collaborative formed and how is it organized?

3. What are the interactions between the collaborative leaders and the individual physicians participating as collaborative members and how do these interactions support the physicians' uptake of the innovation?

4.1 Collaborative Quality Initiatives in Michigan

> "Most urologists held a long-term view that if we, as specialists, did not deliver better value and outcomes in the care we provide, someone else would likely impose blunt and potentially ill-advised solutions (Montie, Linsell, and Miller, 2014)."

Early efforts of multi-organizational quality improvement collaboratives were voluntary in nature (IHI, 2003). These innovative organizations came together in a meaningful way to improve the quality of care across the collaborative. In today's healthcare industry, physician practices and other healthcare organizations often band

together to form quality improvement collaboratives in response to social, political and economic pressures to improve quality and reduce costs. In this boundary spanning activity, a group of teams from multiple sites attempt to combine efforts and share resources to improve the quality of care across the collaborative (Plsek, 1997). Several important functions of this collaborative effort include pooling data, identifying evidence-based practices, disseminating information, coordinating change strategies, reporting results, and sharing best practices (Hulscher, Schouten, Grol, & Buchan, 2013).

This organizational strategy was well established within the state of Michigan, primarily through relationships between hospitals and physician practices, the University of Michigan, and the state's largest health insurer, Blue Cross Blue Shield of Michigan (BCBSM). The first partnership originally started in 1997, when a hospital-based, regional collaborative was established between 31 hospitals and BCBSM (funding provided by BCBSM) to improve percutaneous coronary interventions. The collaborative's efforts were centered on data collection, assessment, and feedback. This larger pool of data allowed for more robust, rapid assessment of relationships between process and outcomes and of the effects of quality improvement interventions (Share et al. 2011).

The success of this program prompted BCBSM to expand their investment in regional collaborative quality initiatives (CQI) under the Value Partnership Program (Share et al. 2011).   In 2005, they formed a partnership with 34 hospitals and the University of Michigan to form the Michigan Surgical Quality Collaborative, targeting outcomes in general and vascular surgery. The following year, two additional regional

collaboratives were established to improve bariatric and cardiac surgical outcomes. The subsequent successes of these organizations had a synergistic effect, prompting an aggressive expansion into other clinical areas. Currently, BCBSM and physician leaders from the University of Michigan sponsor 14 different hospital-based CQIs and two professional CQIs throughout the state of Michigan (BCBSM, 2015).

The Michigan Urologic Surgery Improvement Collaborative (MUSIC) is one of two professional CQI programs currently sponsored by BCBSM. These professional CQI programs are physician-led collaborations (differing from hospital-based CQI). In this collaboration, urologists from across the state collect, share and analyze data. They then identify best practices and implement changes to improve patient care outcomes. The following section will describe the origin of MUSIC in more detail.

4.2 The Urological Surgery Quality Collaborative

In the backdrop of the BCBSM CQI program, the Urological Surgery Quality Collaborative (USQC) was founded in 2009. This physician-led collaborative was founded by Dr. David Miller, Dr. James Montie, and colleagues from the University of Michigan. The premise was similar to that of the BCBSM CQI program—as a collaborative, the urologist could pool data and resources to improve the practices patterns and quality of care of the group.

The first quality improvement initiative was to improve the use of imaging studies when staging newly diagnosed prostate cancer patients. At the time of this initiative, there were clinical practice guidelines established from the American Urological Association (AUA) and National Comprehensive Cancer Network (NCCN). These

guidelines provided criteria[1] for ordering bone and CT imaging studies when staging

newly diagnosed prostate cancer patients for metastatic cancer. Both of these imaging

studies help to determine if the prostate cancer is metastatic, or spread from the

prostate to other areas. A bone scan is performed to determine if the cancer has

metastasized in the bone, while the CT scan of the pelvis and abdomen is performed to

check for metastasis in the soft tissue and lymph nodes. Although there were several

professional guidelines available, there were clear trends showing unnecessary imaging

in men with low-risk[2] disease (overuse) and underuse of imaging in higher risk cancer.

For example, a study using Surveillance, Epidemiology, and End Results (SEER)-

Medicare claims data from 2004-2007 estimates that 31% of patients with apparent

low-risk prostate cancer underwent a bone scan, yet <1% of the studies were positive.

These unnecessary studies cost Medicare an estimated $2.2 million per year (Falchook,

Salloum, Hendrix, and Chen, 2014). Additionally, Falchook and his colleagues (2014)

estimate that only 62% of patients with apparent high-risk disease received a bone scan,

of which 14% were found to have metastasis. It's important to understand that failing to

diagnose metastasis could result in improper treatment as well as other complications.

The original cohort involved in the USQC included 60 urologists from three urology

practices. The administrative center was located at the University of Michigan. From

May 2009 through September 2010, each site manually collected patient-level data on a

standardized form and faxed it to the administrative center. The administrative center

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[1] Criteria are based on three diagnostic tests (PSA, clinical T stage, and Gleason score) used to stage the prostate cancer and determine the imaging requirements and treatment pathways.
[2] Cancer can be categorized as low, intermediate or high risk based on the D'Amico classification. This classification system is designed to evaluate the risk of recurrence following localized treatment of prostate cancer.

aggregated it for performance analysis. There were three phases to the study: the first

was a baseline assessment followed by two intervention periods. For both interventions,

the collaborative hosted a teleconference to discuss the imaging performance and

review the guidelines. They also provided de-identified practice-level performance to

the clinical champions to share with their partners. The clinical champions were tasked

to review and disseminate the current AUA and NCCN imaging guidelines.

The study showed the interventions (feedback on baseline use and review of

clinical guidelines) dramatically reduced variations in practice patterns and improved

adherence with recommended staging practices. Attainment of this goal would establish

legitimacy for the CQI within urology (Miller et al., 2010). More importantly, Dr. Miller

and the USQC leadership also learned organizational lessons that translated into the

development of MUSIC (Montie, Linsell, and Miller, 2014).

4.3 The Michigan Urological Surgery Improvement Collaborative

The Development of MUSIC

Drs. Miller and Montie began the effort to organize their own CQI under the

Value Partnership Program. As Dr. Miller explains, it was important to build the

foundation of the collaborative through interpersonal relationships. To get it off the

ground, they drove to numerous practices to talk with practice members about the

concept (personal communication, March 13, 2014):

> "It's absolutely essential to build the collaborative though interpersonal
> relationships and contact….this isn't some, you know, distant center that's
> collecting data and then every once in a while you get an e-mail from
> somebody you don't even know about changing something. I mean, we've

driven to almost every corner of the state. Jim Montie and I started before even the collaborative was even approved. We drove to four practices, met with them about the concept, and had their buy in before we even went to Blue Cross."

As Dr. Miller describes, the shared vision of these innovators was to establish the

infrastructure to transform prostate cancer care (personal communication, March

13, 2014):

> "It wasn't about a junior faculty member padding his or her CV—or propelling their own academic career. It wasn't about the University of Michigan trying to distinguish itself from the crowd in terms of the care delivery it performs. We thought this opportunity, this moment, this vision for Blue Cross, and this financial support, would allow us to create an infrastructure that could transform how care is delivered for men with prostate cancer in Michigan."

Little did these innovators know, however, that word of this CQI quickly spread

within the professional urology networks in Michigan, and several other urology

practices volunteered to join the collaborative directly through BCBSM:

> "So we wanted to go to Blue Cross knowing that we already had this group of practices that were going to say they'd do it. But then it so happens that about six or seven of the practices did it of their own avail, without us talking to them. So then we had to jump in the car and go visit all those practices and share our vision with them a little bit more so that they had a clear idea about what was going to happen when we hit the ground running (Dr. David Miller, personal communication, March 13, 2014)."

This momentum played a significant role in establishing the CQI. In 2010, they obtained

approval for funding from BCBSM to establish MUSIC. In total, there were 12 urology

practices in the first wave of participants.

Subsequently, the directors and Coordinating Center leaders *recruited urology*

practices to join the collaborative. The practices could join MUSIC on a voluntary basis

by submitting an application to BCBSM. Dr. Miller stated that he and Dr. Montie would

often reach out and leverage pre-existing professional relationships to recruit practices.

They would also leverage these relationships to help market the collaborative to other

practices:

> "There have been at least a few occasions where we've referred practices that were skeptical and wanted a perception of a practice that was not in academics. And we've referred them to one of the existing collaborative practices to talk to them about it, see what they say, you know, straight from the horse's mouth. Not from me or Montie, but from—someone who you may even view as more of a peer. You know, because their life, their world, their practices is more like yours than our practice is at the University of Michigan (Dr. David Miller, personal communication, March 13, 2014)."
> The recruitment efforts changed considerably after the collaborative became a

beacon of quality improvement within the professional community. Practices that were

hesitant to join seemed to be more eager to get involve with collaborative. One of the

clinical champions from a latecomer practice said they were motivated to not be an

outlier:

> Interviewer: Why did your practice join MUSIC?
> Clinical Champion: …whenever I saw that [invitation letter], however many years ago, it looked like a lot of bother and a lot of work—why are we doing this, for you know, the Blues' benefit and, you know, what's in it for us, other than hassle. So, we just let it rest and forgot about it. And then another coaxing letter from Dr. Montie and showing us who else is involved and seeing that we were one of the few outliers in the state not on board yet, and it was an embarrassment. And then to see what they had accomplished is great. [practice 10, clinical champion]

A clinical champion from another latecomer practice said he had heard about MUSIC

while working as a resident. When the senior physician of his practice asked if they

should join, he quickly jumped on the opportunity:

> Interviewer: Why did your practice join MUSIC?
> Clinic Champion: You know, I was a resident in [neighboring state], and that was the first time actually I ever heard of it. Most of the staff down there had graduated from the U of M. I think it was one of first groups to be

involved [in USQC], and then I thought it was great. So that was the first exposure I had to it. Then we came here. I think that [senior physician] mentioned to me, he said "Have you heard of this MUSIC group, Dr. Montie, Dr. David Miller? They actually contacted me. Do you want to be part?" I said absolutely, yes. This is something we should do. Like I felt it was very important to do that. [practice 20, clinical champion]

All of their hard work had paid off in a very short period of time. In total, there were 32 practices and over 200 urologists involved in MUSIC, which was over 80% in the state, when this dissertation research was conducted.

Key Elements of MUSIC

The Department of Urology at the University of Michigan became the Coordinating Center for MUSIC (the physical location was in the research building, separate of the medical campus). The directors, along with the project manager, Susan Linsell, managed the daily operations of the Coordinating Center. They were responsible for establishing the collaborative (e.g. recruiting and onboard practices), providing administrative oversight and support to the member practices (e.g. site visits for QA/QC and training) and coordinating the operations of the collaborative (e.g. meeting, innovation development, performance reports).

MUSIC *recruited experts* to fill key positions and assist as necessary. As a physician-led collaborative, each practice designated an urologist to be the clinical champion. This person interfaced with the collaborative (tasked with attending the collaborative-wide meetings) and served as the local conduit of information to the rest of providers in the group. The clinical champions were also selected to participate with the Executive Committee, Publications Committee, and several task-oriented working

groups on topics of interest. The working groups, which ranged in membership from 5-10 members, were tasked with overseeing the development of specific innovations. For example, the imaging working group provided input into the development of the imaging criteria before it was finalized and disseminated to the larger collaborative. The buy-in from this group was important for establishing validity of the projects.

One of the first major initiatives of the MUSIC was to establish the data collection system. A software vendor developed a web-based data-entry platform called the registry. Each practice identified a person to become a trained abstractor (they would abstract health record information and enter it into MUSIC's data registry). BCBSM provided financial support to the practices based on their case volume accrued in the registry. According to Montie, Linsell, and Miller (2014), this was an important "facilitator." Data entry started in 2012 for the first and second wave practices.

MUSIC established a triannual meeting (*learning sessions*) to formally meet with the clinical champions, data abstractors, and other members of the practices. The sessions were organized to review current performance, disseminate new information, and discuss future innovations. The collaborative members openly celebrated the successes of the members (i.e. publications, presentations, and other contributions) and spoke very highly about the collaborative's achievements with improving quality of care. They purposefully did not focus on negative aspects of performance, such as productivity in the registry or failing to improve. They didn't openly share experiences with implementation, per se, or receive training for change management, which was slightly different than the Breakthrough Series Model. The group did, however, ask

questions and talk about issues to resolve ambiguity and uncertainty with respect to the

imaging appropriateness criteria.

The "Change Package" typically consisted of printed materials (e.g. slide

presentation and handouts) pertinent to the meeting (See Figure 5). This information

was presented by a member of the imaging working group. This was purposefully done

to show the imaging appropriateness criteria were developed by members of the

collaborative, rather than just the leaders of the Coordinating Center.
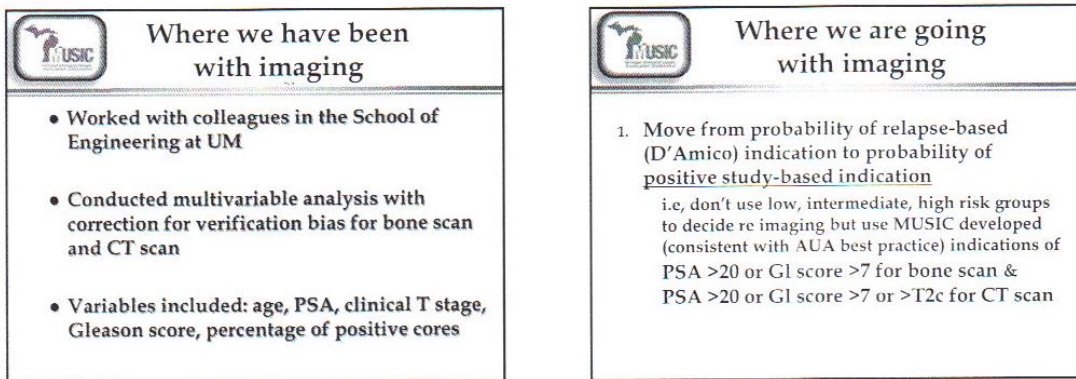
Figure 5. Example Handouts from MUSIC's Triannual Meeting

During the *action period*, the clinical champions were responsible for

implementing changes within their own practice (Of note, there was no established

model for improvement for MUSIC). Although this activity was decentralized, the leaders

of the Coordinating Center would assist as necessary to help with implementation

efforts. For example, they would share data or information (e.g. triannual meeting

slides) with the clinical champion or other members of a practice to help reduce

ambiguity and uncertainty about the innovations.

The collaborative was mindfully organized and the activities were purposeful. Dr.

Miller provided his philosophy for developing a successful CQI program (see Figure 6),

which was adopted from Dr. John Birkmeyer's work with the other CQI programs at the University of Michigan. The model depicts that early stages of social networking, data and measurements, and planning and strategy lead to meaningful improvement work over time. Additionally, as for the collaborative members, they generally start with annoyance and suspicion and move to trust, intellectual engagement, and collective pride. The actions of the collaborative drive the attitudes, beliefs, and behaviors of the collaborative members. Thus, the engagement strategies were mindfully organized in an effort to move the collaborative members through the continuum to higher levels of trust, intellectual engagement, and collective pride.
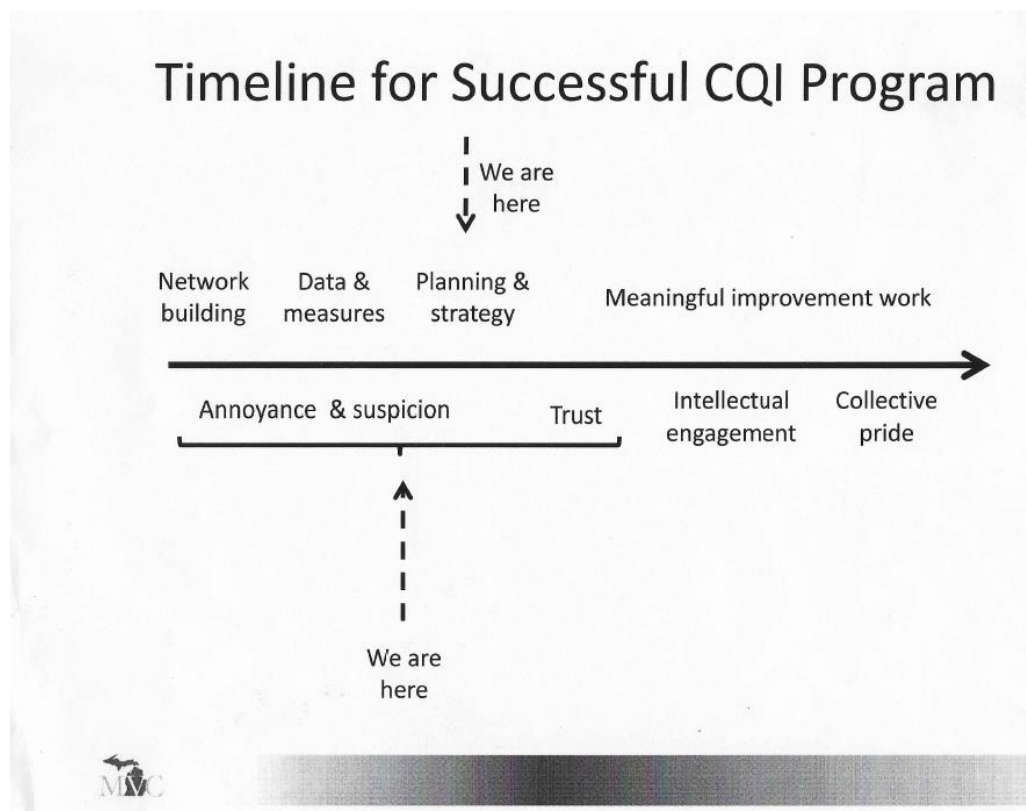
Figure 6. Timeline for establishing a successful CQI program (Dr. John Birkmeyer).

In line with this philosophy, the communication channels of the collaborative were highly interpersonal and professional in nature. Diffusion of information mainly flowed from the Coordinating Center leaders, through the practice champions, to the individual healthcare providers and the staff of the practice. The collaborative leaders mindfully delegated the dissemination and implementation activities to the leaders within the practices and they relied on the clinical champions to "champion" the work of the collaborative. Within this professional network, the physicians would often talk and email each other to get advice and pass information.

The administrative support staff of the Coordinating Center would also routinely visit practices to help train and educate staff and check data quality. This field work was primarily conducted with the clinical champion, data abstractors and support staff of the urology practices that were directly involved with MUSIC. The staff would also field daily questions and help coordinate changes across the collaborative if they realized there were systemic issues. Occasionally they would host conference calls with the data abstractors to synchronize efforts with respect to the data registry.

Data collection and performance reporting were important to the improvement efforts. The Coordinating Center staff managed the data registry which helped to share data and performance information (the website and database were hosted by an external organization). BCBSM provided funding to each of the practices so they could hire a data abstractor to extract their health record data and populate it into the data registry. These abstractors were trained by the Coordinating Center staff but were

located in each of the practices. These abstractors often acted as liaisons for MUSIC related information.

The Coordinating Center was responsible for developing the *performance measures*, analyzing the data, and providing reports to the practices. The collaborative continually worked on improving data collection and reporting to provide useful and actionable information to the practices. For example, when they disseminated the innovation at the tri-annual meeting in January, 2014, they also provided a draft of the imaging efficiency scores (See Figure 7). These efficiency scores were originally developed to quantify the collaborative's improvement and evaluate the effectiveness of the intervention.
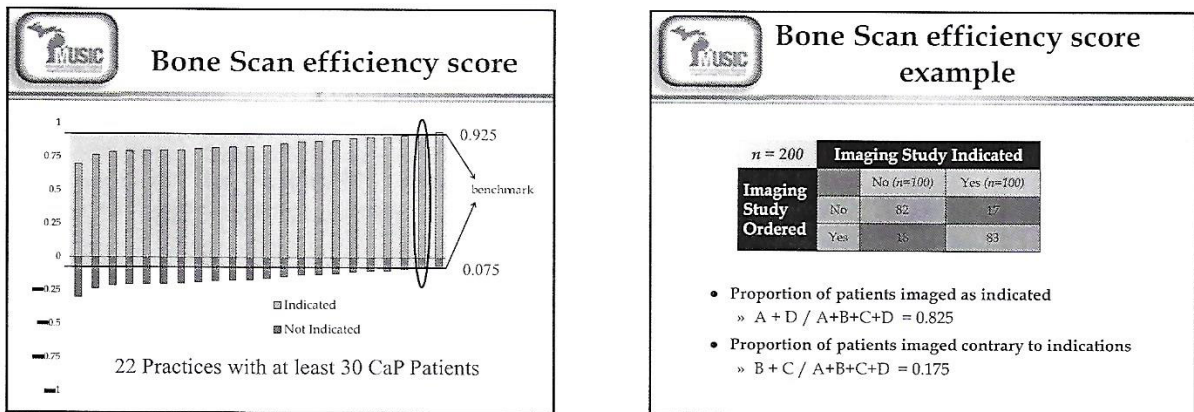
Figure 7. Presentation with the proposed bone and CT scan efficiency scores.

After receiving feedback from the collaborative participants, they updated the layout of the reports to provide detailed information at both the practice (See Figure 8) and physician-level (See Figure 9). The term efficiency was also changed to appropriateness. This newer version was disseminated during the May, 2015, tri-annual meeting.

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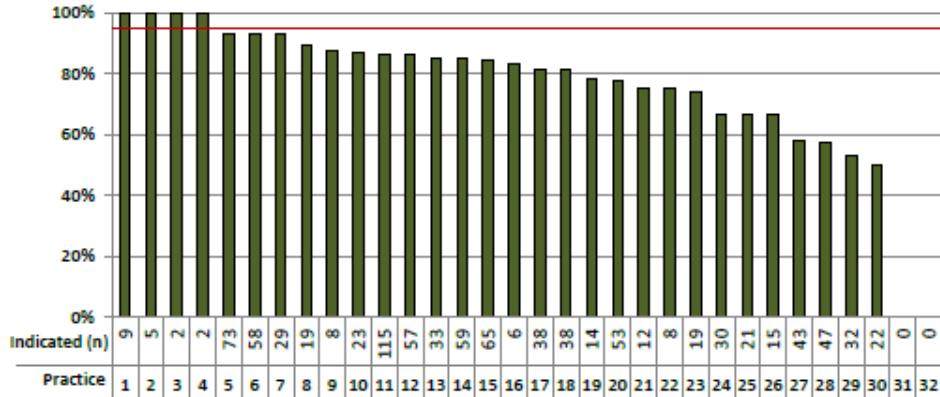
Figure 8. Practice-level performance report for ordering bone scans.
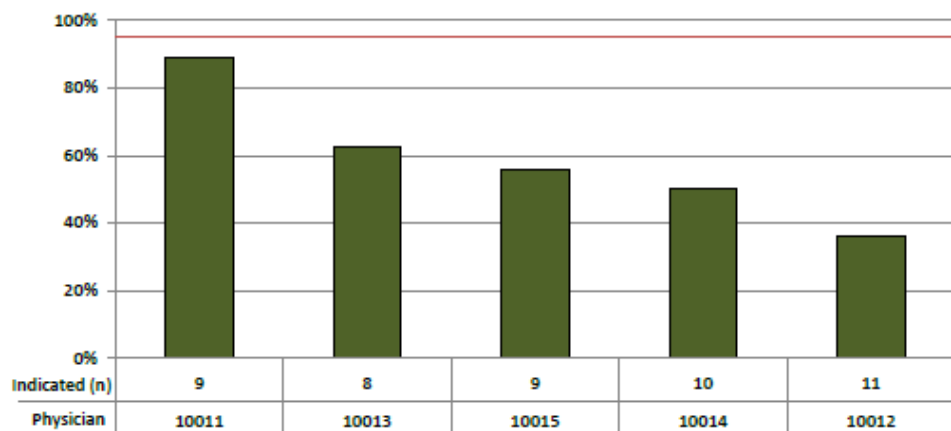
Figure 9. Physician-level performance report for ordering bone scans.

By the October, 2014, triannual meeting the collaborative had updated the data registry to provide real-time information about the practice, urologists, and performance trends over time.

The collaborative leaders placed a great emphasis on providing de-identified information in order to maintain trust and professionalism within the collaborative. For instance, the practice-level performance report in Figure 9 shows the benchmark performance for all the practices, but they are listed using a de-identified practice code. Figure 10 also shows that only a urologist's provider's registry code is listed to maintain the anonymity of the individuals (the clinical champion was given the provider numbers so they could work with the urologists in their practice). The collaborative also emphasized that the practices could use this performance information for reporting quality measures, but not for gaining a competitive advantage on each other. They were very serious about this level of trust and professionalism.

This imaging performance was framed in a positive manner when it was presented at the triannual meeting. For example, they would often highlight the drop in overuse of imaging across the collaborative and then frame the success in terms of how much they improved the quality of care to the patients. Thus, the benchmarked performance was used to improve compliance or behavior in a positive way, rather than shaming the participants for poor performance or pressuring them to comply. As stated by the leadership of MUSIC:

"Surgeons are a competitive lot. If a surgeon sees credible data demonstrating that another surgeon has fewer complications or better

outcomes, he or she will likely make an effort to improve (Montie, Linsell, and Miller, 2014)."

If any practice-level performance issues arose, such as failing to comply with data entry or low performance towards an imaging guideline, the leaders of the Coordinating Center would rely on social levers to influence behavior. This was done in a professional and private way. For example, the co-directors would often reach out to the clinical champions to find see if they needed assistance. They would also personally visit the practices to talk with the urologists if the clinical champion needed their help to influence or share knowledge with their colleagues (e.g. one director visited with some senior urologists during their grand rounds to talk about the imaging appropriateness criteria because they were skeptical). The collaborative leaders would also proactively schedule visits with certain practices if they thought it would help to improve compliance with an innovation (e.g. the Coordinating Center hosted a dinner with the urologists of a low implementation practice in order to reinforce the mission and vision of MUSIC).

It was clear they were opinion leaders within the professional community (Opinion leaders are individuals who influence other individual's attitudes towards an object or behavior (Rogers, 2010)). The professional status of each leader was important in defining who they could influence. For instance, Dr. Miller described mindfully leveraging their relationships with other colleagues to help shape the attitudes of the members of the collaborative. He stated that Dr. Montie had a general influence over most of the urologists because he was well known in urology and he had a specific influence with senior urologists who were his peers. Dr. Miller, on the other hand, had

more influence and better professional connections with his peers and younger

physicians (personal communication, March 13, 2014):

> "Well, I think, clinically, Jim Montie has a huge amount of influence here…he is a phenomenal clinician with an impeccable reputation and universal respect. And so when he calls on people they listen."

He further stated:

> "Those are situations where I'm much more at ease with people who are more my generation because they don't, kind of, look at me and say, "Wait. I was practicing urology when you were in diapers, you know." But for people who are a bit more senior and have been doing it longer, and arguably have—who do have more experience than me. They've had a career of interacting with Jim Montie."

> Additionally, the collaborative leaders would leverage the imaging working group

to help influence the other members. They used them to cultivate the innovation. This

grassroots approach placed the ownership on the collaborative participants rather than

the leadership. They also purposefully leveraged the working group's adoption and use

of this innovation to help positively shape the behaviors of the other members. As Dr.

Miller states, these working groups played a large role in helping to shape behaviors

within the collaborative (personal communication, March 13, 2014):

> "We also leverage that [social] pressure, you know, through the working group—we basically take this idea that we think is important, right—and we pass it through a first litmus test of the real world, which is our working group. And once we kind of have the buy in, the endorsement of the working group—we feel like we can be a bit more aggressive in getting the rest of the collaborative to use it."

As described, it appears the grassroots efforts and the opinions of the larger groups

were important in shaping the beliefs about the collaborative and innovation they

developed. As Rogers (2010) proposes, most individuals will often evaluate an

innovation based on the subjective evaluation of peers who have already adopted the innovation, rather than scientific evidence. Thus, it appears this strategy was purposefully used to leverage the working group's adoption and use of the innovation to help positively shape the behaviors of the other members.

In summary, while the overall structure of MUSIC was similar to that of the IHI Breakthrough Series, the social infrastructure appeared to be more elaborate than previously discusses. This is likely because the collaborative itself was organized by physicians who wanted to make a difference within their own profession. It was not designed to be a short-term learning system. Rather, this group of professionals was focused on collectively improving prostate cancer care. The next section will discuss the innovations at the center of their quality improvement efforts.

4.4 Low-risk Imaging and the Imaging Appropriateness Criteria

MUSIC's initial area of focus for improvement was with prostate cancer. The specific areas targeted for improvement within prostate cancer were proposed and selected by the leadership and clinical champions within MUSIC (Montie, Linsell, and Miller, 2014). One of the first areas targeted for improvement was bone and CT scan utilization, an extension of the previous work from the USQC.

The first major imaging initiative was targeted at reducing imaging in low-risk patients. This initiative was similar to the first initiative developed by the USQC. It also aligned with the AUA "choosing wisely" campaign. The premise was to not use bone and CT scans for low-risk patients because it was not necessary (no studies were positive for metastatic disease). The imaging exposed the patient to unnecessary radiation and

increased the costs of care. For example, the 2015 Medicare national average

reimbursement rate for a bone scan (CPT code 78306) is $260.88 and a CT scan (CPT

code 74177) is $261.67. Thus ordering both of these tests when not clinically indicated

would cost the government an average of $522.55.

This quality initiative was developed and implemented in a similar fashion to the

first. There were three phases to the cycle. In March of 2012 the first wave of

participants started collecting data. This data collection period ran through October

2012. At the tri-annual meeting in October, the collaborative discussed the baseline

data performance and reviewed the guidelines (the intervention). The second wave of

practices started collecting data at this time (seven practices). The next intervention was

in January 2013. MUSIC utilized the same intervention: feedback and review of

guidelines. The third wave of practices started collecting data shortly thereafter (seven

practices). The post intervention time ran through October of 2013. This initiative

produced statistically significant differences in bone and CT imaging use for low-risk

patients (from ~5% to ~2%).

Next, MUSIC established a more progressive stance with respect to imaging

usage. This was done for two reasons. First, they had collected more data on prostate

cancer, which demonstrated continued opportunities for improvement. For example,

the collaborative had collected nearly 10,000 patients in the registry and an analysis

showed that approximately 15% of intermediate-risk patients received imaging for

staging but less than 1% of the studies identified metastases. On the other hand, the

data showed that only 70% of high-risk patients had imaging studies performed for

staging, despite the fact that approximately 12% of high-risk patients have studies

identifying metastases.

In conjunction with this, MUSIC's imaging workgroup recognized there was

ambiguity with respect to the current professional guidelines and criteria (see table 7).

For example, the NCCN guidelines suggested ordering a bone scan based on a

combination of T stage and PSA, while the AUA Best Practice statement suggested a

more discrete criterion. Additionally, the D'Amico classification (low, intermediate, and

high-risk) was not an ideal criterion for determining imaging because it was based on

risk of recurrence after therapy, not on risk of imaging detecting a metastasis.

Table 7. Comparison of Imaging Guidelines and Criteria

	Bone scan	**CT scan**
MUSIC's imaging appropriateness criteria	*PSA≥20 or Gleason score ≥8*	*PSA≥20 or Gleason score ≥8 or ≥T3c disease*
American Urological Association (AUA) PSA Best Practice statement	*PSA≥20 or Gleason score ≥8 or ≥T3 disease*	*PSA≥20 or Gleason score ≥8*
National Comprehensive Cancer Network (NCCN) clinical practice guidelines for prostate cancer	*T1 with PSA≥20 T2 with PSA≥10 or Gleason score ≥8 or T3/T4 disease*	*T3/T4 disease or T1/T2 disease and nomogram with probable lymph node involvement >10%*

The goal of the imaging innovation was to build upon the concepts established by the AUA and NCCN guidelines, yet establish a set of imaging criteria using patient data from the registry. To accomplish this, MUSIC collaborated with the University of Michigan Department of Industrial and Operations Engineering. This team of experts developed the imaging appropriateness criteria using a multivariate analysis of over 10,000 prostate cancer patients (imaging use and outcomes data). The new criteria for bone scans were PSA≥20 or Gleason score ≥8 and the criteria for the CT scan was PSA≥20 or Gleason score ≥8 or ≥T3c disease. Based on these new criteria, the chance of missing a positive bone scan or CT scan would be less than 1%.

These imaging appropriateness criteria were a truly an evidence-based innovation. It was based on the probability of having a positive imaging study identifying metastatic disease, rather than the risk of recurrence of prostate cancer. The criteria recommended that an urologist not order bone and CT scans when it wasn't appropriate, or not likely to be positive, and order it when it was appropriate, or likely to be positive. The collaborative framed this concept as the efficient use of imaging based on scientific evidence. The mantra was "Do when you should, don't when you shouldn't."

The Coordinating Center disseminated the information about this innovation through the tri-annual meeting in October 2013 (bone scan) and January 2014 (CT scan). The offsetting times were due to the delayed analysis for the CT scan criteria. The primary intervention was the clinical champions for each of the practices. Within their role, the clinical champions were tasked to disseminate the information and to develop

implementation strategies at the practice-level. The current imaging performance

feedback was provided at both the October and January meetings.

Field site visits with all 32 practices in the collaborative were conducted two to

four months after initial dissemination of the imaging appropriateness criteria. For each

visit, two researchers travelled to the practice and interviewed key individuals involved

with MUSIC. The intent was to assess implementation efforts for best practices and

obtaining feedback on the imaging performance reports. This was also when the data

was collected for this dissertation. Having summarized MUSIC's organization and

activities related to imaging, I now turn to the analysis of imaging performance before

and after the innovation.

4.5 Implementation Effectiveness

To assess implementation effectiveness within the collaborative, bone and CT

scans performance was calculated before and after the innovation was disseminated.

Imaging performance was defined as the rate of adherence to the imaging

appropriateness criteria for when it was indicated and when it was not indicated. For

example, if an urologist ordered imaging and it was clinically indicated in accordance

with the imaging appropriateness criteria, then it would be recorded as correctly

ordered.

There were two time periods used for this comparison. The first was

approximately one year before the CT imaging criteria innovation was disseminated at

the tri-annual meeting. The second was from the time the criteria were disseminated

out to the collaborative up to approximately nine months after. The dissemination date

of January 17, 2014 assumed the bone and CT innovation was implemented on the same

day, rather than offsetting starting points. However, this data was compared to the

actual time periods matching the actual offset dissemination dates and there were no

significant differences. In addition, this single implementation date was chosen to match

patients for bone and CT scans and to control the effects of time. The endpoint of the

post innovation time period was felt to be appropriate for two reasons. First, the

imaging data was retrieved from the collaborative's data registry on December 31, 2014

and the data was still being entered for the months of October-December 2014. More

importantly, however, the collaborative deployed an educational intervention to

improve imaging performance in the middle of October, 2014.

Table 8. Imaging Performance Trends by Practice Size

Size (# practices)	Pre-innovation[1]		Post-innovation[2]		
	# cases (n)	% correct	# cases (n)	% correct	Δ % correct
Solo (6)	233	82.4	215	96.7	14.3
Small (13)	1076	82.3	1372	85.9	3.7
Medium (9)	1625	85.2	941	88.3	3.1
Large (4)	1475	83.7	1733	85.2	1.4
Total (32)	4409	83.8	4261	86.7	2.9

[1] Pre-innovation = January 1, 2013 to January 16, 2014
[2] Post-innovation = January 17, 2014 to October 16, 2014

Table 8 shows the overall imaging performance trends by practice size. The size

was determined by the number of urologists within the practice: solo (1); small (2-4);

medium (4-9); and large (>10 urologists). There were 32 practices contributing into the

data registry during this time period. Three of the newer practices had little to no data

in the registry before the innovation was disseminated. They were still included in the

analysis as this was only an exploration of the data.

During the pre-innovation period there were 4,409 cases. Of this sample,

approximately 83.8% would have met the imaging criteria. That is, the urologist ordered

when it was indicated and did not order it when it wasn't indicated. In the post-

innovation period there were approximately 4,261 cases and the compliance rate was

86.7%. Overall, this was a 2.9 percentage point increase in performance during the post-

implementation period, which was not a statistically significant change (p=.12; two-

tailed Student's t-test). This data shows that there was an overall improvement in the

post-innovation time period. The most improvement was seen with the solo-

practitioners (+14.3%).

CT Scan Performance

Next, the performance data were analyzed by imaging modality and by

appropriateness category (when not indicated, or overuse, and when indicated, or

underuse). Table 9 shows these performance trends by practice size. There were 1,648

cases during the pre-innovation period and 82.0% would have met the standards for not

ordering a CT scan when it was not indicated. During the post-innovation period there

were 1,611 CT cases with an imaging criteria compliance rate of 87.3%. Overall, the

performance improved by 5.3 percentage points for this category, reflecting a

statistically significant reduction in CT scan imaging when it wasn't necessary (p=.04;

two-tailed Student's t-test). Most of the practices experienced an average improvement

of five percentage points, while the most improvement was seen with the solo practitioners (+15.9%).

The performance of the practices was a mixed for when a CT scan was indicated but not ordered. During the pre-innovation time, there were 538 cases that required CT imaging and 78.1% of them had the imaging ordered. During post-innovation there were 502 cases and 75.1% of them had CT scans ordered. Overall, this was a 3.0 percentage point decrease in performance for underuse of CT scans. The solo practitioners and small practices had the most improvement (4.1% and 2.0%, respectively). The other larger groups experienced a decrease in performance.

Bone Scan Performance

The performance trends for the bone scans were similar to the CT scans (See Table 10). During the pre-innovation period there were 1,683 cases and 86.7% had no bone scan ordered when it wasn't indicated. During the post-innovation period there were 1,659 CT cases with an imaging criteria compliance rate of 90.4%. Overall there was an increase in performance by 3.7 percentage points for this category, reflecting a statistically significant reduction in bone scan usage when it wasn't necessary (p=.03; two-tailed Student's t-test). Again, all the practices experienced improvement, but the most improvement was seen with the solo-practitioners (+12.4%).

The performance trends were again mixed for when a bone scan was indicated but not ordered. During the pre-innovation time, there were 540 cases that required a bone scan and 86.1% had the imaging ordered. During post-innovation there were 489 cases and 83.8% had a bone scan ordered. As with the CT underuse, this was a 2.3

Table 9. CT Scan Performance Trends by Practice Size

	CT scan is not indicated						CT scan is indicated				
	Pre-innovation[1]		Post-innovation[2]				Pre-innovation[1]		Post-innovation[2]		
Size	# cases (n)	% correct	# cases (n)	% correct	Δ % correct	Size	# cases (n)	% correct	# cases (n)	% correct	Δ % correct
Solo	82	81.7	82	97.6	15.9	Solo	34	88.2	26	92.3	4.1
Small	397	80.6	483	85.7	5.1	Small	140	77.1	201	79.1	2.0
Medium	598	85.3	360	91.1	5.8	Medium	207	80.2	104	78.8	-1.3
Large	571	79.7	686	85.3	5.6	Large	157	73.9	171	65.5	-8.4
Total	1648	82.0	1611	87.3	5.3*	Total	538	78.1	502	75.1	-3.0

[1] Pre-innovation = January 1, 2013 to January 16, 2014

[2] Post-innovation = January 17, 2014 to October 16, 2014

*p ≤ 0.05

Table 10. Bone Scan Performance Trends by Practice Size

	Bone scan is not indicated						Bone scan is indicated				
	Pre-innovation[1]		Post-innovation[2]				Pre-innovation[1]		Post-innovation[2]		
Size	# cases (n)	% correct	# cases (n)	% correct	Δ % correct	Size	# cases (n)	% correct	# cases (n)	% correct	Δ % correct
Solo	81	83.9	82	96.3	12.4	Solo	36	75.0	25	100.0	25.0
Small	402	85.3	490	91.0	5.7	Small	137	83.2	198	80.8	-2.4
Medium	612	86.1	373	87.9	1.8	Medium	208	87.0	104	89.4	2.4
Large	588	88.6	714	90.6	2.0	Large	159	90.0	162	81.5	-8.5
Total	1683	86.7	1659	90.4	3.7*	Total	540	86.1	489	83.8	-2.3

[1] Pre-innovation = January 1, 2013 to January 16, 2014

[2] Post-innovation = January 17, 2014 to October 16, 2014

*p ≤ 0.05

percentage point decrease in performance for underuse of bone scans when indicated. The solo practitioners and medium practices had an increase in performance (25.2% and 2.4%, respectively), while the small and large practices experiences a decrease in performance.

4.6 Discussion

This part of the dissertation was intended to provide a better understanding of the formation of MUSIC and how it was organized. It was also focused on describing the interactions between the collaborative leaders and the individual physicians participating as collaborative members and analyzed how these interactions supported the physicians' uptake of the innovation. The findings of this field research show there was a considerable amount of effort put into its development.

This collaborative was forged from the ground up by a group of innovative leaders in urology who sought to improve their profession in a meaningful way. It was constructed in the backdrop of numerous other quality initiatives sponsored by Blue Cross Blue Shield of Michigan, the University of Michigan, and other healthcare organizations from throughout the state of Michigan. It was, however, the first physician-led collaborative quality initiative. These factors played an important part in how the urology leaders conceptualized and organized it for quality improvement.

The early efforts of the Urological Surgery Quality Collaborative were centered on data collection, learning sessions, and performance reporting. These elements, which aligned with the IHI Breakthrough Series Model, helped enforce the existing professional standards and reduce variation in imaging for prostate cancer care. This organizational

design was carried forward to the current collaborative. However, there were a number

of changes that needed to happen to make this a large scale quality improvement effort.

The initial efforts of the MUSIC focused heavily on data collection in an effort to

assess the diagnoses and treatment of prostate cancer care across the collaborative.

The structures and processes of these efforts, however, were more robust than

previously mentioned in the literature on collaborative effectiveness. They established

their own data registry and the sponsor provided funding for a dedicated data

abstractor at each practice. This way of organizing was a considerable investment, but it

was designed to facilitate long-term quality improvement efforts. This element was a

major change from IHI's Breakthrough Series Model, whereas the practices traditionally

extracted data and reported their own performance to the collaborative leaders. This

was likely due to the short-term nature of most collaboratives.

MUSICs initial focus on quality improvement was to enforce the professional

standards and reduce imaging use for low-risk patients. However, as they collected and

analyzed the patient-level data, they became innovative and developed their own

evidence-based practice to use imaging more appropriately. These new imaging

appropriateness criteria were a departure from the existing professional guidelines.

They were complex, focusing on both increasing the appropriate use of imaging for

bone and CT scans as well as decreasing the inappropriate use. Thus, the features of the

innovation itself appeared to be an important element of implementation and

collaborative effectiveness, and few research studies have focused on this area.

Though, despite this complexity, the collaborative was successful at changing the urologists' use of imaging. Overall, bone and CT scan usage was improved and most of the implementation success was realized with the overuse of bone and CT scans. The innovation did appear to have little effect on the use of imaging when it was appropriate. However, this could be due to ceiling effects. That is, it's often difficult to improve performance when it is already at or above 80%.

It was also clear that behavior change was easier to achieve in smaller organizations, especially with the solo-practitioners. This is likely because, as a solo-practitioner, the physician is the clinical champion who attends the tri-annual meetings. Additionally, in the smaller practices, the clinical champion may only have to focus their efforts on changing the behaviors of a few physicians who they work closely with. Therefore, the dynamic of practice size appears to be important with improving implementation efforts.

There were specific strategies the collaborative used to ensure its success. Early in the development, the social and professional networks of the leaders were leveraged to recruit and organize the efforts of the member practices. Urologists from throughout Michigan voluntarily joined to help achieve the vision of being an innovator in physician-led quality improvement activities related to prostate cancer. The success of the collaborative created a momentum in recruitment and practices joined to not be outliers within the profession.

Because their improvement efforts were narrowly focused on urology, prostate cancer in particular, MUSIC was comprised of a homogenous group of professionals.

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This is different than other quality improvement collaboratives, which are largely

comprised of multidisciplinary teams. This lack of professional diversity played an

important part in the social dynamics within this organization. As described, the opinion

leaders within the Coordinating Center had a tremendous amount of influence on the

participants because they were leaders within their profession. There were three

significant strategies the collaborative leaders used to shape the beliefs and attitudes of

the members towards the collaborative and the innovation.

First, the collaborative leaders thoughtfully organized their activities to build

trust and maintain professional relationships within the collaborative. For example, they

provided performance reports with de-identified information. They also decentralized

the dissemination and implementation activities to the practices and worked closely

with the clinical champions and the data abstractors to provide immediate support as

necessary. All of these activities helped to build a professional rapport between the

Coordinating Center and the practices, and make the collaborative appear to be

unobtrusive to the urologists. Though, there were some tradeoffs to this way of

organizing.

For instance, the collaborative didn't require the practices to use a specific a

model for improvement (i.e. Plan-Do-Study-Act cycles) to help systematically implement

changes. They also didn't engage in specific types of interorganizational learning

activities (i.e. conference calls) outside the tri-annual meeting. They did, however, allow

the practices to determine their own needs. Again, this aligned with professional

behaviors. Ironically, these elements related to learning were reported to be important

for improving collaborative performance (Nembhard, 2012; Nembhard and Tucker, 2011). However, these elements may be more important if the innovation requires it (i.e. complex intervention with process changes; larger groups or multi-disciplinary teams).

The final strategy of influence was centered on positive feedback. For example, MUSIC's quality improvement activities became well known throughout the profession of urology. The collaborative leaders openly celebrated the successes of the members (i.e. publications, presentations, and other contributions) and spoke very highly about the collaborative's achievements with improving the quality of prostate cancer care. They purposefully didn't focus on negative aspects of performance, such as productivity in the registry or failing to improve in performance. Again, these purposeful activities appeared to foster positive attitudes towards the collaborative and establish its legitimacy in the profession.

Next, they strategically organized to reinforce that the collaborative and the innovation were grassroots efforts. For instance, the leaders purposefully organized the imaging working group, with varied membership from across the practices, to assist with the development of the imaging appropriateness criteria. The working group members provided updates during the tri-annual meetings, which helped place ownership on the members themselves, rather than the leaders of the collaborative. Once adopted, the leaders leveraged the opinions of these working group members to influence the other urologists to adopt and use the innovation. All of these efforts helped to positively

shape the collaborative members' beliefs and attitudes about the organization and the innovation they developed.

The combined activities of the collaborative appeared to have a major effect on the urologists. The professional interplay built trust and strengthened the urologist's attitudes towards MUSIC. The success and positive reinforcement further strengthened their beliefs about the collaborative's legitimacy. The inclusiveness and grassroots effort positively shaped the attitudes towards the collaborative as well as the new innovation they developed. Consequently, the collective opinion of the collaborative shaped the behaviors of the individuals. They adopted and used the new innovation.

As described, these social influences appear to be similar to that of the opinion leader, but on a collective level. Accordingly, the collaborative is a "collective opinion leader." That is, as a collective, the collaborative influences other individual's attitudes towards an object or behavior (Rogers, 2010). Previous research in this subject has primarily focused on an individual's influence on others.

Chapter 5. Barriers and Facilitators to Implementation at the Practices

This chapter of the dissertation was intended to provide a better understanding of the barriers and facilitators of implementation within the urology practices. It was designed to explore the beliefs and attitudes of the individuals within the urology practice. The CFIR was used to guide the collection of qualitative data and systematically assess the factors explaining the variation in implementation experienced by the urology practices within MUSIC. I used a comparative case study with high and low implementing practices to help isolate these barriers and facilitators of implementation.

The specific research questions to be addressed in this chapter are the following:

3. What are the interactions among physicians from the same practice participating in a collaborative and how do these interactions support physicians' uptake of the innovation?

4. What are the social and environmental factors that influence physicians participating in a collaborative to develop intentions to follow the evidence-based practice?

This chapter begins with a brief overview of the findings. I then present the specific details of the significant constructs for each of the domains. The remaining constructs that were not significant predictors or not assessed are summarized in Appendix C. I also discuss the barriers and facilitators in more detail in the final section of the chapter.

5.1 Overview of Findings

Of the 37 CFIR constructs assessed, seven constructs strongly distinguished and another eight constructs weakly distinguished between practices with high and low implementation effectiveness (See Table 10). There were ten constructs for which evidence was mixed and nine constructs with no apparent influence across the practices. The remaining three constructs had insufficient data to assess the impact on implementation effectiveness.

Table 10. Ratings Assigned to CFIR Construct by Case

	High Implementation Practices		Low Implementation Practices		
Practice Size	Medium	Small	Small	Medium	
I. Intervention Characteristics Domain					
Intervention Source	**+2**	0	-1	-1	*
Design Quality & Packaging	0	0	**-2**	**-2**	*
Evidence Strength & Quality	**+2**	**+2**	**-2**	**-2**	**
Complexity	**+2**	**+2**	**+2**	**+2**	
II. Outer Setting Domain					
Needs & Resources of Patients	**+2**	**+2**	**-2**	**-2**	**
Cosmopolitanism	**+2**	**+2**	-1	-1	*
External Policy & Incentives	+2	**+2**	0	**-2**	*
III. Inner Setting Domain					
Structural Characteristics	**+2**	+1	-2	-1	*
Networks & Communications	**+2**	**+2**	**-2**	**-2**	**
Readiness (Leadership Engagement)	**+2**	**+2**	**-2**	**-2**	**
IV. Characteristics of Individuals Domain					
Knowledge & Beliefs about the Innovation	**+2**	**+2**	**-2**	**-2**	**
Individual Identification with Organization	**+2**	**+2**	0	-1	*
V. Process					
Planning	-1	-1	-1	-1	
Engaging (Champions)	**+2**	**+2**	**-2**	**-2**	**
Engaging (Innovation Participants)	**+2**	**+2**	0	0	*
Executing	**+2**	**+2**	0	0	*
Reflecting & Evaluating	+1	**+2**	**-2**	**-2**	**

** Construct strongly distinguishes between high and low imaging performance.

 * Construct weakly distinguishes between high and low imaging performance.

The following sections briefly describe the constructs that distinguished between the high and low performing practices and how they manifested in the practices.

5.2 Intervention Characteristics Domain

Intervention source

"Intervention source" construct can be described as the perception of key stakeholders about whether the intervention is externally or internally developed. This construct was only weakly distinguished between high and low implementation practices. Respondents from three of the four practices regarded the imaging appropriateness criteria as being externally developed. All of them said they heard of the innovation at the tri-annual meeting. On the other hand, the highest implementation practice described the innovation as being internally developed. The clinical champion said he was part of the imaging workgroup that oversaw the development of the innovation. He stated that he regularly sought feedback from his practice partners when it was in the development stage. Furthermore, when it was disseminated, the urologists in the practice were already aware of the recommendations.

There was also interplay between organizational identity and innovation source. The lower implementation practices felt that MUSIC's Coordinating Center was an extension of the University of Michigan, which one site felt was a detriment more than a plus. In contrast, the higher implementation practices felt the Coordinating Center was a stand-alone facility that represented the collaborative. Taken together, when the

innovation was perceived to be developed externally to the practice, but in internally to

the collaborative, it was looked upon favorably. When it was perceived to be external to

both the practice and the collaborative (from an academic research institution), it was

regarded as unfavorable.

Design quality and packaging

The construct Design quality and packaging was defined as the perceived

excellence in how the intervention is bundled, presented, and assembled. This construct

weakly distinguished between the high and low implementation practices. All of the

individuals interviewed said they attended the briefing and received the photo copies of

the slides at the tri-annual meetings. A few remembered that the criterion for the bone

scan was disseminated before the criterion for the CT scan.

In turn, all of the clinical champions mentioned they disseminated the

information to their practice partners by word-of-mouth and by using the summary

slides. The high implementation practices had no issues with the design quality and

packaging. However, both of the low implementation practices mentioned having issues

with the innovation's design. One mentioned that guidelines did not take into account

differences across subtypes of aggressive cancer and whether race or ethnicity should

be addressed:

> "So there are both races and different ethnicities I think you have to be
> careful with. And there's occasional subtypes of the cancer that might be a
> little bit, that aren't well categorized. For example, if someone does have a
> low grade cancer with a PSA that's low, but they have a high volume of the
> disease and it's, and clinically the stage seems a little bit higher, I think the
> guidelines aren't as clear. At least certain of the MUSIC ones aren't as clear
> as to what you need to do. I mean, the MUSIC guidelines suggest that you

shouldn't do some of the scanning. But I think we have to—Clinical judgment tells you that you probably ought to do some additional scanning." [practice 4; clinical champion]

The other clinical champion from practice 3 mixed up the imaging criteria with the previous low-risk "choosing wisely" criteria. He also mentioned the criteria didn't address the potential differenced in imaging use by race or ethnicity.

Some of the themes related to this construct appeared to overlap with evidence strength and quality. This is likely because of the low-quality packaging (e.g. slides with bulleted information) and the fact that the dissemination of the innovation was primarily by word-of-mouth.

Evidence strength and quality

The construct Evidence strength and quality was defined as the stakeholders' perceptions of the quality and validity of evidence supporting the belief that the intervention will have desired outcomes. This construct highly distinguished between the high and low implementation facilities. The high implementation practices felt strongly that there were no issues with the evidence and their clinical champion, who was involved with the imaging working group, stated the criteria were "…based on (the) probability of a positive study rather than risk of recurrence." One of the senior physicians at practice 2 felt the criteria provided legal confidence when ordering imaging. In contrast, the low implementation practices had a strong negative view of the evidence. One clinical champion said he had issues with not ordering imaging for intermediate-risk patients. He also said his partners were skeptical of the evidence because they didn't clearly understand how the criteria were developed:

"They didn't attend the meeting. So they probably didn't see the data spelled out as clearly as I saw it. So I don't know what their practice pattern is regarding the imaging studies at this time. The general information was conveyed to them." [practice 4; clinical champion]

The clinical champion at practice 3 mentioned similar issues with the evidence, specifically saying that "…a little bit of a gray zone when it comes to volume of disease." He also stated, "We just need documentation to knock you off—take you off the fence." The practice manager mentioned the partners were "A little bit resistant because they're always worried about that percentage that still could be missed."

As previously mentioned the themes of this construct were closely intertwined with Design quality and packaging. It also appeared to have an association with the construct focusing on "Needs and resources of those served by the organization." For example, practices that had higher proportions of African American patients were more sensitive to the evidence and the generalizability of the imaging appropriateness criteria to other races and ethnicities. Several clinical champions mentioned African Americans had more aggressive prostate cancer.

5.3 Outer Setting Domain

Patient needs and resources

The construct Patient needs and resources is defined as the extent to which patient needs, as well as barriers and facilitators to meet those needs are accurately known and prioritized by the organization. For example, some patients may not have health insurance which could provide a barrier to accessing health care when it is

required while others may have health insurance that provides access. This construct

highly distinguished between the high and low implementation practices. The high

implementation practices did not have any issues with patient resources (i.e. not being

able to get imaging when it was recommended because the patients didn't have

resources) nor did they have issues with patients requesting imaging when it wasn't

indicated. One of the practices was in an affluent part of the city with few African

Americans in the patient population. The other practice was in an area with a diverse

population of patients. Despite the differences in patient demographics, both of the

clinical champion felt the criteria applied to all their patients regardless of race or

ethnicity.

On the other hand, the low implementation practices mentioned several patient-

level characteristics and needs that influenced their beliefs about being able to follow

the criteria. Both of the clinical champions at these sites said they had a higher mix of

African Americans in their patient population and they believed that African Americans

had more aggressive prostate cancer than men from other races. These racial

differences were not addresses by the new imaging appropriateness criteria. Both of the

physicians also mentioned they often had patients who couldn't get imaging when they

recommended it because the patients didn't have resources, such as insurance

coverage. The clinical champion at practice 4 also said he had an issue with his patients

requesting imaging even though it wasn't indicated. He said the patients were scared of

having cancer and they wanted the imaging done despite the fact there was it was not

medically necessary. This urologist also said he was more likely to provide the imaging if

it was requested by the patient because he wanted to meet the needs of the patient. The other clinical champion at practice 3 said the patients would ask for imaging, but they would often retract the request if he highly recommended against it.

Cosmopolitanism

The construct Cosmopolitanism is defined as the degree to which an organization is networked with other external organizations. This construct weakly distinguished between the high and low implementation practices. The high implementation practices said they were highly networked with the hospitals and urology groups in the area. The clinical champions mentioned specific instances where they would meet with the physician group and other leaders from the local hospital or health system. They had very collegial work relationships with the professionals in the community. They also mentioned the importance of being connected to other urologists in the collaborative. One specifically mentioned he talked with other urologists at the tri-annual meeting and outside the meeting when they returned to their practices.

The other two clinical champions from the low implementation practices mentioned fewer network connections outside their own organization. The champion from practice 4 explained that his practice was part of a larger urology group and he met with these urologists at the local hospital. He mentioned talking with competitors at the hospital, but there were few examples provided. The clinical champion at practice 3 mentioned his practice worked with several hospitals in the area but they were not networked with other urologists. Neither of clinical champions said they talked with other members of the collaborative outside of their own organization.

External Policy and Incentives

The construct External policy and incentives was broadly defined as strategies to spread interventions, to include policy and regulations, external mandates, recommendations and guidelines, pay-for-performance, collaboratives, and public or benchmark reporting. This construct weakly distinguished between the high and low implementation practices. The largest disparity was centered on the existing professional criteria of the AUA PSA Best Practice statement and/or the NCCN clinical practice guidelines. In fact, all of the clinical champions mentioned they were aware of existing professional guidelines. The perceived differences between the new imaging appropriateness criteria and existing AUA and NCCN guidelines is what created the issues with the urologists.

One of the high implementation practices felt the imaging appropriateness criteria were better than the existing D'Amico Risk Criteria and AUA Best Practice statement. The other high implementation practice felt the new imaging appropriateness criteria were similar to the existing professional criteria. The senior physician at practice 2 said the radiology norms were to order the bone scan first and then order the CT scan based on the results of the bone scan. Despite this perceived difference from the radiology norms, they both said they were proud to follow the new imaging appropriateness criteria. Practice 2 also used the imaging criteria from MUSIC's data registry for their "appropriate use" measures at the local hospital. This appeared to help keep them abreast of their performance.

On the other hand, one of the low implementation practices said there were differences between the existing criteria and MUSIC's imaging appropriateness criteria. He also mentioned the norm was to order a bone scan first, but the criteria from MUSIC didn't support that. He also wasn't sure what the real criteria were supposed to be:

> "I think a bone scan is what they recommend. But I think our data hasn't really shown much in the bone scan area…clearly the recommendation from the AUA or the NCCN is different than the recommendation for MUSIC. So, you know, I guess it just depends on who you follow. So I think there's data for both. I'm sure someone has to parse the data and figure out actually what the real criteria are. So that…I'm still open to ideas on that." [practice 4; clinical champion]

The other clinical champion from practice 3 knew of the existing professional criteria. He felt that MUSIC's criteria were empirically developed from data and the national criteria lacked the documentation. Additionally, he mentioned insurance companies were following the criteria to reduce overuse (the medical assistant said there were strict for pre-certifications for imaging). He mentioned this helped with his patients:

> "Well here it says you should do imaging, you know. And now all of the sudden we have a collaborative that clearly shows there's no benefit to it, which we all knew.   But now we have documentation to support that fact. Which, then also the insurance companies can say, "Listen, we're not going to approve it unless there's other reasons." So the insurance company's saying it, the collaborative is saying it, now the patients are off our backs." [practice 3; clinical champion]

Despite this apparent positive influence, however, this clinical champion consistently referenced the low-risk imaging criteria rather than the current imaging appropriateness criteria (i.e. he mentioned the practice implemented the innovation a year before the new imaging appropriateness criteria was released, which aligned with the low-risk imaging intervention). He also heavily criticized

the new imaging appropriateness criteria. Taken together, it appeared to be a mixed influence so it was assessed as neutral.

5.4 Inner Setting Domain

Structural characteristics

The construct Structural characteristics was defined as the social architecture, age, maturity, and size of an organization. This construct weakly distinguished between the high and low implementation practices. Practice 1 was a medium sized practice and they only had three practice locations. This made it easy for them to organize and manage their staff. On the other hand, practice 4 was spread across six locations while practice 3 had 10, which made it difficult for their staff to synchronize their efforts.

Networks and communication

The construct Networks and communication was described as "The nature and quality of webs of social networks and the nature and quality of formal and informal communications within an organization." This construct highly distinguished between the high and low implementation practices. The highest implementation practice included the practice administrator and the two nurse managers in their operations' meeting. It was very apparent the work relationships were collegial. The nurse manager and administrator said they worked closely with the physicians to plan and manage the operations. Several mentioned they hosted staff luncheons on a monthly basis. They even referenced the clinical champion by his first name during the interview.

Practice 2 was smaller in size, so they didn't have as many formal meetings. The clinical champion typed summary memos after the tri-annual meeting in order to codify and distribute the information to the practice partners. He also developed his own cue cards for the imaging appropriateness criteria and hung them in the area where they ordered imaging. It appeared they had a collegial work relationship in the practice. For example, one of the urologists specifically asked his nurse to screen the imaging orders against the imaging appropriateness criteria to make sure it was in compliance (she showed me the cue cards hanging above the computer).

In contrast, the low implementation practices appeared to have major differences in the quality of the work relationships. One low implementation practice had a seemingly aggressive clinical champion, who was also the managing partner of the practice. The work relationships appeared to be very hierarchical and toxic. Information didn't readily flow to the staff. Consequently, few of them knew about MUSIC and they consistently had issues with data quality in MUSIC's registry. For example, during our interview, the clinical champion questioned the validity of the performance data and became hostile towards the practice manager:

> Clinical Champion: Which provider is this?
> Interviewer: The provider numbers are here.
> Clinical Champion: Bam, bam, [practice manager]! I want to find out. (He slams the desk and angrily yells for the practice manager to come identify the providers on the worksheet) [practice 3; clinical champion]

Practice 4 also had issues with the quality of work relationships within the practice. The social network appeared to be hierarchical and information was close held.

For example, the practice manager felt he was kept in the dark with regards to the

medical operations. He said they only discussed financial information at their practice

meetings. In fact, neither the practice manager nor the medical assistant knew about

MUSIC. The practice manager was frustrated that he wasn't involved any further and he

was embarrassed for not knowing any of the information we discussed about MUSIC:

> "Great doctors and clinicians…but doctors don't go to school for communications or for business…and a lot of them fall short there. And…I think it would be beneficial for the staff to know what's going on. If we, you know, for five minutes at our monthly meeting, to discuss these MUSIC things, but…it's forgotten about or put off on the back burner and not discussed, and…I'm sure when you speak with our medical assistant who's here, she'll be even more clueless than I am about it because of that. So, I don't like sitting here not knowing what I'm talking about. It frustrates me a great deal." [practice 4; practice manager]

The findings in this construct appeared to be aligned with those in the construct

Cosmopolitanism. For instance, the high implementation practices had stronger

networks and high quality work relationships inside and outside of their practice. The

low implementation practices, on the other hand, had fewer network connections

outside their organization and had issues with the quality of the professional work

relationships and communication inside the practice.

Readiness for Implementation

The construct Readiness for implementation was defined as tangible and

immediate indicators of organizational commitment to its decision to implement an

intervention. There were three sub-constructs related to implementation climate. Of

the three, the third sub-construct, Leadership engagement, was highly distinguished

between the high and low implementation practices. The leadership and senior

physicians of the high implementation practices attended the tri-annual meetings in addition to the clinical champions. The leaders and managers of both programs were committed to making MUSIC as success and they actively managed the program within their own practices. For example, both practices hired a separate person to fill the role of the data abstractor. They also sent additional physicians to the tri-annual meetings in order to give them an opportunity to get involved and better understand MUSIC.

> "Again, other doctor's involvement…has been us taking them to another meeting—taking them to a meeting, which I think is unique for our group. I don't think any other practices or any other groups are taking—visiting doctor just to have them experience MUSIC also. So that way we're getting other doctors involved and then again, just by disseminating information." [practice 1; clinical champion]

In addition, the clinical champion from practice 1 said they paid the physician's salary for the day when then visited the MUSIC tri-annual meeting, which was uncommon because they normally didn't generate revenue when they were not seeing patients in the clinic.

The low implementation practices didn't have the same leader commitment. For example, the urologist from practice 3 who was dual-hatted as the managing partner and clinical champion had spent little attention developing the MUSIC program within his practice. For example, this managing partner didn't hire a separate person for the data abstractor position. He simply gave the additional responsibilities to the practice manager and senior nurse. Consequently, they performed data entry in their personal time and were several months behind. This lack of oversight an emphasis also led to numerous quality issues with their data collection.

The senior physician in practice 4 was not involved with MUSIC related activities and the MUSIC program primarily fell upon the clinical champion to develop and manage. This practice mindfully decided to only send the clinical champion to the tri-annual meetings. They also didn't have a dedicated abstractor within the practice. Because of this lack of leadership engagement, there was a lot of uncertainty and ambiguity with respect to MUSIC.

5.5 Characteristics of Individuals Domain

Knowledge and beliefs about the intervention

This construct was defined as individuals' attitudes toward and value placed on the intervention as well as familiarity with facts, truths, and principles related to the intervention. In an effort to not duplicate the already existing information in the other domains, this analysis focused primarily on the clinical champion's perspective. This construct highly distinguished between the high and low implementation practices.

The clinical champion from the highest implementation practice knew the criteria and he repeated it verbatim. He said he was motivated to follow the criteria because it was the right thing to do for the patients. He felt that identifying imaging requirements for prostate cancer patients was a medical decision made by an urologist, so he didn't see the need to share the information with the clinical support staff. Overall, this construct was assessed as positive (+2) as the physician was very knowledgeable and his attitude was positive.

The clinical champion from practice 2 knew the criteria, although he stated in in

terms of D'Amico risk level. He said he was motivated to follow them because it was

good patient care. He said he didn't share the criteria with the support staff because the

providers ordered the tests, but he thought it would be a good idea:

> "No. Just because of mostly the providers are ordering the tests and studies
> and so forth. But yeah, I think it would be a great idea to get them involved
> as well." [practice 2; clinical champion]

Overall, this construct was assessed as positive (+2) as the physician was generally

knowledgeable and his attitude was very positive.

The clinical champion of practice 3 stated the criteria for bone scan but didn't

state the additional identifier for the CT scan. He also stated the criteria in terms of

D'Amico risk level. He originally said the criteria were important because the

professional standards lacked documentation, but it appeared he was talking about the

low-risk "choosing wisely" criteria. He also had issues with MUSIC telling him to order

imaging when it was indicated for metastatic disease:

> "Which means I should be ordering CT's when I'm not. Which, I may
> disagree with MUSIC's doing that, because CT rarely shows adenopathy. So
> I'm not exactly sure why those would fall out." [practice 3; clinical
> champion]

He didn't share the criteria with the support staff because he felt it wasn't necessary:

> "No, because the physicians determine all tests that were ordered. So once
> you tell the physicians it's a done deal." [practice 3; clinical champion]

Overall, this construct was assessed as negative (-2) as the physician seemed to be

confused about the criteria and his attitude was generally unfavorable.

The final clinical champion was in practice 4. He stated the criteria in terms of the D'Amico risk stratification. He felt the support staff didn't need to know about the imaging appropriateness criteria because the clinical staff wasn't involved in the actual decision making. His attitudes of the criteria were quite mixed. On one hand he said he believed in the evidence and thought the criteria were good for patients. Conversely, he had issues with the criteria not being generalizable to other races and ethnicities. He was also aware the criteria were different from the existing professional guidelines from the AUA. He stated that he would prefer to side on the error of ordering the imaging:

"For low risk, low stage prostate cancer, I think PSA less than ten, Gleason score six or less. No, really don't need anything, no bone scan, no prostate cancer. For med-, for high risk, I think PSA greater than 20, Gleason score eight or higher. They don't recommend CT scan and bone scan for intermediate-risk, but there's a lot of controversy and debate. The criteria that are recommended by MUSIC are a little bit different than the national criteria. And for that, I error on the side of just getting the study..." [practice 4; clinical champion]

He also stated the following beliefs about the imaging criteria:

"Right now there's leeway in that they have the recommendations but there's no stick to make sure that you follow the rules. So, you know, if they stay recommendations—that's great. But ultimately I'm sure—whenever you have recommendations usually it's followed by reporting and identifying you as a quality outlier. And negative repercussions after that." [practice 4; clinical champion]

Overall, this construct was assessed as negative (-2) as the physician did not know the criteria and his attitude about the criteria was very unfavorable.

Individual identification with the organization

The construct Individual identification with the organization was "A broad construct related to how individuals perceive the organization and their relationship and

degree of commitment with that organization." This construct weakly distinguished between high and low implementation practices.

The clinical champion of practice 1 thought the collaborative was important for synchronizing urology efforts across the state. He also said it was important in extending his social network.

> "So we can see how we are doing things compared to other urology groups and gain information that will help us take care of our patients in the best way possible. I think build relationships with other urologists—I think that's important and something that, I think, medicine is something that's being lost. You know, we all are working with computers now….and at least within urology, you know, we can stay connected and collaborate in good ways with MUSIC." [practice 1; clinical champion]

He didn't feel the collaborative had an identity as the University of Michigan. He also thought his practice had contributed to the collaborative and he didn't feel that he needed to be recognized for his individual contributions.

The clinical champion from practice 2 thought the collaborative was important for improving care. He had no issues and provided no recommendations for changing the collaborative. He also believed that the Coordinating Center was a stand-alone facility and not part of the University of Michigan. The felt that his practice contributed to MUSIC and thought he was recognized for his own contributions. The senior physician from this practice also talked very highly of the collaborative. He said it was important for smaller practices without the resources for research and development. He felt the criteria provided them with legal confidence when ordering imaging.

The clinical champion of practice 3 said he joined the collaborative because it was the "right thing." When asked to described MUSIC he said:

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> "I think MUSIC is very interesting concept. I mean, I think it's important to see how a variety of practices can collaborate the information to try and increase or improve outcomes." [practice 3; clinical champion]

He was motivated to follow the recommendations because he said "ultimately the best practice standards will come out." Overall, he had no issues with the collaborative itself. He said the Coordinating Center was great but he perceived it was part of the University of Michigan, which was "more of a detriment than a plus." He had strong feeling that Academic centers were too far from the practitioners. And finally, he thought his practice had contributed to MUSIC and he didn't feel that he needed recognition for this contribution. This construct was evaluated as neutral (0) because the positive and negative influences appeared to manifest.

The final clinical champion was from practice 4. He said they joined the collaborative to improve patient care and described MUSIC as:

> "…a collaborative designed to improve surgical quality and find best practices that are unique I think to Michigan." [practice 4; clinical champion]

When asked what motivated him to follow MUSIC's recommendations, he stated:

> "There's first, a financial incentive. And number two, there's a reduction in biopsy related complications. Those are two big things that we've seen a direct benefit from." [practice 4; clinical champion]

This clinical champion had no issues with the collaborative and said the Coordinating Center was great. He said he originally though the collaborative had an identity as the University of Michigan, but now it seemed to be more independent—which was "good." He thought his practice had contributed to MUSIC by providing data and through his individual efforts on a working group. This construct was assessed negative (-1) because

the champion focused narrowly around surgical outcomes, was motivated by financial

incentives, and perceived the Coordinating Center in an unfavorable manner.

5.6 Process Domain

Engaging

The construct Engaging was defined as attracting and involving appropriate

individuals in the implementation and use of the intervention through a combined

strategy of social marketing, education, role modeling, training, and other similar

activities. There were five roles listed under this construct (Opinion leaders and formally

appointed implementation leaders were not mentioned in the study). Each of these key

stakeholders will be described below:

Champions

The champion was defined as Individuals who dedicate themselves to

supporting, marketing, and driving through an implementation, overcoming indifference

or resistance that the intervention may provoke in an organization. This sub-construct

highly distinguished between the high and low implementation practices. As mentioned

throughout most of this analysis, the high implementation practices had clinical

champions who were very engaged. They attended the tri-annual meetings and

returned to "champion" the innovation. The low implementation practices both had

urologists who approached the role with a laissez-faire attitude. Neither of them knew

the criteria verbatim. Both said they had issues with the innovation but they never

voiced their concerns with the Coordinating Center. Neither tried to further develop or

enhance the MUSIC program within their practice.

Innovation participants

This sub-construct included the prostate cancer patients that were seen with the

urology practices. This sub-construct weakly distinguished between the high and low

implementation practices. This theme manifested when the urologist described the

process of identifying imaging requirements and their interactions with the patients.

Both of the clinical champions from the high implementation practices mentioned

talking about MUSIC with their patients during the "cancer talk":

> "Since being involved in MUSIC, I have included that in my talking point with
> them, that we're involved in a statewide collaborative effort of 90 some
> percent urology practices in the state….and we've collected data and
> shown—found out for sure that, you know, we don't need to do bone scans,
> CT scan, unless your PSA is greater than 20. So I have used that as a talking
> point. And I think that is helpful. I think that's—patients find that
> reassuring, that we're actively involved in something like that." [Medium,
> high implementation practice; clinical champion]

The clinical champions from the two low implementation practices did not mention

MUSIC or the criteria during their "cancer talk" discussion.

Executing

The construct Executing is defined as "Carrying out or accomplishing the

implementation according to plan." This sub-construct weakly distinguished between the high

and low implementation practices. None of the practices developed a formal implementation

plan, so it was difficult to assess this construct. Nonetheless, the clinical champions were asked

"On a scale of 0-10, how successful do you think your practice has been with the

implementation?" Both of the high implementation practices provided high ratings (9-10) and

said they felt they were highly successful at implementing the change. Conversely, both of the low implementation practices rated themselves lower on the scale (7-8). The clinical champions said they weren't sure how they were implementation. The clinical champion for practice 3 said he still had some staff ordering imaging when it wasn't required (overuse).

Reflecting and evaluating

The construct Reflecting and evaluating was defined as quantitative and qualitative feedback about the progress and quality of implementation accompanied with regular personal and team debriefing about progress and experience. This sub-construct highly distinguished between the high and low implementation practices. Both of the high implementation practices said they wanted to achieve MUSIC's goals. They both used the limited information from the tri-annual meetings to see where they could improve performance. Neither said they looked in the registry to check their performance. However, as previously stated, practice 2 received a monthly report from the hospital so they could to check their progress.

The other two low implementation practices did not establish any goals for MUSIC's imaging appropriateness criteria. They also didn't look into the registry to see how they were implementation or use the information from the tri-annual meetings to see where they could improve. Furthermore, the administrator of practice 4 didn't even know they had a MUSIC data registry.

5.7 Discussion

This chapter of the dissertation was intended to provide a better understanding of the barriers and facilitators of implementation within the urology practices. It was focused on the interactions among physicians within the practice and how this influenced their behavior. It also assessed the social and environmental factors that influenced the physician's intentions to follow the new evidence-based practice, the imaging appropriateness criteria.

The comparison of high and low implementing practices revealed there were numerous factors associated with implementation success. In particular, 15 of the constructs manifested more positively in the high implementation practices versus the low implementation practices. The majority of these constructs were related to social interactions and engagement within the practice.

The clinical champions in the high implementation practices were truly champions of the collaborative. It was very apparent they were highly influenced by the collaborative. They spoke very highly of MUSIC and had no issues with the imaging appropriateness criteria. They believed both were important for improving the quality of care for patients. These champions consistently engaged the professional staff to ensure they were aware of the current information related to MUSIC and the imaging criteria. They also provided feedback on performance and proactively developed materials to educate their staff. They even brought other physicians and staff members to MUSIC's tri-annual meetings. All of these efforts gave them a better understanding of the collaborative and shaped positive beliefs about the organization.

These practices also had leaders, such as the owner or senior member of the professional staff, who were involved in the implementation efforts. For example, they also attended the tri-annual meetings with the clinical champion and emphasized the importance of the collaborative at their own staff meetings. They also provided dedicated resources to ensure these efforts were successful within the practice (i.e. the allowed more physicians to attend the tri-annual meeting, which potentially decreased revenue for the practice). The behavior of these opinion leaders appeared to influence the beliefs and attitudes of the other urologists within the practice.

The high implementation practices also had high quality work relationships amongst their staff. They were very collegial and the environment appeared to be flattened, rather than hierarchical. The professional staff met regularly to discuss their clinical operations. They also talked regularly about MUSIC with the urology staff and included the nurses and clinical administrative support in the discussion as necessary (they were not directly involved with the imaging criteria, though). These activities helped to provide transparency and synchronize their efforts related to MUSIC. This was not the norm across the practices, however.

Conversely, the low implementation practices had issues with engagement and the quality of work relationships inside their practice. The environment appeared to be hierarchical and centered on professional roles. The designated clinical champions didn't actively engage their colleagues or "champion" the implementation efforts. Additionally, the leaders didn't emphasize MUSIC's activities or allocate resources to ensure they were successful. It was apparent their beliefs about the collaborative were

not as strong as the high implementation practices. Thus, knowledge of MUSIC was

often compartmentalized and kept within the professional ranks of the urologists. These

issues within the internal setting of the practice ultimately led to implementation

problems.

Most importantly, the strength and quality of the evidence appeared to be a

major barrier in these practices. The clinical champions indicated their partners had

issues with the recommendation to not order imaging for intermediate-risk patients.

The physician's questioned the evidence that indicated imaging was not clinically

necessary for these patients, especially when it was close to the cutoff for a positive

imaging study. This appeared to be an issue even though the collaborative leaders

explicitly stated these criteria were simply recommendations and clinical judgement of

the physician was imperative. This ambiguity and uncertainty was likely due to the fact

that this was an innovation and there was no published evidence.

In line with this thought, the imaging appropriateness criteria were often

contrasted against the existing professional guidelines from the AUA and NCCN, as well

as other radiology norms for imaging. The urologists in the lower implementation

practices appeared to be anchored to these existing professional standards. Several

mentioned they believed the imaging appropriateness criteria were a clear departure

from these professional standards, which was problematic. These beliefs appeared to be

centered on the risk of litigation. For example, in tort law, claims of malpractice are

based upon the acceptable standard of care and deviations from this standard. This

professional standard of care is often based upon standards or guidelines that are

generally followed in the profession, such as those from the AUA and NCCN. Thus, failing to follow the acceptable professional "standard" could place an urologist at risk of litigation if there was an issue or bad outcome related to care.

There were also environmental factors affecting the implementation efforts. The first was related to both the evidence and the urologist's beliefs about the consequences of following the criteria. Specifically, the clinical champions from the lower implementing practices believed the criteria were not generalizable to their African American patients. They believed this subset of patients had more aggressive types of prostate cancer than other races (there was evidence of this phenomenon within the urology community). However, the criteria didn't address this issue of racial differences. The urologists from these practices also stated that they had a lot of African American patients in their community, so they were more aware or sensitive to this potential issue.

These practices also mentioned there were other issues related to the patients within their community. These factors, however, were related to resources and the environment. For instance, some of the patients in their community couldn't get a bone and CT scan when it was clinically indicated because they lacked the necessary resources. This negatively affected the urologist's ability to provide quality care and it impacted the practice's imaging performance with respect to underuse of imaging when indicated.

Additionally, the clinical champions revealed they were influenced by their patients to order imaging. The patients often asked even though it wasn't clinically

necessary. They would often fulfill these requests because it would either make the patient feel more at ease or reduce the chance of litigation in the event something negative happened. Thus, these patient-level pressures influenced their ability and/or intention to follow the imaging criteria.

This phenomenon related to patient's influence, however, may be unique to cancer and the resources available. That is, cancer creates fear in patients. When someone hears they have (prostate) cancer, they naturally want to have as much done as they can to diagnose, treat, and and/or remove it. So, this demanding type of behavior may not be generalizable to other diseases. Furthermore, if patients have insurance coverage or other resources to pay for imaging, they are more likely to pursue getting the imaging done if they desire it. Meaning, either the urologist can order the imaging when it's requested or the patient will go elsewhere. This also provides a different type of pressure on the urologist.

The clinical champions in the high performing practices said they didn't have these types of issues. They believed the criteria were generalizable and applicable to all races (they also had African American patients in their community). They also believed the criteria were legally sound. In fact, one urologist believed the imaging appropriateness criteria provided him legal confidence when ordering imaging. He said he was very proud to follow it and considered it the standard of practice. Furthermore, these high performing practices said they talked with their patients about MUSIC and the imaging criteria, which seemed to reassure them that they were receiving high

quality urological care. Thus, the patient-level influences didn't affect them in the same way.

A Medical Decision

There were two constructs that didn't differentiate between the high and low implementation practice. However, they appeared to have an impact on the implementation efforts in a unique way. The first was the perceived complexity of the innovation and the second was plan for implementation.

Nearly every staff member interviewed in this study believed the innovation was not complex. They simply described the new imaging appropriateness criteria as a medical decision that was centered on the physician and the patient. It was believed to be an update to the urologist's existing medical knowledge. Because of this, the process of dissemination aligned with the normal pathways of learning within the profession of medicine. This was done to build trust and maintain professional relationships within the practice.

Because the innovation was cognitively framed as such, none of the practices developed a robust plan of implementation after it was disseminated. In fact, none of the practices indicated they used a process improvement strategy to help effectively manage the quality improvement efforts within their practice. In addition, very few of the urologists felt it was necessary to talk with the clinical support staff (i.e. nurses) about the change in the imaging guidelines.

As previously mentioned, this was a deviation from the IHI's *model for improvement,* which uses Plan-Do-Study-Act cycles to help systematically implement

changes. Previous research on from Nembhard (2009) suggested these features related to deliberate learning provide the collaborative participants with motivation, social support, and project management skills. However, if this innovation is framed as a medical decision, it may be difficult to use these activities in a productive way without seeming intrusive. Though, it would likely depend on the provider's that are involved.

Despite being a medical decision, a model for improvement could possibly help identify other key points in the process that could help with implementation. For example, one of the high performing practices was an outlier with respect to engaging the nurses and support staff. The champion of this urology practice created cue cards for the common area where imaging was ordered. This was done to remind the staff of the criteria. In addition, another physician in this practice asked his nurse to oversee the imaging orders to make sure the bone and CT scans were ordered in compliance with the imaging appropriateness criteria. These improvements appeared to contribute to their success in implementation. However, this was far from the norm as nearly all the practices kept the change within the physician ranks.

As a final thought, it's important to understand the concept of autonomy in the profession of medicine. Traditionally, physicians are autonomous practitioners and they make medical decisions based on their medical training and professional norms. Research suggests this hierarchical and individualistic culture of medicine can create issues with implementation efforts (Nembhard, Alexander, Hoff, and Ramanujam, 2009). For example, physicians are socialized to be autonomous practitioners. The professional identity developed from their socialization can overshadow an

organizational identity, which would limit an individual's motivation to collaborate with others from an "outside" organization (Nembhard, Alexander, Hoff, & Ramanujam, 2009). Therefore, a perceived attack on autonomy in decision making could be viewed as an attack on the professional themselves. Taken together, these social and psychological issues could lead to potential barriers to implementation success within the collaborative.

This phenomenon could explain a lot of the findings described in this chapter of the study. For example, the collaborative's imaging appropriateness criteria were cognitively framed as a medical decision. Therefore, a physician with a strong sense of professional autonomy may believe the criteria are restricting their medical decision making authority. Thus, they would be more likely to have a poor attitude towards the criteria and not follow the innovation.

Conversely, an urologist with no autonomy issues would likely have a positive attitude towards the collaborative and the imaging criteria, thus they would behave accordingly when ordering imaging. This underscores the importance of attitudes towards the collaborative and the concept of the "collective opinion leader." For example, if an urologist has experiences with the collaborative and has developed a positive attitude towards it (i.e. they believe it is professional, trustworthy, and legitimate), they are likely to be influenced to follow the innovation.

Chapter 6. Determinants of Behavioral Intent

As discussed in the previous chapter, a multitude of factors can influence the intentions and behaviors of the urologists within MUSIC. This part of the project aimed to build upon the qualitative findings in order to gain a better understanding of the various factors affecting the intentions and behaviors of the urologists within the collaborative. In order to do this, a questionnaire was developed based on the TDF questionnaire by Huijg et al. (2014) and the findings from the semi-structured interviews. The survey was deployed to all the urologists in MUSIC in an effort to assess the various factors that were influencing the physicians' intentions to follow the imaging appropriateness criteria. This method was used to gain a better understanding of the cognitive mechanisms underlying the intentions of the individual urologists.

The following research question is being addressed in this chapter:

1. What factors influence physicians' intentions to follow evidence-based practice?

There were several steps to this project which are explained in detail in chapter 3. In this chapter I will focus on the analysis and findings from the survey data. I start with the descriptive statistics of the survey data and then present the analysis of the factors and findings from the regression model. The instrument that was developed for this part of the study can be found in Appendix B and the results of the exploratory factor analysis can be found in Appendix D.

6.1 Descriptive Statistics of the Sample

There were 115 (75.2 percent) urologists that finished the questionnaire. This response rate was a true testament to the dedication of urologists within this collaborative. Of this total, nine indicated that they didn't provide prostate cancer care. This left a total 106 (69.3 percent) complete surveys for analysis. The descriptive statistics of the final sample is listed in Table 11. There were 32 clinical champions in the collaborative, which represented 30.2 percent of the sample. This meant there was at least one survey completed from each of the practices within the collaborative. The mean volume of prostate cancer care was 27.7 percent. Although there were a few urologists that specialized in prostate cancer care, the majority of them had less than 40 percent of their practice volume related to prostate cancer. The years of experience in practice (post-residency) ranged from 2 -45 years, with a mean of 18.7 years. The majority of the urologists in the sample had more than 10 years of experience in urology. The distribution of respondents by practice size shows the sample was relatively even across all three size categories.

There were nine urologists who started the survey but indicated they didn't provide prostate cancer care (The survey was setup with skip logic, so when the urologist indicated "no" on this first question it jumped to the end of the survey). Thus, the data for these individuals was incomplete and not used for the final analysis. A comparison between the final sample and this excluded sample shows there were a few minor differences: they were from medium and large practices and there were no clinical champions. This is expected as all the clinical champions completed the survey.

There were a few who indicated they provided a small amount of prostate cancer care

(≤ 5%), but they likely chose "no" on the first question because it was negligible.

Table 11. Descriptive Statistics of the Sample by Completed Surveys

Provided prostate cancer care (n=106)			Didn't provide prostate cancer care (n=9)[a]		
Characteristic	Percent	(n)	Characteristic	Percent	(n)
Volume of prostate cancer			Volume of prostate cancer		
0%	0.0%	0	0%	55.6%	5
1-9%	5.7%	6	1-9%	44.4%	4
10-19%	26.4%	28	10-19%	0.0%	0
20-29%	32.1%	34	20-29%	0.0%	0
30-39%	16.0%	17	30-39%	0.0%	0
40-59%	8.5%	9	40-59%	0.0%	0
>60%	11.3%	12	>60%	0.0%	0
Years of experience			Years of experience		
1-4	14.2%	15	1-4	0.0%	0
5-9	11.3%	12	5-9	22.2%	2
10-14	14.2%	15	10-14	22.2%	2
15-19	17.9%	19	15-19	33.3%	3
20-24	11.3%	12	20-24	22.2%	2
25-29	9.4%	10	25-29	0.0%	0
30-34	10.4%	11	30-34	0.0%	0
>35	11.3%	12	>35	0.0%	0
Clinical Champion			Clinical Champion		
No	69.8%	74	No	100.0%	9
Yes	30.2%	32	Yes	0.0%	0
Number of urologists in practice			Number of urologists in practice		
1-4	30.2%	32	1-4	0.0%	0
5-9	34.0%	36	5-9	33.3%	3
>10	35.8%	38	>10	66.7%	6

[a] Urologist's who indicated they didn't provide prostate cancer care were skipped to the end of the survey. Because of this, the data for these surveys was incomplete and not included in the final analysis.

6.2 Factors and Items

The results of the exploratory factor analysis is described in detail in Appendix D.

Table 12 provides a summary of these results, to include the Cronbach alpha for each

factor, as well as the rotated factor loading, mean, and standard deviation for each

item. The factor analysis produced 10 factors from 28 items. Sixteen of these items were

from the TDF questionnaire while 12 were developed from the interviews.

Table 12. Internal Consistency and the Corresponding Factor Loadings (n = 106)

Domain and Items	Response[a]	Rotated Factor Loading[b]	Source[c]	Mean	Std. Dev.
D1 Knowledge (α = 0.88)					
I am aware of the content and objectives of MUSIC's imaging appropriateness criteria	Agree	0.93	TDF (Yes)	4.62	0.58
I know the content and objectives of MUSIC's imaging appropriateness criteria	Agree	0.91	TDF (Yes)	4.47	0.69
I believe there is enough evidence to justify following MUSIC's imaging appropriateness criteria	Agree	0.86	Interviews	4.47	0.64
D3 Social/ professional role and identity (α = 0.52)					
It is my responsibility as a physician to identify when a patient requires a bone or CT scan when staging newly-diagnosed prostate cancer*	Agree	-0.70	TDF (Yes)	4.90	0.31
Ordering a bone and CT scan is something I always do when staging patients with newly-diagnosed prostate cancer	Agree	0.71	TDF (No)	1.33	0.56
In my established clinic work-flow, support staff (i.e. registered nurse or medical assistant) help me identify when a patient requires a bone or CT scan for staging newly-diagnosed prostate cancer	Agree	0.77	Interviews	1.42	0.65
D4 Beliefs about capabilities (α=.96)					
How much control do you have when ordering bone scans when staging patients with newly-diagnosed prostate cancer?	Control	0.98	TDF (No)	4.68	0.49
How much control do you have when ordering CT scans when staging patients with newly-diagnosed prostate cancer?	Control	0.98	TDF (No)	4.66	0.51
D6 Beliefs about consequences (α = 0.68)					
If I follow MUSIC's imaging appropriateness criteria it will have a broader impact on prostate cancer care	Agree	0.81	TDF (Yes)	4.08	0.78
For me, MUSIC's imaging appropriateness criteria are…	Useful	0.69	TDF (No)	4.58	0.62
I believe MUSIC's imaging appropriateness criteria will hold up to legal scrutiny	Agree	0.68	Interviews	4.13	0.83

I would follow MUSIC's imaging appropriateness criteria regardless of patient demographics, such as age, race, ethnicity or socioeconomic status	Agree	0.66	Interviews	4.30	0.71
D7 Reinforcement (α=.57)					
How often do you get financial reimbursement when ordering bone scans?	Always	0.87	TDF (No)	1.08	0.47
How often do you get financial reimbursement when ordering CT scans?	Always	0.87	TDF (No)	1.35	0.95
D11 Environmental context—Patients (α = 0.37)					
Even if it's NOT indicated in accordance with the MUSIC's imaging appropriateness criteria, I feel the need to order a bone and CT scan to protect myself legally	Agree	0.81	Interviews	1.76	0.66
Even if it's NOT indicated in accordance with the MUSIC's imaging appropriateness criteria, I feel the need to order a bone and CT scan when a patient requests it	Agree	0.66	Interviews	2.57	1.01
My patients have sufficient financial resources (e.g. insurance coverage) to order bone and CT scans in accordance with MUSIC's imaging appropriateness criteria*	Agree	-0.53	TDF (Yes)	3.70	0.76
D11 Environmental context—Resources (α = 0.56)					
Even if it IS indicated in accordance with the MUSIC's imaging appropriateness criteria, I feel that I don't need to order a bone and CT scan because it's a waste of resources	Agree	0.84	Interviews	1.63	0.72
If I order a bone scan to stage a newly diagnosed prostate cancer patient, and the results are negative, I feel that I don't need to order a CT scan because it's a waste of resources	Agree	0.76	Interviews	2.08	0.95
If I follow MUSIC's imaging appropriateness criteria it will disadvantage my relationship with my radiology colleagues	Agree	-0.58	TDF (Yes)	1.51	0.75
D12 Social influences —Subjective Norms (α = 0.78)					
Most physicians who are important to me think I should order a bone and CT scan in accordance with MUSIC's imaging appropriateness criteria	Agree	0.91	TDF (Yes)	3.97	0.85
Most physicians whose opinion I value would approve of me ordering a bone and CT scan in accordance with MUSIC's imaging appropriateness criteria	Agree	0.91	TDF (Yes)	4.32	0.64
D12 Social influences—Collaborative (α = 0.75)					
I believe that I am a valued member of the MUSIC?	Agree	0.78	Interviews	4.09	0.77
What is your overall satisfaction with	Satisfied	0.89	Interviews	4.42	0.69

MUSIC?					
Considering your experience with MUSIC, how likely would you be to recommend MUSIC to other urologists who are not associated with the collaborative?	Likely	0.80	Interviews	4.68	0.54
D14 Behavioral regulation (α = 0.64)					
I keep track of my overall progress towards MUSIC's goals for imaging Appropriateness criteria	Agree	0.68	TDF (No)	3.60	1.08
I have a clear plan of how I will order bone and CT scans in accordance with MUSIC's imaging appropriateness criteria	Agree	0.85	TDF (No)	4.42	0.72
I believe I have contributed to the success of MUSIC's imaging appropriateness criteria	Agree	0.81	Interviews	4.24	0.76

[a] Agree: Strongly disagree – strongly agree; Control: No control at all – total control; Useful: Not useful at all – Very useful; Always: Never – all of the time; Satisfied: Very dissatisfied – very satisfied; Likely: Very unlikely – very likely

[b] Rotated factor loading represents how the item is weighted for each factor and the correlation between the item and the factor.

[c] (Yes/No) indicates TDF discriminant content validity from Huijg et al. (2014)

*Indicates scales were reversed to calculate a domain score.

6.3 Analysis of Factors

Pearson's correlation and defined as low (0.0 to 0.39), moderate (0.40 to 0.69), or high (0.70 to 1.0). The correlations between the factors ranged from low to high (Table 13). The factor Knowledge correlated highly with Behavioral regulation (0.76; $p <$ .001), and moderately with Beliefs about consequences (0.64; $p < $.001), and the two factors related to Social influences: Subjective Norms (0.61; $p < $.001) and Collaborative (0.62; $p < $.001). Beliefs about consequences was also moderately correlated with Behavioral regulation (0.64; $p < $.001) and the factors Subjective Norms (0.62; $p < $.001) and Collaborative (0.48; $p < $.001). And finally, Behavioral regulation was moderately correlated with the sub-factors Subjective Norms (0.57; $p < $.001) and Collaborative (0.59; $p < $.001). This is likely due to the fact that urologist's who are familiar with the

imaging criteria, have a favorable attitude of the collaborative, feel social pressure to follow it, have a plan, and know their imaging performance.

The factor related to Patients was negatively correlated with Subjective Norms (-0.39; p < .001). This suggests that an urologist's increased perception that others expect them to comply with the imaging criteria would reduce their beliefs that they need to order imaging to protect themselves legally or when a patient requests it. Additionally, the factor Resources was negatively correlated with the factor Collaborative (-0.31; p < .001). This appears to show that increases in favorable attitudes towards the collaborative would decrease environmental influences or pressures related to resource usage.

Table 13. Correlation Matrix of the Factors

	Knowl.	Role & Ident.	Beliefs Capab.	Beliefs Conseq.	Reinf.	Environ. (Patient)	Environ. (Res.)	Social Inf. (Norms)	Social Inf. (Collab.)	Beh. Reg.
Knowledge	1.00									
Role and Identity	-0.28**	1.00								
Beliefs Capabilities	0.07	-0.08	1.00							
Belief Consequences	0.65***	-0.17	0.11	1.00						
Reinforcement	0.03	0.01	-0.15	-0.05	1.00					
Env. (Patients)	-0.15	0.17	-0.06	-0.33***	0.11	1.00				
Env. (Resources)	-0.26**	0.23*	-0.20*	-0.30**	-0.07	0.21**	1.00			
Social Inf. (Norms)	0.61***	-0.21*	0.09	0.62***	-0.07	-0.39***	-0.20*	1.00		
Social Inf. (Collab.)	0.62***	-0.20*	0.16	0.48***	0.10	-0.18	-0.31***	0.34***	1.00	
Beh. Regulation	0.76***	-0.26**	0.12	0.64***	-0.08	-0.30**	-0.27**	0.57***	0.59***	1.00

*** p<.001, ** p<.01, * p<.05

A mean score and 95% confidence interval was calculated for each of the factors (See Figure 10) to provide a cursory review of the facilitators and barriers to implementation. The maximum value of the scale was five and the lowest was one. A

low mean score for the domain suggests that it may be a barrier for implementing the imaging appropriateness criteria, while a higher mean score suggests the domain may help facilitate implementation. The red bar across the middle of the graph is a point of reference, depicting the middle of the scale.
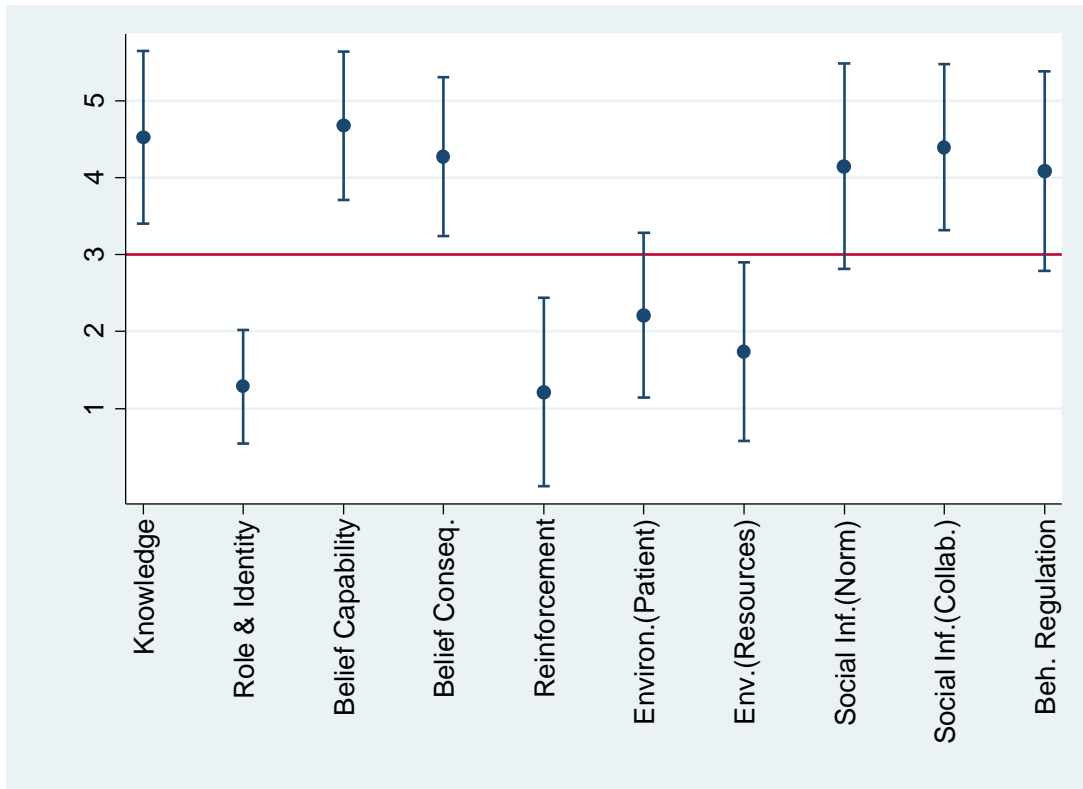

Figure 10. The mean factor scores with 95% confidence intervals (n = 106).

The mean factor scores show there are six factors that appear to be facilitators of implementation. They are Knowledge (4.52), Beliefs about capabilities (4.67), Beliefs about consequences (4.27), Subjective Norms (4.15), Collaborative (4.39), and Behavioral regulation (4.09). Conversely, there are four potential barriers to implementation within the collaborative. This can be seen in the following factor scores: Social/professional role and identity (1.28), Reinforcement (1.21), Patients (2.21), and

Resources (1.74). It is, however, difficult to understand the relationships among the factors or how they impact implementation from this type of cursory review. For example, Reinforcement has the lowest mean score and thus appears to be a barrier to implementation. However, there were no financial incentives to follow the criteria and few physicians received financial reimbursement when ordering imaging.

6.4 Assessing Determinants of Behavioral Intent

For an empirically-based assessment, a regression analysis was used to assess the relationships between the factors and the urologist's intention to follow imaging appropriateness criteria (see Figure 11). There were six different regression models used in this assessment. The first four were reduced models to explore the relationships between the smaller groupings of related factors. The fifth model was the full model to assess all the variables together. The final regression model is a reduced model with

Factors

Knowledge
Beliefs about consequences

Beliefs about capabilities
Reinforcement
Environmental context (patients)
Environmental context (resources)

Professional role & identity
Social influences (Norms)
Social influences (Collaborative)
Behavioral regulation

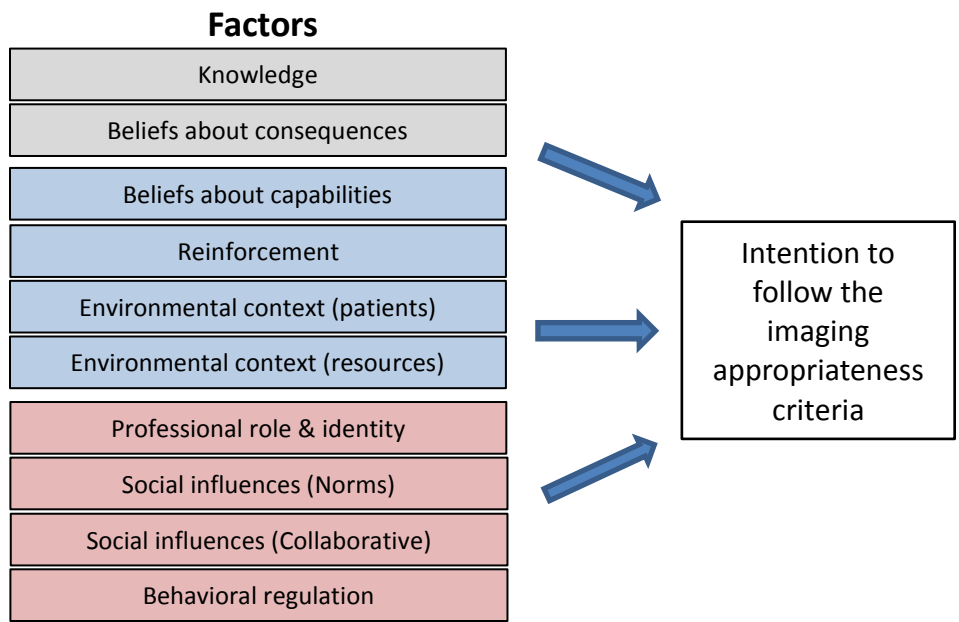Intention to follow the imaging appropriateness criteria

Figure 11. Factors used to predict intention to follow the imaging criteria.

only the statistically significant factors from the full model. Table 14 provides a summary of the results.

The first regression model assessed the effects of the urologist's knowledge and beliefs about the consequences of the imaging appropriateness criteria. Both of these predictor variables were statistically significant and positively related to behavioral intent. The factor related to knowledge had a beta coefficient of 0.58 ($p<.001$) while the factor related to beliefs about consequences had a beta coefficient of 0.29 ($p<.001$). The item related to practice size was also significant and negative, suggesting urologists in smaller practices were more likely to have a higher intention to follow the imaging criteria that those in larger practices. Overall, this simple model with two predictors accounted for 67% of the variance in behavioral intent ($F(7, 98) = 28.66$, $p<0.001$).

The next model assessed the factors related to behavioral control and the external environment. Two predictor variables related to the environmental context and resources were statistically significant and negatively related to behavioral intent. The factor related to the patients had a beta coefficient of -0.28 ($p<.01$) and the other related to resources had a beta coefficient of -0.26 ($p<.01$). The control for practice size was also significant. These findings suggest the external environment can play a role in shaping the beliefs and intentions of the urologists. Overall, this model accounted for 26% of the variance in behavioral intent ($F(9, 96) = 3.81$, $p<0.001$).

Table 14. Standardized Beta Coefficients of Regression Models Predicting Intent

Factor	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Knowledge	0.58***				0.54***	0.57***
Beliefs Conseq.	0.29***				0.20*	0.23**
Env. (Patients)		-0.28**		-0.06	-0.15*	-0.16**
Env. (Resources)		-0.26**		-0.07	-0.05	
Reinforcement		-0.04		-0.05	-0.06	
Beliefs Capab.		-0.01		-0.07	-0.07	
Beh. Regulation			0.36***	0.33***	0.02	
Social Inf.(Norms)			0.26***	0.25**	0.01	
Social Inf.(Collab.)			0.21*	0.21*	0.05	
Role and Identity			-0.15*	-0.14*	-0.12*	-0.13*
Volume	0.02	0.05	-0.02	-0.02	-0.01	-0.01
Experience	-0.06	-0.05	-0.04	-0.02	-0.01	-0.02
Champion	-0.08	0.11	0.04	0.03	-0.07	-0.05
Practice Size	-0.16*	-0.22*	-0.06	-0.09	-0.18*	-0.19**
Wave of Entry	-0.04	-0.04	-0.01	0.00	-0.05	-0.06

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
*p ≤ 0.05	n = 106	n = 106	n = 106	n = 106	n = 106	n = 106
**p ≤ 0.01	$F_{(7,98)}=28.66$	$F_{(9,96)}=3.71$	$F_{(9,96)}=15.69$	$F_{(13,92)}=10.96$	$F_{(15,90)}=15.48$	$F_{(9,96)}=26.35$
***p ≤ 0.001	pr <0.001	pr <0.001	pr <0.001	pr <0.001	pr <0.001	pr <0.001
	$R^2 = 0.67$	$R^2 = 0.26$	$R^2 = 0.60$	$R^2 = 0.61$	$R^2 = 0.72$	$R^2 = 0.71$
	VIF=1.45	VIF=1.21	VIF=1.44	VIF=1.43	VIF=1.82	VIF=1.48

The third model assessed several factors related to the social interactions and attitudes towards the collaborative itself. All four of these predictors were statistically significant. The factor related to Professional role/identity had a beta coefficient of -0.15 ($p<.05$), suggesting a urologist with stronger beliefs related to professional roles, such as autonomy in decision making, was less likely to intend to follow the imaging criteria. On the other hand, the two factors related to social influences were both positively associated with intent. The factor subjective norm had a beta coefficient of 0.26 ($p<.001$) while the factor related to attitudes towards the collaborative had a beta coefficient of -0.21 ($p<.05$). Finally, the factor related to Behavioral regulation was positively related to intent with a beta coefficient of 0.36 ($p<.001$). This model accounted for 60% of the variance in behavioral intent ($F(9, 96) = 15.69$, $p<0.001$). These findings suggest that social factors can play a significant role in shaping the beliefs and intentions of the urologists within the collaborative.

Next I tested a combination of factors related to the external environment and social influences. All four of the factors related to social influences were still statistically significant and their beta coefficients changed very little from model 3. On the other hand, the factors related to the environment were not significant predictors of intention. The model itself was significant ($F(13, 92) = 10.96$, $p<0.001$) and it accounted for 61% of the variance in behavioral intent. These findings suggest that factors related to social influences can play a significant role in shaping the beliefs and intentions and could also have a mediating effect on the environmental factors.

To assess the effects of all the factors, the fourth regression model was constructed as a full model. This model produced four statistically significant factors and one significant control. It also accounted for 72% of the variance in behavioral intent. However, the variance inflation factor (VIF) was high (1.82) indicating there were multicollinearity issues. The highest VIF scores were for Knowledge and Behavioral regulation, which makes sense as the two are highly correlated (i.e. if an urologist doesn't know about the imaging criteria they are less likely to have a plan and/or keep track of their progress). Additionally, there are too many parameters being estimated in this model for this sample size. Because of these issues, the number of predictors was reduced to stabilize the results.

The final regression model tested only the statistically significant factors from the full model. Removing several of the factors improved the VIF (1.48) and brought number of estimated parameters to a normal level. This final model was statistically significant (F(9, 96) = 26.35, $p<.001$) and accounted for 71% of the variance in behavioral intent. The factor related to Knowledge had the highest beta coefficient at 0.57 ($p<.001$). The second highest factor was Beliefs about consequences with a beta of 0.23 ($p<.01$). The other two statistically significant factors were negatively related to behavioral intent. The first factor was Professional role and identity, with a beta coefficient of -0.13 ($p<.05$) and the other was Environmental context (Patients), with a beta coefficient of -0.16 ($p<.01$). The control for practice size was also significant ($p<.01$).

As a final check, I adjusted the standard errors for the practice level. This adjustment didn't make a difference in the results, suggesting the variation was mainly attributed to the individuals rather than the practices they were embedded within.

6.5 Discussion

This part of the dissertation aimed to build upon the qualitative findings in order to gain a better understanding of the various factors influencing the physicians' intentions to follow evidence-based practice. A survey instrument was constructed and deployed to accomplish this assessment and answer the research question. The exploratory factor analysis of the questionnaire items produced 10 factors from 28 items. These 10 factors covered a wide range of theoretically-based behavioral determinants related to the individual's beliefs and attitudes of innovation and their surrounding environment.

The regression analysis shows the strongest predictors of behavioral intention are knowledge of the imaging criteria and Beliefs about the consequences. These two factors alone accounted for 67% of the variance in the urologist's intention to follow the imaging appropriateness criteria. The findings appear to validate those from the qualitative research. That is, the urologist's intention to follow the criteria is increases considerably when they are aware of the criteria and believe there is enough evidence to justify following it. Additionally, the urologist's intention will increase if they believe the criteria will hold up to legal scrutiny, it will have an impact on prostate cancer care, and believe it's useful, regardless of patient demographics. Thus influence attempts should focus on these facilitators of implementation.

It's important to note that these factors were not explicitly addressed in the previous literature on collaborative effectiveness. Although studies have focused on the innovation, such as packaging, they provide little detail about these specific drivers of beliefs, such as the evidence or potential legal issues related to the innovation. In addition, these two items related to evidence and legal scrutiny were developed from the interview data and will contribute to the research with the Theoretical Domains Framework.

Implementation is more likely to be successful when an urologist has a clear plan and monitors their progress (Behavioral regulation). The previous literature on collaborative effectiveness focused on this type of deliberate learning, so this support the findings there. However, the factor related to these concepts is highly correlated with the factors Knowledge, Beliefs about consequences, and the two factors related to Social Influences, making it difficult to determine the true effects. This makes sense, however, as an urologist who has a plan and monitors their performance towards the criteria is also likely to have favorable attitude towards the collaborative and know the specific details about the criteria. In addition to the collinearity issue, it's hard to determine if the factor related to Behavioral regulation is an actual determinant of intention or if there is reverse causality. Meaning, a higher intention to behave in a certain way could predict if a person has a plan.

There were several factors related to social influences or interactions among the staff (model 3). The factors related to subjective norms and attitudes towards the collaborative were positive and statistically significant predictors of intentions. These

findings suggest that positive attitudes towards the collaborative and higher perceptions of social influence to follow the criteria will be facilitators of implementation. This aligns with the findings from the collaborative and the practice research. That is, opinion leaders and positive attitudes towards the collaborative helped to influence people to follow the innovation. Also, as described in the previous chapters, having a stronger attitude towards the collaborative will increase a person's intention to follow the criteria. Thus, it's clear to see that social influences play a major role in implementation efforts. It's important to note, the items measuring attitudes towards the collaborative are also newly developed and will contribute to the TDF research.

Conversely, the factor associated with professional role and identity was significant and negatively related to intentions. This suggests that urologists with higher professional identity issues, such as those mentioned with respect to autonomy, will have less intent to follow the criteria. These finding also validate the qualitative research. That is, physicians that appeared to have more issues with hierarchy or strong physician identity were more likely not to follow the criteria.

Both patients and resources were significant and negatively associated with behavioral intention. These results validate the findings from the qualitative research. That is, factors associated with patients and the resources environment can impede implementation efforts. Therefore, these barriers should have interventions developed to reduce their impact on the collaborative's implementation efforts. For example, several urologists discussed MUSIC and the imaging appropriateness criteria with their patients. They said their patients felt like they were receiving high quality of care

because they were following the criteria. Thus, this type of intervention (talking points) would likely help reduce patient level influences.

The Social influences (Subjective Norms) factor was also negatively correlated with Environmental context (Patients), which suggests that normative beliefs would help reduce the impacts of patient-level factors. Furthermore, the Social influences (Collaborative) factor was negatively correlated with Environmental context (Resources), suggesting stronger attitudes towards the collaborative would reduce the impacts of resource norms in the environment. These findings also validate those in the qualitative work in the previous chapter.

Chapter 7. Conclusions

In this dissertation, I have reported on a multimethod study of the barriers and facilitators to implementation within the Michigan Urological Surgery Improvement Collaborative. I conducted seven months of field research throughout MUSIC to study the history and organization of the collaborative and the social interactions between the Coordinating Center and the practice members. I conducted field site visits and interviews with key members of the urology practices to assess and explain the barriers and facilitators of the implementation efforts within the urology practices. I then developed and deployed an instrument to assess and explain the specific factors affecting the behavioral intentions of the urologists in the collaborative.

Through this extensive assessment, I have shown how the collaborative can organize in a purposefully way to positively shape the intentions and behaviors of the individual members. I have shown that subjective norms and positive attitudes towards the collaborative will facilitate the implementation efforts by improving behavioral intentions. My research has shown that knowing and understanding the imaging criteria and the evidence that supports it, as well as having strong beliefs about the consequences, are highly significant predictors of the urologist's intention to follow this innovation. And finally, beliefs related to professional identity, along with patient or resource constraints, can be barriers to implementation efforts.

In this final chapter, I review and synthesize my contributions. Then I discuss the implications of my work. I conclude with a discussion of limitations and possibilities for future research.

7.1 Contributions

The primary contribution of this research is the characterization of the individual, organizational, and environmental factors influencing the healthcare professionals' behavioral intent. This offers guidance to researchers, policymakers, and practitioners in understanding how these types of factors can impact collaborative effectiveness. In this section, I review and synthesize the main findings and conclusions of the three chapters.

In chapter 4, I provided an historical overview of the formation of MUSIC and how it was organized. I also described the interactions between the collaborative leaders and the individual physicians participating as collaborative members and analyzed how these interactions supported the physicians' uptake of the innovation.

I presented several key historical events that helped set the trajectory and shape the organization to be what it is today. I found that the collaborative was built in the backdrop of other collaborative quality initiatives in Michigan. Early successes in quality improvement efforts helped establish legitimacy for the leaders and launch this physician-led collaborative quality initiative. The collaborative was sponsored by the state's largest health insurer, Blue Cross Blue Shield of Michigan, under the Value Partnership Program. They established the Coordinating Center and built the foundation of the collaborative through interpersonal relationships. One of the first major initiatives

of the MUSIC was to establish the data collection system. This enabled them to study the diagnosis and treatment patterns across the state, which was key in advancing the innovation.

I showed there were specific strategies that the collaborative leaders used to ensure its success. These strategies included: 1) organizing the collaborative's activities to appear unobtrusive, build trust, and maintain professional relationships; 2) framing operations positively and promoting the collaborative's success in quality improvement; and 3) using a grassroots effort to develop the innovation. I suggested these strategies helped to positively shape the collaborative members' beliefs and attitudes about the collaborative and the innovation. Thus, the influence attempts from the collective ultimately influenced opinion of the urologists to follow the innovation. Therefore, the collaborative itself took on the role as the "collective opinion leader."

In chapter 5, I described the barriers and facilitators of implementation efforts within several high and low implementation practices. I focused on the interactions among physicians within the practice and assessed the social and environmental factors that influenced the physician's intentions to follow the imaging appropriateness criteria. In total there were seven constructs that highly differentiated between high and low implementation practices and they centered on the inner setting and the process.

I showed that the urologists believed the imaging appropriateness criteria were not complex and simply a medical decision that was centered on the physician and the patient. Because it was cognitively framed in this manner, there was no formal plan or model for improvement employed. Rather, the process of dissemination and

implementation aligned with the normal pathways of learning within the profession of medicine. This was done to build trust and maintain professional relationships within the practice.

Several factors played a significant role in facilitating the adoption and use of the imaging appropriateness criteria. The high implementation practices had champions that spoke very highly of MUSIC and the imaging appropriateness criteria. They also proactively engaged their professional staff and provided education and feedback so the urologists were aware of the collaborative and their contribution. In addition, the leaders were engaged in the efforts, and they fostered a collegial work environment, which set the conditions for success. I proposed these activities helped positively shape the beliefs and attitudes of the urologists towards MUSIC and the imaging criteria. This influenced them to not only adopt and use the innovation, but to talk about it with their patients.

I also showed that the practices with low implementation effectiveness did not have the same positive influences shaping the urologists' beliefs about the collaborative and the innovation. Therefore, the urologist's questioned the quality of the evidence of the criteria and contrasted it against the existing professional guidelines and radiology norms. They were also influenced by patients and resources within the community. These beliefs appeared to be centered on the risk of litigation and the negative consequences of following the criteria.

I proposed this behavior was tied to professional autonomy in decision making. I argued that the collaborative's work as a "collective opinion leader" had a major effect on breaking down the barriers related to professional identity and autonomy.

In Chapter 6 I used the survey data from a TDF-based questionnaire that I developed and deployed to assess the factors affecting the urologist's intention to follow the imaging appropriateness criteria. The exploratory factor analysis of the survey items produced 10 factors related to behavioral determinants. The mean analysis score of these factors revealed there were six facilitators and four potential barriers of implementation.

The results of the regression suggest knowledge of the criteria and beliefs about consequences were statistically significant predictors of intent, accounting for 67% of the variance in the urologist's intention to follow the criteria. Of all the factors, knowledge of the imaging criteria was by far the strongest predictor of intent. This suggests attempts to increase intentions should focus on the beliefs related to the evidence and the consequences of following the criteria.

The factors related to subjective norms, attitudes towards the collaborative, and behavioral regulation were also statistically significant predictors of intentions. The factors associated with professional role and identity, patients, and resources were significant and negatively associated with intention. All of these results validate the findings from the qualitative research. That is, social interactions and engagement can facilitate implementation while patients and the environment can impede implementation efforts. Moreover, the factors related to the collaborative and

subjective norms were negatively related to resources and patients, respectively. This

could suggest that the effects of the patients and resources diminish as organizational

identity and social influences increase. This would validate the qualitative findings.

Together these three chapters provide a rich characterization the various factors

that can influence the behaviors of the healthcare professionals' within of a quality

improvement collaborative. More importantly, it underscores the important concept

that the collaborative itself can be mindfully organized to influence behavioral change.

7.2 Implications

The findings from this research lead to a number of implications for policy and

practice, research and methods, and organizational theory.

This research provides implications for both policymaking and practice. First, the

collaborative for quality improvement in this study was physician-led, but truly a team

effort. It included the state's largest insurer, Blue Cross Blue Shield of Michigan, along

with medical professionals from across the state. The innovations that were made

within prostate cancer care would likely not have happened without this level of

support from these major stakeholders. Policymakers, as well as leaders in medicine,

should provide incentives and research funding for these innovative ways to bring

stakeholders together and improve the quality of care in medicine.

Additionally, this effort required some investments in infrastructure. The

Coordinating Center and the data collection system of the collaborative were

instrumental to these improvement efforts. This provided the necessary oversight to

advance the efforts. The data collection system in particular enabled the systematic

collection of the diagnosis and treatment data from the various health records being used across the collaborative. This data was key for analyzing opportunities for improvement; it helped the collaborative move from reducing variation for the existing professional standards to developing and implementing an innovative evidence-based practice. Policymakers should support funding for this type of infrastructure to support the long-term establishment of quality improvement collaboratives.

The data collection system also provided transparency and performance reporting, but in a respectful manner. The collaborative purposefully organized the performance reporting system to build trust and maintain professional relationships. More specifically, they produced benchmarking reports with de-identified information at the practice and individual-level. Thus it provided the necessary feedback to the urologists and clinical champions—it benchmarked them against their peers, yet it maintained their anonymity. Ironically, this way of organizing is in direct contradiction to today's healthcare environment, where performance reporting is often focused on transparency and accountability in a punitive way. Policymakers and practitioners should, however, develop systems of reporting for quality improvement activities that accomplish the objectives of providing transparency and accountability, all while maintaining trust and professionalism. This would likely break down many barriers.

This research also provides implications for studying and implementing organizational change within a collaborative setting. This research was developed using the stepwise approach suggested by Skolarus and Sales (2015). I first identified the barriers and facilitators of implementation using the CFIR. I then developed a TDF-based

instrument to measure the determinants of behavior and used this data to predict a

healthcare provider's intentions. The next step in this design is to develop the

intervention and subsequent implementation strategies to address the specific barriers

and facilitators of behavioral intention (Fishbein and Ajzen, 1975; Michie, Van Stralen,

and West, 2011). This systematic approach would likely improve the uptake and routine

use of the intervention and the collaborative's effectiveness. This innovative method

will also advance the field of Implementation Science (Skolarus and Sales, 2015).

And finally, this research also has theoretical implications in organizational

theory. I argued the mindful work of the collaborative helped to strengthen the

urologist's attitudes towards the organization, which had a major effect on breaking

down the barriers related to professional identity and autonomy. I proposed that the

success of the collaborative also helped to establish its legitimacy across the profession,

which positively influenced the urologists to follow the collaborative and the innovation.

Therefore, the collaborative itself took on the role as the "collective opinion leader."

That is, the opinion of the collective shaped the behaviors of the individuals. Previous

research in this area of opinion leadership has primarily focused on an individual's

influence on others (Rogers, 2010).

7.3 Limitations and Future Work

There were several limitations to the qualitative research. First, the sample was

small for the comparative case study analysis, limiting the generalizability of the

findings. This research also did not assess the full range of practices by size, such as

larger practices or practices with only one physician. This was a significant predictor of

intention to behave in the regression models. Thus, future research should focus on this characteristic of the practice.

Furthermore, the nature of qualitative methods involves an inherent level of subjectivity in data collection and analysis. The findings drawn from this research would have been strengthened by triangulation with an additional reviewer. Several procedures were included in this analysis to ensure a high level of internal validity in findings and drawing conclusions from the qualitative data. However, future research would benefit from quantitative validation.

There were also several limitations with the survey data. The size of the sample affected the factor analysis. More specifically, the sample was small and the number of items was large. This made it impossible to run the factor analysis with all the items. Thus, increasing the sample size would help to test the factor structure of more items and possibly reduce the number of items further.

Additionally, the items related to subjective norms were very general in nature. They did not determine if the perceived social pressures were coming from within the practice or from the larger collaborative. The items also did not differentiate if the perceived social pressure was from the leader of the practice or the clinical champion. Future research would benefit from this distinction to see which roles might have more influence on the person's behavior.

In addition, several of the factors related to the criteria and collaborative were highly correlated (i.e. knowledge of the criteria, beliefs about consequences, attitudes towards the collaborative, and behavioral regulation). This suggests there is possibly a

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higher-level factor related to beliefs and attitudes about the collaborative in general. For example, if an urologist doesn't know about the collaborative, they probably don't know about the imaging criteria, or if they don't know about the criteria they are less likely to have a plan and know their performance. Thus, another factor analysis could be conducted to reduce the data further. I purposefully did not do this in order to maintain the integrity the items measuring the original TDF domains. This could be an area of focus for future research, though.

The regression analysis was conducted to predict behavioral intentions. There was no assessment of the actual behavior. This was a limitation because this study was not approved by the IRB to link the survey data with other performance data (it was de-identified). This was purposefully done, however, because the sample of urologists was small to begin with. Anonymity was maintained in an effort to get more urologists to participate in the survey. Thus, future research could further analyze the relationships between the behavioral determinants and the actual behavior or the behavioral intentions and the actual behavior.

And finally, this project was conducted on a single collaborative located in a single state in the Midwest. This would likely limit the generalizability. Furthermore, the evidence-based practice in this study was a true innovation. The findings may not be generalizable to other types of changes or healthcare interventions within a collaborative setting. Also, this study focused on physicians that primarily work in a practice settings. This may not generalize to other professions or settings where multidisciplinary professionals work closely together.

APPENDICES

Appendix A. Semi-Structured Interview Guide

Hello, my name is [name of interviewer]. Introduce self and other team members in the room.

Introduce the project

The purpose of this quality improvement initiative is to independently evaluate your implementation of MUSIC's imaging appropriateness recommendations. Today's interview will mainly focus on your efforts to implement the IAR in order to get a better understanding of your experiences and codify your lessons learned.

This research has been deemed non-regulated by the University of Michigan IRB.

We will be recording today's conversation so we can transcribe and analyze the data. Your name will be kept confidential and your answers will remain anonymous. You don't have to answer all the questions if you don't feel like you need to. Please stop me at any time.

Do you have any questions for me? [Answer any questions]

Are you ready to begin? I'm going to start recording now.

I am going to ask you a series of open ended questions. I want to hear your thoughts so please do not hesitate to share whatever you believe might be related to any of the topics. Please keep in mind that there are no right or wrong answers. You know your own context best and we just want to understand your experiences.

File Name:

Interview Date:

Interviewer:

Note Taker:

CFIR CONCEPT	QUESTIONS	RATING
IIIa. Structural Characteristics	**What is your title? To whom do you report?** **What are your main responsibilities**? How is your time allocated?	How is the organization governed?
Vb3. Clinical Champion	**What role(s) do you play in MUSIC? Time allocated for MUSIC?** **Are you on any other MUSIC committees?**	Are you the clinical champion? What does this entail?
IVa. Knowledge and Beliefs of Intervention (double code) IVd. Individual identification with the organization	**Could you explain what you know about MUSIC?**	If you could describe MUSIC, what would it be?
IVa. Knowledge and Beliefs of Intervention	**Could you explain what you know about MUSIC's Imaging Appropriateness Recommendations (IAC)?**	Do you understand the difference between the IAC and the "risk based" recommendations?
Ia. Intervention Source (double code) Vb3. Networks & communication	**How did you first hear about the IAC?** **How were the IAC communicated to you?**	● When did you find out about the new IAC for Bone Scan? CT Scan? ● Triannual meeting
Ig. Intervention Characteristics (Design Quality and Packaging) (double code) IIIe2. Available resources	**What kinds of information and materials have been made available to you?**	● Slides from meeting ● Email or personal contact ● Handouts ● Only briefed information
Ib. evidence strength & quality (double code) IId. External Policy and Incentives	**What kind of information or evidence were you made aware of to show whether these IAC were appropriate?** To what degree did this evidence influence your opinion of the IAC before it was implemented?	● Information from your own experience, knowledge of AUA guidelines, published literature, or other sources? From co-workers? From supervisors?

Ib. evidence strength & quality (double code) IIa. Needs and resources	**Do you think the IAC are generalizable across races and ethnic backgrounds?**	Do they apply to African Americans who may have more aggressive cancer?
Vb4. External Change Agents (double code) Vb3. Networks & communication	**If you had a problem with these recommendations, how would you communicate it to the Coordinating Center? Who would you talk with?**	
IIId1. Tension for change (double code) IId. External Policy and Incentives	**Do/did you see a need for this type of intervention? Why or why not?** **Were other physicians reluctant to implement these IAC?**	● Did other people feel it was needed? Similar to AUA guidelines? ● Any problems with urologists in the practice (don't want to follow recommendations; don't care about MUSIC)?
Va. Plan (double code) Vb3. Clinical Champion	**How have you been involved in getting these new IAC implemented within your practice? Did you formulate a plan for how you were going to implement the IAC? With whom did you work?**	● Formal or informal planning
Vb. Engaging (double code) Vb3. Networks & communication (triple code) Vb5 Key Stakeholders	**How do you communicate the IAC to the other providers?** **To the support staff?**	● Who presented the information to the staff?
IIIe3. Access to knowledge and information (double code IIIe2. Available resources	**What info (or data/handouts) did you use to communicate the new IAC to your practice?**	
Vb. Engaging (triple code) IIIa. Structural Characteristics (triple code) IIIc. Culture	**Who do think is involved in the MUSIC collaborative within your practice? What formal positions do you have to support MUSIC?**	● Physicians only or support staff
Vd. Reflecting & evaluating	**Do you develop specific goals related to MUSIC's IAC? (e.g., Bone Scan when indicated goals)? Do you use the registry to**	● Have you seen data reports? ● If data are reported,

	look at your practice performance?	what happens in response?
If. Complexity	**And now, summing up your experience with the new IAC thus far: On a scale of 0-10, how difficult has it been to implement IAC? Why?**	0 is easy (no difficulties) à 10 (extremely difficult; it couldn't get any more difficult)
Vc. Executing	**On a scale of 0-10, how successful do you think your practice has been with the implementation? Why?**	*0 is complete failure à 10 is I can't imagine how it could be any more successful.*

Structure & Process for Implementing the Imaging Appropriateness Recommendations (Fidelity)

Patient identification - screening	Please describe your process for screening patients to determine if they need a bone scan or a CT scan. Do you use a hardcopy of the medical record or EMR?	● How do you check for PSA, Gleason, & cT ? ● EMR prompts?
Patient identification – IAC candidate	Do you talk with your staff before the patient arrives to identify patients that need a bone scan or a CT scan?	● Does your staff help identify the patients?
Patient-provider communications – shared decision making	If a patient requires imaging for staging prostate cancer, how do you introduce it to them? Do you have talking points if it is not indicated?	● Talking points for the new recommendations?
Vb6. Innovation Participants (patients)	What kind of information do you share with patients about MUSIC or the IAC? Do you have materials to provide to the patient? MUSIC IAC specific information?	● Do they review MUSIC specific info? ● Do you have a brochure?
Ordering process	Who is able to order imaging studies? When ordering the study, are there any computer prompts that alert you about the imaging guidelines?	● Anyone other than urologists, such as PA or NP?
Standardized approach or individual preference	In your practice, is this a standardized process to screen patients and order bone or CT imaging for staging patients with prostate cancer.	● Do you sit down as a team to establish the structure and process? ● Does this involve the clinical staff?
	Areas that would influence the practice	

IIa. patient needs & resources	**Have you ever had a patient that couldn't get an imaging study even though it was indicated because they didn't have insurance? Any other factors? What happens if the imaging is not required (appropriate), but the patient still requests it (because they have insurance)?**	● What do you think are reasons that patients have chosen to follow the IAC?
IIb. Cosmopolitanism (double code) IIIa. Structural Characteristics	**Do you work with a specific imaging organization?** Do you have a close working relationship with an imaging organization? If so, what type?	● Any connection to the imaging center?
IIb. Cosmopolitanism (double code) IIIa. Structural Characteristics	**What hospitals do you normally work with? Do you refer patients to them for imaging studies? Do you receive financial compensation from them?**	● Any connection to the local hospitals?
IIc. Peer Pressure (double code) IIIa. Structural Characteristics	**Are there any other urology practices that are located in this immediate area? Do you collaborate with them (MUSIC or otherwise) or is your relationship competitive?**	● Any local competitors or members of MUSIC you collaborate with?
IIId2. Compatibility (double code) IIIa. Structural Characteristics	**Do you own your own imaging equipment?**	● Which typea?
Ic. Relative Advantage	**Do you use MRI instead of CT?**	● Other imaging equal to bone scan or CT scan?
IIIe1. Leadership engagement (double code) IIIa. Structural Characteristics	**What level of involvement do/did clinical leaders at your facility have with the new IAC? Do other clinic leaders get involved in the implementation (Administrator, Nurse or MSA)?** Do you feel they are too involved or not involved enough? Why? What about administrative leaders? Facility director?	● Did they know about the new IAC? ● What kind of support do they give you? Specific example. ● Do they provide any feedback? What kind of feedback?
Vb3. Networks & communication (double code) Vb1. Opinion Leaders	**Who is the most influential person in your practice (physician, RN, admin)?** How do they influence others?	● Who is influential and why?

IIIb. Networks & communication (double code) IIIa. Structural Characteristics	**How do you normally share information in your practice? Who attends the meetings? What meeting agendas has the new IAC been on or been a topic of discussion?**	● Do you have meetings? How often (Monthly, weekly, adhoc)? ● Surgeons, support staff, admin?
IIId3. Relative Priority	**How do you prioritize the implementation of MUSIC's initiatives against your practice's operations?**	Example with imaging, swab, checklist, and augmented antibiotics.
IIId5. Goals and feedback	**Do you track performance measures for your practice? Do you have a formal ways to evaluate the employees in the practice?**	Example: Financial, quality, or productivity. Does this include the physicians?
IIId4. Organizational Incentives & Rewards	**Do you provide incentives or awards for performance? Do you provide incentives for MUSIC related performance?**	Does this include the physicians?
IIId6 Learning Climate	**Do you have Quality Improvement projects in your practice?** What types of activities? What type of change philosophy do you employ (PDSA, LSS)?	Formal programs for improvement?
IIId6 Learning Climate	**Do the physicians train and mentor the support staff? Can the support staff bring problems directly to the physicians?**	Collegial relationships?
IIIc. Culture (double code) IIId6 Learning Climate	**Can the support staff bring problems directly to the physicians?**	Hierarchical or collegial relationships?
IIIe2. Resources	**What resources are dedicated for implementation and on-going operations** (including money, training, education, physical space, and time)? **Do you have any issues with not having resources for implementing the IAC?**	● How do you track the amount of time per person?
	Now, taking a step back, I'd like to ask a few more general questions.	
IVe. Motivation	**What motivates you to follow MUSIC's recommendations**? How or why?	

IVd. Individual Identification with the organization (double code) IIb. Cosmopolitanism	**What are your thoughts of MUSIC?** **Why did your practice join?** **Do you feel your contribution (individual or practice) has made a difference with MUSIC?** Do you feel that you are recognized for your contributions to the collaborative?	
Ia. Innovation Source	**So do you feel that the collaborative has too much of an identity as the University of Michigan?** When you envision the Coordinating Center, do you think it is a part of the University of Michigan?	
IVd. Individual Identification with the organization	If you could change anything about the collaborative, what would it be? What would you want to see from the Coordinating Center? If you could change it, what would you do?	*Reporting time?* *Type of data?*

Appendix B. MUSIC Survey

Michigan Urological Surgery Improvement Collaborative   (MUSIC)

Thank you for agreeing to participate in our survey. Your inputs will be very valuable to us in our efforts to improve the Michigan Urological Surgery Improvement Collaborative (MUSIC).

Before we get started, could you please answer the following question?

Do you provide care related to the diagnosis and/or treatment of patients with prostate cancer?

Note: If you answer "No" to this question the survey will skip to the end and bypass the questions specific to prostate cancer.

Yes   ○

No   ○

This group of questions focus more generally on ordering bone and computed tomography (CT) scans when staging patients with newly-diagnosed prostate cancer. Please answer the following questions as they pertain to this subject.

1. Please indicate your level of agreement or disagreement with the following statements...

	Strongly Disagree	Disagree	Neither Disagree	Agree	Strongly Agree	Don't Know
a. It is my responsibility as a physician to identify when a patient requires a bone or CT scan when staging newly-diagnosed prostate cancer	○	○	○	○	○	○
b. Ordering a bone and CT scan is something I always do when staging patients with newly-diagnosed prostate cancer	○	○	○	○	○	○
c. In my established clinic work-flow, mid-level providers (i.e. nurse practitioner or physician assistant) help me identify when a patient requires a bone or CT scan when staging newly-diagnosed prostate cancer	○	○	○	○	○	○
d. In my established clinic work-flow, support staff (i.e. registered nurse or medical assistant) help me identify when a patient requires a bone or CT scan for staging newly-diagnosed prostate cancer	○	○	○	○	○	○

2. How much control do you have when ordering the following imaging studies when staging patients with newly-diagnosed prostate cancer?

	No control at all	Little Control	Some control	A lot of control	Total control	Don't Know
Bone Scan	○	○	○	○	○	○
CT Scan	○	○	○	○	○	○

3. How often do you get financial reimbursement when ordering the following imaging studies?

	Never	Rarely	Sometimes	Often	All of the Time	Don't Know
Bone Scan	○	○	○	○	○	○
CT Scan	○	○	○	○	○	○

The next group of questions focuses specifically on MUSIC's imaging appropriateness criteria. These criteria were released at MUSIC's collaborative-wide meeting in January of 2014 in an effort to improve the quality of care when ordering bone and CT scans when staging patients with newly-diagnosed prostate cancer. Please answer the following questions in reference to these criteria.

4. Please indicate your level of agreement or disagreement with the following statements...

	Strongly disagree	Disagree	Neither Disagree	Agree	Strongly Agree	Don't Know
a. I am aware of the content and objectives of MUSIC's imaging appropriateness criteria	○	○	○	○	○	○
b. I know the content and objectives of MUSIC's imaging appropriateness criteria	○	○	○	○	○	○
c. I believe MUSIC's imaging appropriateness criteria are equivalent to the imaging guidelines in the American Urological Association's (AUA) PSA Best Practice statement	○	○	○	○	○	○
d. I believe MUSIC's imaging appropriateness criteria are equivalent to the imaging guidelines in the National Comprehensive Cancer Network's (NCCN) clinical practice guidelines for prostate cancer	○	○	○	○	○	○
e. I believe there is enough evidence to justify following MUSIC's imaging appropriateness criteria	○	○	○	○	○	○
f. I believe MUSIC's imaging appropriateness criteria will hold up to legal scrutiny	○	○	○	○	○	○

5. Please indicate your level of agreement or disagreement with the following statements...

	Strongly Disagree	Disagree	Neither Disagree	Agree	Strongly Agree	Don't Know
a. I will definitely follow MUSIC's imaging appropriateness criteria over the next month	○	○	○	○	○	○
b. I keep track of my overall progress towards MUSIC's goals for imaging appropriateness	○	○	○	○	○	○
c. I have a clear plan of how I will order bone and CT scans in accordance with MUSIC's imaging appropriateness criteria	○	○	○	○	○	○
d. My clinical support staff can remind me of MUSIC's imaging appropriateness criteria when I order a bone scan or CT scan contrary to the indications	○	○	○	○	○	○

6. Please indicate your level of agreement or disagreement with the following statements...

	Strongly Disagree	Disagree	Neither Disagree	Agree	Strongly Agree	Don't Know
a. Most physicians who are important to me think I should order a bone and CT scan in accordance with MUSIC's imaging appropriateness criteria	○	○	○	○	○	○
b. Most physicians whose opinion I value would approve of me ordering a bone and CT scan in accordance with MUSIC's imaging appropriateness criteria	○	○	○	○	○	○
c. If I follow MUSIC's imaging appropriateness criteria it will have a broader impact on prostate cancer care	○	○	○	○	○	○
d. I believe I have contributed to the success of MUSIC's imaging appropriateness criteria	○	○	○	○	○	○

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7. For me, MUSIC's imaging appropriateness criteria are...

Very useful ○

Somewhat useful ○

Neutral ○

Not very useful ○

Not useful at all ○

Don't Know ○

8. How often do you remember MUSIC's imaging appropriateness criteria when ordering a bone or CT scan for staging a patient with newly-diagnosed prostate cancer?

All of the Time ○

Often ○

Sometimes ○

Rarely ○

Never ○

Don't Know ○

Other factors may influence your decision to order a bone or CT scan when staging patients with newly-diagnosed prostate cancer. Please answer the following questions about theseinfluences.

9. Please indicate your level of agreement or disagreement with the following statements...
10.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Don't Know
a. Even if it's NOT indicated in accordance with the MUSIC's imaging appropriateness criteria, I feel the need to order a bone and CT scan to protectmyself legally	○	○	○	○	○	○
b. Even if it's NOT indicated in accordance with the MUSIC's imaging appropriateness criteria, I feel the need to order a bone and CT scan when a patient requests i	○	○	○	○	○	○
c. Even if it IS indicated in accordance with the MUSIC's imaging appropriateness criteria, I feel that I don't need to order abone and CT scan because it's a waste of resources	○	○	○	○	○	○
d. I order a bone scan to stage a newly-diagnosed prostate cancer patient, and the results are negative, I feel that I don'tneed to order a CT scan because it's a waste of resources	○	○	○	○	○	○

11. Please indicate your level of agreement or disagreement with the following statements...

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Don't Know
a. My patients have sufficient financial resources (e.g. insurance coverage) to order bone and CT scans in accordance with MUSIC's imaging appropriateness criteria	○	○	○	○	○	○
b. I would follow MUSIC's imaging appropriateness criteria regardless of patient demographics, such as age, race, ethnicity or socioeconomic status	○	○	○	○	○	○
c. If I follow MUSIC's imaging appropriateness criteria it will disadvantage my relationship with my radiology colleagues	○	○	○	○	○	○

This group of questions are focused more generally on the collaborative. Please answer the following questions about MUSIC.

12. Please indicate your level of agreement or disagreement with the following statement...

I believe that I am a valued member of MUSIC?

Strongly Agree	○
Agree	○
Neither Agree nor Disagree	○
Disagree	○
Strongly Disagree	○
Don't Know	○

13. If MUSIC had the resources to expand into another area of urology, which area would you like to see MUSIC participate in?

14. What is your overall satisfaction with MUSIC?

Very Satisfied	○
Satisfied	○
Neutral	○
Dissatisfied	○
Very Dissatisfied	○
Don't Know	○

15.   Considering your experience with MUSIC, how likely would you be to recommend MUSIC to other urologists who are not associated with the collaborative?

Very Likely   ○

Likely   ○

Undecided   ○

Unlikely   ○

Very Unlikely   ○

Don't Know   ○

Thank you for completing the survey on imaging appropriateness. Would you mind telling us a little about yourself?

Note: These questions have been added to control for individual-level factors. They are not meant to helpidentify any participants of this survey.

What is the estimated percentage of your clinical volume that relates to prostate cancer?

% of clinical volume   [▼]

What year did you finish your residency training?

Year   [▼]

Are you the designated clinical champion for MUSIC related activities?

Yes   ○

No   ○

How many urologists are in your practice?

1 - 4 urologist(s)   ○

5 - 10 urologists   ○

> 10 urologists   ○

Appendix C. Non-significant CFIR Constructs by Domain

This section lists the CFIR constructs that were either not assessed or not significantly different between high and low implementing practices.

Table 15. Ratings Assigned to CFIR Construct by Case (Non-significant)

	High Implementation Practices		Low Implementation Practices	
Practice Size	**Medium**	**Small**	**Small**	**Medium**
I. Innovation Characteristics Domain				
Relative Advantage	0	0	0	0
Adaptability	0	0	0	0
Trialability	0	0	0	0
Complexity	**+2**	**+2**	**+2**	**+2**
Cost	0	0	0	0
II. Outer Setting Domain				
Peer Pressure	0	0	Missing	0
III. Inner Setting Domain				
Culture	Missing	Missing	Missing	Missing
Implementation Climate				
Tension for Change	+1	+1	+1	+1
Compatibility	-1	0	0	0
Relative Priority	Missing	Missing	Missing	Missing
Organizational Incentives & Rewards	0	0	0	0
Goals & Feedback	0	**+2**	**-1**	-1
Learning Climate	+1	-1	-1	0
Readiness for Implementation				
Available Resources	-1	0	**-2**	0
Access to Knowledge & Information	-1	**+2**	-1	-1
IV. Characteristics of Individuals Domain				
Self-Efficacy	Missing	Missing	Missing	Missing
Individual Stage of Change	Missing	Missing	Missing	Missing
Other Personal Attributes	Missing	**+2**	Missing	**-2**
V. Process				
Planning	-1	-1	-1	-1
Engaging				
Opinion Leaders	0	0	0	0
Formally Appointed Internal Implementation Leaders	0	0	0	0
External Change Agents	Missing	**+2**	Missing	0
Key Stakeholders (Support staff)	0	+1	0	0

Missing: Construct was not formally assessed

Intervention Characteristics Domain

There were eight constructs related to this domain. The constructs innovation source, design quality and packaging, and evidence strength and quality were determined to distinguish between the high and low implementation practices. The following five constructs did not differentiate between high and low implementation.

Relative advantage

This construct was defined as the stakeholders' perception of the advantage of implementing the intervention versus an alternative solution. This was not a distinguishing construct across sites. For this construct we focused on alternative types of imaging for staging prostate cancer, such as Magnetic Resonance Imaging, which was used as an alternative to CT scans. However, none of the practices used MRI as an alternative to CT scans. There were codes related to existing professional guidelines, such as the AUA PSA Best Practice statement and the NCCN clinical practice guidelines. But these were listed under External policy and incentives.

Complexity, Adaptability, Trialability, and Cost

The constructs Complexity, Adaptability, Trialability, and Cost were not distinguishable across sites. The new imaging appropriateness criteria from MUSIC generally aligned with the existing professional guidelines from the AUA and NCCN. All of the clinical champions felt the criteria were not complex and they were easy to implement. The sites did not mention issues with implementation costs.

Outer Setting Domain

There were four constructs related to this domain. The constructs needs and resources of patients, cosmopolitanism, and external policy and incentives were determined to distinguish between the high and low implementation practices. The following construct related to peer pressure did not differentiate.

Peer Pressure

The construct Peer pressure is defined as mimetic or competitive pressure to implement an intervention; typically because most or other key peer or competing organizations have already implemented or in a bid for a competitive edge. This was not a distinguishing construct. The findings were relatively neutral across the practices. One of the high performers said their market had a lot of competition, but they were very collegial. The other high implementation practice mentioned there was occasionally a visiting urologist in the area, but they didn't really interact. One of the low performers mentioned having competitors, but there was no competitive pressure. The other didn't mention having competitors or competitive pressures in the market.

Inner Setting Domain

There were twelve constructs related to this domain. Culture was not assessed during the interviews. The constructs structural characteristics, network and communication, and leadership engagement were determined to distinguish between the high and low implementation practices. The following constructs did not differentiate between high and low implementation.

Culture

The construct Culture was not explicitly assessed during the interviews.

Implementation climate

The construct Implementation climate was defined as the absorptive capacity for change, shared receptivity of involved individuals to an intervention and the extent to which use of that intervention will be rewarded, supported, and expected within their organization. There were six sub-constructs related to implementation climate and none of them were distinguishing constructs between the high and low implementation practices. The following paragraphs provide a summary of the sub-constructs.

All the clinical champions felt the criteria were needed, but most focused on the problem of overusing imaging when it wasn't necessary (tension for change). As for compatibility, one practice owned a CT scanner. However, this didn't appear to affect their imaging performance, as they were the highest performer of all 32 practices.

There was a little variation with respect to organizational incentives and goals and feedback, but nothing differentiated between high and low implementation. Most of the support staff across all practices received an annual performance evaluation, while none of the physicians did. In addition, none of the practices used incentives or performance evaluations related to MUSIC activities. One of the low implementation practices mentioned using incentives; however, it was only for productivity-based performance.

None of the practices established formal goals nor had they received feedback from the collaborative. However, one of the high implementation practices said the local hospital tracked their imaging performance for their "meaningful use" measures.

The hospital provided this monthly feedback to the physicians to improve their imaging performance with respect to overuse. Although it wasn't related to MUSIC's overall imaging performance per se, this was the strongest area of influence in this construct of Implementation climate.

The final sub-construct was learning climate. Although there was variation across practices, this was not a distinguishing construct between the high and low implementing practices. Respondents were asked specifically if they used formal process improvement strategies, such as Lean Six Sigma or the Deming Cycle. None of the practices mentioned using them and most of the staff didn't even know what they were. Accordingly, there were several disparities mentioned that were related to change management and staff engagement, which often resulted in a negative learning climate. For example, the LPN and practice manager from the practice 2 complained about a major procedural change made by a physician without consulting with the manager or the support staff:

> "A medical assistant actually questioned the provider about, "Well, why aren't you doing this, and you should be doing this, not this." And that did not go well…They did it, but the physician did not like that the medical assistant came back and said, "Why are you doing this?"
> [practice 2; practice manager]

Additionally, the clinical champion in practice 3 seemed to approach change management in a very direct way. For example, the he appeared very commanding when he talked with his partners about the imaging appropriateness criteria:

> Interviewer: How did you formulate a plan and disseminate the information to—
> Clinical Champion: In a corporate meeting…with an immediate start time of that morning.

Interviewer: How would you influence them to follow it [the imaging appropriateness criteria]?

Clinical champion: It's very simple. I've talked to them, and said, "Listen, you know, show me one of these that are ever going to be positive." And they're not going to be. So, I think they will convert quickly. [practice 3; clinical champion]

The other low implementing practice (Practice 4) appeared to have mixed influences related to this construct. For example, the clinical champion and medical assistant mentioned they had several quality improvement activities within their practice. The clinical champion also referenced MUSIC-related activities when asked about their quality improvement efforts. So, the themes appeared to support a positive influence on learning climate and performance improvement. However, this practice also appeared to have hierarchical relationships amongst the professional staff, which limited the support staffs' assistance and input.

Readiness for Implementation

The construct Readiness for implementation was defined as tangible and immediate indicators of organizational commitment to its decision to implement an intervention. There were three sub-constructs related to implementation climate. Of the three, available resources and access to knowledge and information were not distinguishing constructs. However, the third sub-construct, Leadership engagement, was highly distinguished between the high and low implementation practices.

Characteristics of Individuals Domain

There were five constructs related to this domain. Self-efficacy, Individual stage of change, and other personal attributes were not directly assessed. The remaining two constructs related to knowledge/beliefs and individual identification with the

organization were determined to distinguish between the high and low implementation practices.

Process Domain

There were ten constructs related to this domain. The constructs engaging champions, engaging innovation participants, executing, and reflecting/evaluating were determined to distinguish between the high and low implementation practices. The following constructs did not differentiate between high and low implementation.

Planning

The construct Planning was defined as the degree to which a scheme or method of behavior and tasks for implementing an intervention are developed in advance and the quality of those schemes or methods. This was not a distinguishing construct. None of the practices described a formal planning process for implementing the new imaging appropriateness criteria. They felt that identifying imaging requirements was a medical decision. Thus, they simply disseminated the information to their partners after the tri-annual meeting.

External change agents

External change agents were defined as individuals who are affiliated with an outside entity who formally influence or facilitate intervention decisions in a desirable direction. This sub-construct was not a distinguishing construct between the high and low implementation practices. There were two practices that had some external change agent support. The first was practice 2, who mentioned they were closely affiliated with

the local hospital. This healthcare organization tracked their imaging usage and provided performance reports on a monthly basis. Practice 4 didn't mention engaging with an external change agent; however, the Coordinating Center arranged to have dinner with the members of the practice to educate them on MUSIC and their performance. The effects of this interaction on the implementation was unclear.

Key Stakeholders

The professionals within the practice were categorized under key stakeholders. This sub-construct was not a distinguishing construct. All the physicians were told about the criteria. There was a general consensus that the clinical support staff didn't need to be involved with the innovation because they didn't make medical decisions. However, one of the nurses was told about the criteria to make sure they ordered the imaging in accordance with the criteria. The nurses in the other three practices didn't know about the criteria. Two of them said it would be important to know because they talked with the patients about their imaging requirements. One said it was important to understand what they were doing—"you can't do something unless it makes sense." One also said it would be important for the front desk staff to know because they helped their physicians place the imaging orders. However, despite these beliefs, engagement with the support staff didn't appear to impact the implementation efforts.

Appendix D. Exploratory Factor Analysis of Survey Data

Table 11 provides a summary of the results, to include the Cronbach alpha for the domain, as well as the rotated factor loading, mean and standard deviation for each item. Each of the domain definitions were taken from Cane, O'Connor, and Michie's (2012) original work with the TDF. The analysis produced 10 factors and 28 items. Sixteen of the items were from the TDF while 12 were from the interviews.

Knowledge

The first domain, Knowledge, was defined as an awareness of the existence of something. Of the five items analyzed, three items were determined to measure the domain and were included in the final factor solution. These items were related to awareness and knowledge of the content and objectives of the imaging criteria as well as believing there was enough evidence to follow the criteria. The two items measuring the relation of the criteria to the other known urology guidelines were removed because they were loading as a separate factor. The internal consistency for this domain was 0.88, which was the highest of all the factors with more than three items. The combined explained variation was 0.81 (X^2(3) = 182.7, $p<.001$).

Social/Professional Role and Identity

The domain Social/professional role and identity was defined as a coherent set of behaviors and displayed personal qualities of an individual in a social or work setting. There were originally three items thought to measure this item. However, two

additional items loaded onto this factor. The first item was from the TDF (Table 6, item 31) and it stated "Ordering a bone and CT scan is something I always do when staging patients with newly-diagnosed prostate cancer." This item was originally intended to measure automaticity from the domain Behavioral regulation (D14). However, there was no discriminant content validity of the item and the wording was changed from the original content. It makes sense that this item would load with the items related to professional identity and decision making. The second item was from the list of interview items (Table 9, item 27). It was intended to measure social support for the domain Social influence: "My clinical support staff can remind me of MUSIC's imaging appropriateness criteria when I order a bone scan or CT scan contrary to the indications." This makes sense as the item was closely worded with the other items related to help from the support staff.

Although they seemed to be correlated, when all five items were included in the factor analysis, two of them were loading onto a separate factor. In addition, the internal consistency of the domain was below 0.30. Therefore, two items related to support staff assistance (Table 6, item 7 and 27) were eliminated from the analysis. With the final three items, the internal consistency for the domain Social/professional role and identity was 0.52 and the combined explained variation was 0.53 (X^2(3) = 24.8, p<.001). The rotated factor loadings for the three items were -0.70, 0.71, and 0.77. The TDF item related to professional identity has a negative sign, suggesting a stronger professional identity is related to less automaticity and less assistance from support staff when identifying imaging requirements. These findings align directly with the

findings from the interviews. Furthermore, because the TDF item measuring

professional identity is theoretically contrary to implementation effectiveness, the

scores were reverse coded to calculate the mean score for the domain.

Beliefs about Capabilities

The domain Beliefs about capabilities was defined as acceptance of the truth,

reality, or validity about an ability, talent, or facility that a person can put to

constructive use. There were originally only two items measuring this domain and no

other items loaded with them on the factor analysis. This was likely because both items

were worded similarly and they had unique responses measuring a perceived level of

control (no control at all – a lot of control). The general theme between the two items

was perceived behavioral control over the different types of imaging. The internal

consistency of the domain was 0.96 and the combined explained variation was 0.96

(X^2(1) = 203.9, p<.001).

Beliefs about Consequences

The domain Beliefs about consequences was defined as acceptance of the truth,

reality, or validity about outcomes of a behavior in a given situation. There were three

items originally thought to measure the domain. Two were from the TDF "If I follow

MUSIC's imaging appropriateness criteria it will have a broader impact on prostate

cancer care" and "For me, MUSIC's imaging appropriateness criteria are… (useful)", and

one from the interviews "I believe MUSIC's imaging appropriateness criteria will hold up

to legal scrutiny." However, an additional item from the interviews loaded on this

factor: "I would follow MUSIC's imaging appropriateness criteria regardless of patient

demographics, such as age, race, ethnicity or socioeconomic status." This item was

originally thought to measure the External context and resources. However, it makes

send that it would load with beliefs about consequences. The internal consistency of this

final domain solution was 0.68 and the combined explained variation was 0.51 (X^2(6) =

66.3, $p<.001$).

Reinforcement

The domain Reinforcement was defined as increasing the probability of a

response by arranging a dependent relationship, or contingency, between the response

and a given stimulus. There were originally only two items measuring this domain and

no other items clustered with them on the factor analysis. As previously mentioned, this

was likely because both items were worded similarly and they had unique responses

measuring how often they received financial reimbursement for imaging. The general

theme of this domain was financial incentives. The internal consistency was 0.57 and

the combined explained variation was 0.75 (X^2(1) = 29.3, $p<.001$). It appears there was

more variation in the responses for the second item, which targeted receiving financial

reimbursement for CT scans.

Environmental Context and Resources

The domain Environmental context and resources was defined as any

circumstance of a person's situation or environment that discourages or encourages the

development of skills and abilities, independence, social competence, and adaptive

behavior. This domain was identified as one of the weakest areas of the TDF by Huijg et

al (2014). Consequently, there was a total of six items assessed to measure this domain

to get a broad assessment of environmental influences. When the six items were assessed in the model together, there were two factors that emerged. The first was related to prostate cancer patients and the second was related to utilization of radiology resources. As suggested by Huijg and his colleagues (2014), both factors were kept as separate sub-factors of the environment in order to analyze the relationship and influence of these different external sources.

There were three items that loaded onto the first factor and the general theme was related to patient influences. The first item was from the TDF: "My patients have sufficient financial resources (e.g. insurance coverage) to order bone and CT scans in accordance with MUSIC's imaging appropriateness criteria." The other two were from the interviews. They were "Even if it's NOT indicated in accordance with the MUSIC's imaging appropriateness criteria, I feel the need to order a bone and CT scan to protect myself legally" and "Even if it's NOT indicated in accordance with the MUSIC's imaging appropriateness criteria, I feel the need to order a bone and CT scan when a patient requests it." The internal consistency of this factor was 0.37 and the combined explained variation was 0.46 (X^2(3) = 14.4, $p<.01$). The low internal consistency was likely due to the larger variation in the item related to patient request for imaging. The rotated factor loading revealed the item measuring patient resources was negatively correlated to the others (-0.58). Because of this, the scores were reverse coded to calculate the mean score for the domain. This sub-domain was labelled Environmental context (Patients).

The second factor was related to using imaging resources. There were three items measuring this sub-domain. The first item was "If I follow MUSIC's imaging appropriateness criteria it will disadvantage my relationship with my radiology colleagues." The other two items measure the subjective use of imaging resources, or possibly norms related to ordering radiology studies. It makes sense that all three would load together, as this topic was discussed by the urologists in the low implementing practices. The internal consistency of this factor was 0.56 and the combined explained variation was 0.54 (X^2(3) = 35.7, p<.001). This sub-domain was labelled Environmental Context (Resources).

An additional factor analysis was conducted on these two sub-factors to gain a better understanding of the higher-level domain Environmental context and resources. This analysis yielded a one factor solution. The internal consistency of the combined domain was 0.34 and the combined explained variation was 0.60 (X^2(1) = 4.5, p<.05). It appears the overall explained variation improved, but the internal consistency maintained a lower value in the moderate range.

Social Influence

The domain Social influences was defined as "Those interpersonal processes that can cause individuals to change their thoughts, feelings, or behaviors." There were originally six items developed to measure this domain. As previously mentioned, however, one of items focusing on social support loaded with the items from the domain Social/ professional role and identity. This left five items to measure this domain. The five items loaded onto two separate factors. The first factor was related to

subjective norms and the second was related to social influences from the collaborative. As with the environmental analysis, both factors were kept as separate sub-factors in order to analyze the relationship and influence of these different social influences.

Both TDF items in the first factor were developed to measure the subjective norms, or social pressure, to ordering imaging and following the imaging appropriateness criteria. The items were "Most physicians who are important to me think I should order bone and CT imaging studies in accordance with MUSIC's imaging appropriateness criteria" and "Most physicians whose opinion I value would approve of me ordering order bone and CT imaging studies in accordance with MUSIC's imaging appropriateness criteria." The internal consistency of this factor was 0.78 and the combined explained variation was 0.83 ($X^2(1) = 61.79$, $p<.001$). This sub-domain was labelled Social influences (Subjective Norms).

The second factor was centered on the theme of the collaborative. The three items were developed to measure the respondent's beliefs and attitudes about the collaborative. The first was "I believe that I am a valued member of the MUSIC?" Next, was "What is your overall satisfaction with MUSIC?" The last was related to an attitude: "Considering your experience with MUSIC, how likely would you be to recommend MUSIC to other urologists who are not associated with the collaborative?" The internal consistency of this sub-domain of Social influence was 0.75 and the combined explained variation was 0.68 ($X^2(3) = 94.5$, $p<.01$). This sub-domain was labelled Social influences (Collaborative).

The exploratory factor analysis of the two sub-factors yielded a one factor

solution. The internal consistency of the combined domain was 0.51 and the combined

explained variation was 0.67 ($X^2(1) = 13.1$, $p<.001$). It appears the overall explained

variation and internal consistency maintained moderate levels.

Behavioral Regulation

The final domain was Behavioral regulation and it was defined as "Anything

aimed at managing or changing objectively observed or measured actions." There were

originally four items developed to measure this domain. As previously mentioned, the

TDF item measuring automaticity loaded onto the domain Social/ professional role and

identity. This left three items of which two were from the TDF questionnaire and one

from the interviews. All three of the items formed a factor solution and the general

theme was proactive monitoring and planning. This theme supports several of the

findings in the higher implementing practices. The internal consistency of this domain

was 0.64 and the combined explained variation was 0.61 ($X^2(3) = 55.0$, $p<.001$).

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