IMPLEMENTATION AND EFFECTIVENESS OF TRIGGERED PALLIATIVE CARE CONSULTS IN ONCOLOGY

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ABSTRACT

Lisa D. DiMartino: Implementation and Effectiveness of Triggered Palliative Care Consults in Oncology
(Under the direction of Bryan J. Weiner)

The overall objectives of this research were to: (1) determine whether triggered palliative care consultation (TPCC) could achieve effective consult implementation in oncology and (2) examine the effect of inpatient palliative care consults on health resource use (i.e., hospice discharge and 30-day readmissions).

We used a mixed-methods research design of two distinct inpatient oncology services at UNC Hospital. Data sources included qualitative interviews and secondary data using the UNC Palliative Care Clinical Research Database linked to electronic medical record data from 2010 to 2016. The first study used a two-case study design of palliative care consult implementation in the medical oncology and gynecologic oncology services. Qualitative data were collected through in-person interviews with clinicians. Quantitative data on consult uptake were used to complement the qualitative findings. The study provided an in-depth understanding of organizational contextual factors associated with effective palliative care consult implementation and suggested refinements to organizational theory.

The second study used difference-in-difference regression models to longitudinally examine the impact of two TPCC approaches on palliative care consult uptake and timeliness. TPCC supported by a single strategy was associated with greater consult uptake compared to usual care (aRR 1.45, $p<.05$), and TPCC supported by multiple strategies was

associated with greater consult uptake compared to a single strategy (aRR 2.34, p<.001). TPCC did not significantly impact time to consult.

The third study used multivariate regression with propensity score matching to examine associations among inpatient palliative care consultation, hospice use (discharge), and 30-day unplanned readmissions. The likelihood of having a 30-day readmission did not significantly differ between the palliative care consult and usual care groups. However, the palliative care consult group was significantly more likely than usual care to have a hospice discharge (aRR = 4.09, p<.001). The predicted probability of readmission was lower when palliative care consultation was combined with hospice discharge compared to consultation with discharge to non-hospice post-acute care or usual care (p<.001).

In sum, TPCC improved consult implementation in oncology, and inpatient palliative care consults leading to hospice discharge resulted in reduced 30-day readmissions. Health care systems should consider the organizational context for implementation to identify optimal strategies for integrating palliative care consults into oncology and improving outcomes for cancer patients.

Dedicated to my late father, Dante DiMartino. The courage and strength he displayed while battling cancer has always been my daily motivation and inspiration.

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CHAPTER 1. INTRODUCTION

Cancer patients, particularly those with advanced disease, often experience high symptom burden and costly inpatient care.[1-3] Evidence from several randomized controlled trials (RCTs) demonstrate the potential of palliative care delivered concurrently with cancer-directed treatments to improve quality of care and outcomes for patients diagnosed with advanced cancer.[4-7] Palliative care is often provided as a consult service delivered by a multidisciplinary team of clinicians who provide symptom management, clarify goals of care, and facilitate collaboration between the oncology provider, patient, and family members to identify appropriate next steps in care. Palliative care differs from hospice because it is available to cancer patients at any stage of disease and can be provided while still receiving life-prolonging therapies. However, although several practice guidelines emphasize the importance of integrating palliative care with cancer-directed treatments,[7-9] many eligible cancer inpatients do not receive palliative care consults. For example, one study conducted at a major academic medical center found less than half of cancer inpatients received palliative care consultation before in-hospital death,[10] while another study showed palliative care consults occurred in only 5% of patients hospitalized with advanced head and neck cancer.[11] In addition, recent studies have shown even in highly integrated healthcare systems, cancer inpatients do not receive timely palliative care consults (i.e., early during the hospitalization).[12,13] Thus, important gaps remain in improving the consistency and quality of palliative care implementation in inpatient oncology settings.

According to the American Society of Clinical Oncology,[14] clinical triggers that alert oncology providers about patients needing palliative care are a promising approach to improve implementation. Triggered palliative care consultation (TPCC) is based on predetermined screening criteria (i.e., metastatic disease or uncontrolled symptoms). Although prior studies have shown that TPCC improves consult implementation in the intensive care unit,[15] there is limited evidence regarding the impact of TPCC in inpatient oncology.[14,16,17] In addition, less is known about how inpatient palliative care consults in oncology may lead to better clinical outcomes such as reduced hospital readmissions.

Without improved implementation of palliative care in inpatient settings, the ability to realize the benefits of palliative care for cancer patients will continue to fall short, therefore a greater understanding of the organizational determinants associated with effective palliative care consult implementation in oncology should improve quality and appropriateness of care.[18] The overall objectives of this dissertation are to determine whether TPCC can achieve effective consult implementation in oncology and examine the effect of palliative care consults on health resource use. The central hypothesis is that TPCC supported by multiple strategies (e.g., training in palliative care skills, clinician prompting, chart review) will result in improved consult implementation compared to a single strategy (i.e., written guideline) or no strategy and that inpatient palliative care consults (whether triggered or not) result in improved health resource use (i.e., greater hospice discharge and reduced 30-day readmissions) compared to usual care. The rationale for this research is that with the knowledge gained, more effective interventions can be developed that close the palliative care implementation gap in oncology and improve outcomes for cancer patients. I will test my central hypothesis by pursuing the following specific aims:

Aim 1: To explore the organizational contextual factors associated with palliative care consult implementation across two inpatient oncology settings. (Chapter 4)

Aim 2: To evaluate the impact of two TPCC approaches on consult implementation in inpatient oncology. (Chapter 5)

Aim 3: To examine the effect of inpatient palliative care consults on health resource use (i.e., hospice discharge and 30-day readmissions) in oncology. (Chapter 6)

The dissertation used a mixed-methods research design of two distinct inpatient oncology services at UNC Hospital. The primary data sources included qualitative key-informant interviews and secondary data using the UNC Palliative Care Clinical Research Database linked to UNC Hospital electronic medical records from January 1, 2010, to June 30, 2016. Aim 1 used a two-case study design of palliative care consult implementation in the medical oncology and gynecologic oncology services. Qualitative data were collected through in-person interviews with clinicians from the medical oncology, gynecologic oncology, and palliative care services. Quantitative data on palliative care consult uptake were used to complement the qualitative findings and to gain a comprehensive understanding of palliative care consult implementation for each of the cases.[19] The analytic approach for Aim 2 included difference-in-difference regression models to longitudinally examine the impact of TPCC on consult implementation (i.e., uptake and timeliness). The analytic approach for Aim 3 included multivariate regression with propensity score matching to examine associations among inpatient palliative care consultation, hospice use (discharge), and 30-day unplanned readmissions.

The aims from this dissertation were anticipated to produce the following expected outcomes: First, this dissertation would contribute to understanding the organizational context of palliative care consult implementation in oncology. Second, this dissertation would provide scientific knowledge regarding the effectiveness of TPCC for consult

implementation as well as the association between palliative care consults and downstream health resource use. Through examining the organizational context, implementation effectiveness, and clinical outcomes of palliative care consults, the results of this dissertation will generate new evidence that will contribute to closing the palliative care implementation gap, enhancing processes of care, and maximizing patient outcomes in oncology.

The sections of this dissertation are organized as follows. Chapter 2 summarizes the current literature regarding palliative care, including the case for palliative care in oncology, the palliative care implementation gap in oncology, use of TPCC in oncology, and palliative care and health resource use in oncology. It concludes with significance and innovation of the research, including a discussion of using mixed-methods research and justification for the dissertation study design. Chapter 3 provides an overview of the methods used throughout the dissertation. It includes the underlying conceptual model on which the research is based, a description of the study design and rationale, study setting, data sources, study sample, and analytic approaches. Chapters 4-6 are manuscripts corresponding to Aims 1-3, respectively, and are intended for submission for peer-reviewed publication. Chapter 7 summarizes the findings of this dissertation, its policy relevance, and research gaps.

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CHAPTER 2. LITERATURE REVIEW

Cancer Burden in the United States

In 2017, an estimated 1.7 million new cancer cases in the United States will be diagnosed and 600,000 people will die from the disease.[1] Although the number of cancer survivors in the United States continues to increase with improvements in new treatments, approximately one-third of patients who are diagnosed with cancer will succumb to the disease.[2] The economic impact of cancer in the United States is substantial; the direct costs of cancer care is expected to rise from $104 billion in 2006 to nearly $173 billion in 2020, with most of the costs attributed to care received during the last year of life.[3] Cancer patients near the end of life experience overly aggressive care, including costly chemotherapy regimens and hospital stays, even though numerous studies indicate spending time in the hospital conflicts with care preferences and the desire to be at home.[4,5] In fact, expenditures for chemotherapy continue to escalate,[3] and hospitalizations currently account for the largest spending in cancer care.[6] In 2009, 4.7 million hospitalizations were due to adult cancer; the total costs associated with these hospitalizations was $20.1 billion and accounted for 6% of all hospital costs.[7] In addition, cancer patients frequent the emergency department for their acute care needs, such as uncontrolled pain or respiratory distress, which often result in inpatient admissions.[8,9] Given the increasing number of individuals living beyond a cancer diagnosis, finding ways to improve the quality of care and lower costs of cancer care are an urgent priority for policymakers and the U.S. healthcare system.[10]

What is Palliative Care?

Palliative care has the potential to add value and improve quality of cancer care by moderating use of less effective high-cost treatments while enhancing supportive services and symptom control. Palliative care has been broadly defined by the World Health Organization as "an approach that improves the quality of life of patients and their families facing the problems associated with a life-threatening illness, through the prevention and impeccable assessment and treatment of pain and other problems, physical, psychosocial and spiritual."[11] Healthcare providers often equate palliative care with hospice or end-of-life care, but they are not synonymous. Although hospice is a type of palliative care, it is available only to cancer patients no longer receiving therapy with curative intent and typically begins late in a cancer patient's disease trajectory (less than 6-month prognosis). In contrast, "early" palliative care (hereinafter called "palliative care") is delivered to cancer patients while they are still receiving life-prolonging therapies and can begin at any stage of disease, meaning it is not just appropriate for patients with advanced-stage cancer. Figure 2.1 illustrates the relationship between palliative care and hospice across the cancer disease trajectory, from curative to end-of-life care.

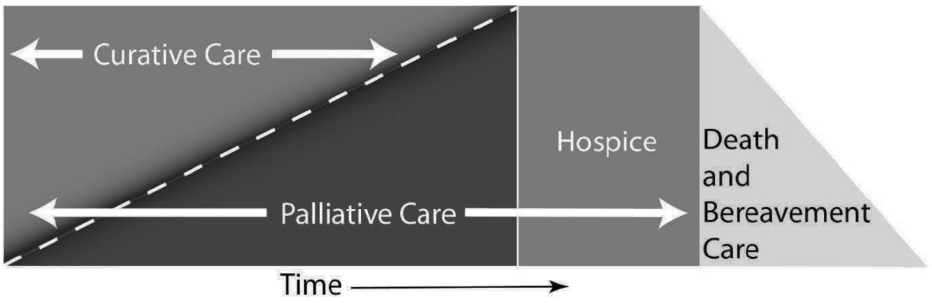

Figure 2.1. Palliative care and hospice across the cancer disease trajectory.

Inpatient Palliative Care Model

Palliative care can be provided in the inpatient, outpatient clinic, or home setting. As an inpatient service, palliative care can be either a consult service or an inpatient unit providing direct patient care. The focus of this dissertation will be solely on the provision of inpatient palliative care as a consult service. As a consult service, palliative care may be available in certain services or across the entire hospital to provide recommendations for care to all involved clinicians. Specialized palliative care consult teams have become increasingly common in inpatient settings. The percentage of large academic hospitals that reported having a palliative care team rose from 25% in 2002 to nearly all hospitals in 2010.[12,13] Inpatient palliative care consult teams aim to: address symptom management; clarify goals of care, including advanced care planning; provide spiritual and psychosocial support; and facilitate care coordination between the oncologist, the patient, and family members during the patient's hospital stay. These teams are typically composed of multiple providers including physicians, nurses, pharmacists, chaplains, and social workers.[14]

The Case for Palliative Care in Oncology

Cancer patients, particularly those with advanced disease, experience many complications associated with their illness, including high symptom burden and poor quality of life, resulting in costly inpatient care.[15,16] Based on evidence from several landmark randomized controlled trials (RCTs),[17-19] integration of palliative care with cancer-directed treatments can reduce symptom burden and improve outcomes. For example, Temel et al. found patients with metastatic non–small cell lung cancer who received palliative care experienced improved quality of life (QOL), less aggressive care, and improved survival compared to usual care.[18] Likewise, Bakitas et al.,[17] Zimmermann et al.,[19] and Grudzen et al.[20] have all demonstrated advanced cancer patients who received palliative care experienced

improved QOL compared to standard cancer care. Most recently, a study by Temel et al. showed patients newly diagnosed with incurable lung or gastrointestinal cancer who received palliative care experienced greater improvements in QOL and depression compared to those who received usual care.[21] Integration of palliative care has also been shown to have substantial cost savings to the healthcare system, and no study has shown cost to increase.[22] Recent studies by May et al. found inpatient palliative care consult soon after admission can shorten length of stay and significantly reduce hospital costs for patients with advanced cancer, with earlier consultation during the hospitalization associated with greater cost saving effect.[23,24] As a result of these findings, the integration of palliative care with traditional cancer treatment earlier on in the disease trajectory for patients with advanced cancer or high symptom burden has been endorsed as guideline concordant care by the National Consensus Project for Quality Palliative Care,[25] the American Society of Clinical Oncology,[22,26] the National Comprehensive Cancer Network,[27] and the Institute of Medicine.[28,29]

Palliative Care Implementation Gap in Oncology

Despite the guideline recommendations and known benefits of palliative care, a quality chasm exists between what is considered ideal care and what actually occurs for cancer patients. Prior studies indicate overall uptake of palliative care is poor, with several studies indicating many eligible cancer patients do not receive a referral for palliative care.[30-33] In fact, one study conducted at a major academic medical center found that less than half of advanced cancer inpatients received palliative care before in-hospital death,[34] while another study showed only 16% of cancer patients who died in the hospital received a palliative care consult.[35] In a large sample of advanced head and neck cancer patients, inpatient palliative care consults occurred in only 5% of cases.[36] Even among cancer inpatients receiving palliative care, adherence to quality indicators for palliative care is

suboptimal. One recent study showed that even in highly integrated healthcare systems, cancer patients in the inpatient setting do not receive timely palliative care for uncontrolled symptoms (i.e., pain or shortness of breath).[37]

Implementation of inpatient palliative care consults poses a challenge because it occurs within complex hospital settings, requiring substantial coordination and cooperation between multidisciplinary teams of clinicians and multiple decision-makers involved in patient care. Focusing on the organization-level determinants of inpatient palliative care consult implementation rather than the patient- or provider-level ones may clarify the underlying context in which implementation occurs. However, no prior studies have examined the organization-level determinants associated with effective palliative care consult implementation in oncology.[38] This knowledge is critical to developing effective interventions that close the palliative care implementation gap in oncology.[38] To fill this research gap, this dissertation examined the organizational context for palliative care consult implementation across two inpatient oncology settings (Aim 1).

Triggered Palliative Care Consultation in Oncology

A promising organizational approach for promoting palliative care consult implementation in oncology may be the use of clinical triggers, which provide a "cue to action" and can be used to proactively alert oncologists to patients who should be receiving palliative care, thereby enhancing consult use.[39] Triggered palliative care consultation (TPCC) is based on predetermined screening criteria (i.e., metastatic disease or uncontrolled symptoms). Although prior research has shown that TPCC improves consult implementation in the intensive care unit,[40] there is limited evidence regarding the impact of TPCC in inpatient oncology.[22,41,42] The few studies examining the use of TPCC in oncology have several limitations. For example, Rocque et al. conducted an observational study of TPCC

among advanced cancer inpatients. Although this study found TPCC had limited impact on palliative care uptake, the study was limited by a small sample size (n=200) and examined the use of triggers only in medical oncology.[43] Similarly, Kistler et al. conducted a proof-of-concept study on the use of TPCC in advanced cancer patients and found that patients who were randomized to the intervention (TPCC) group were significantly more likely to receive a consult compared to usual care (88% vs 18%). However, TPCC did not have a significant effect on time to consult.[44] Although this study was an RCT, it examined the use of TPCC only in one service line, the emergency department.[44] Although Adelson et al. found TPCC for solid-tumor medical oncology inpatients doubled rates of palliative care consultation (41% to 82%), the study had a short duration (3 months) and was primarily descriptive.[45] Therefore, this dissertation is significant because it provided the opportunity to use multiple years of data from a large number of hospitalizations to examine the impact of two TPCC approaches (single strategy vs. multiple strategies) in two inpatient oncology services—solid-tumor medical oncology and gynecologic oncology (Aim 2).

Palliative Care and Health Resource Use in Oncology

Many cancer patients experience poor symptom control and aggressive treatment near the end of their lives, including hospitalizations and emergency department (ED) visits, with limited medical benefits.[9,15,46,47] Studies have reported high unplanned 30-day hospital readmission rates for cancer patients, ranging from 11%[48] to 27%.[6] Likewise, Obermeyer et al. showed approximately of 80% of cancer patients visited the ED in the last 6 months of life,[49] while Mayer et al. found 77% of cancer patients visited the ED in 2008.[9] Reducing unplanned 30-day readmissions is important to patients and to healthcare organizations seeking to lower healthcare costs and avoid penalties under the federal Hospital Readmissions Reduction Program (HRRP).[50] Under this program, hospitals are fined for high

risk-standardized 30-day readmission rates.[51] Cancer hospitals are currently excluded from the HRRP because they provide care for a distinct patient population with different risk-profiles for readmissions compared to other hospitals.[47] However, frequent hospital readmissions and ED visits remain important for oncology patients and are well-accepted indicators of poor-quality care for cancer patients near the end of life.[46,52] Although research shows hospice care is associated with fewer readmissions among cancer patients,[47] conversations about hospice often do not occur between cancer patients and their providers.[2] As a result, cancer patients frequently do not enroll in hospice or are referred late in the disease trajectory.[53]

Palliative care has also been shown to decrease hospitalizations and ED visits among cancer patients when delivered in outpatient settings.[18,54-56] In inpatient settings, palliative care reduces the intensity of hospital treatment and thus reduces the cost of hospital care.[23,57] However, less is known about how inpatient palliative care affects readmissions in oncology.[7,58] For example, O'Conner et al. found inpatient palliative care consultation was associated with greater hospice discharge, and a 30-day readmission rate reduction from 15% to 10%.[50] Similarly, Nelson et al. found readmissions decreased from 1.5 to 0.7 admissions per patient in the six months after inpatient palliative care consultation.[40] However, neither of these studies were focused on the cancer population.

To date, little is known about how hospitals can best achieve reductions in 30-day readmissions in oncology.[7,47,59] Studies focusing on the association between of inpatient palliative care consultation and both hospice and 30-day readmission outcomes in oncology are limited.[58] For example, a recent study of ovarian cancer patients who had received palliative care services while hospitalized had a significantly higher likelihood of hospice

discharge compared to those who did not receive palliative care services, but it did not examine readmissions.[60] Using a propensity-score matched sample, Paris et al. examined the effect of inpatient palliative care consultation on hospice and readmissions within a six-month study period. Although this study also found cancer inpatients who received a palliative care consult were significantly more likely to be discharged to hospice compared to usual care, it did not find an effect of palliative care consults on readmissions. However, this study only included a sample of 201 patients with gastrointestinal cancers and readmissions were not the primary outcome of interest.[61] Likewise, Gonsalves et al. examined the effect of palliative care consultation in a small sample of 200 patients at a Veterans Affairs Hospital and found a significant increase in hospice referrals in the last 30 days of life but no effect on readmissions.[62] This dissertation contributes to the evidence base by using a large sample of hospitalizations across multiple cancer types to examine associations among inpatient palliative care consultation, hospice use (discharge), and 30-day unplanned readmissions (Aim 3).

Significance and Innovation

This dissertation is significant for its potential to close the palliative care implementation gap in oncology and ultimately improve outcomes for cancer patients by: exploring the organizational contextual factors associated with palliative care consult implementation across two inpatient oncology settings—solid-tumor medical oncology and gynecologic oncology (Aim 1); examining the effect of TPCC on consult implementation in oncology (Aim 2); and examining the effect of inpatient palliative care consults on health resource use (i.e., hospice discharge and 30-day readmissions) in oncology (Aim 3). As the prevalence of inpatient palliative care programs continues to expand, the findings from this dissertation will generate timely scientific evidence that directly contributes to the

development of improved interventions for palliative care consult implementation within academic hospitals. In sum, this dissertation is significant given the dearth of research systematically examining implementation of palliative care consults in oncology and the downstream health resource use associated with palliative care consults.

Moreover, this dissertation uses innovative methodological approaches. Studies of palliative care consult implementation often ignore organizational context, which is important to consider because palliative care delivery is context-specific and occurs within the setting of complex healthcare systems. This dissertation applies the Organizational Theory of Innovation Implementation to understand the implementation of palliative care consults in oncology. Furthermore, this research extends organizational theory by examining the role of formal and informal policies and practices in shaping a strong and sustainable implementation climate and subsequent effective innovation implementation. The dissertation also uses a novel service (organization)-level treatment and comparison group, which provided the opportunity to use innovative econometric approaches to studying the impact of two TPCC approaches in the inpatient oncology services within an academic hospital. Finally, as Figure 2.2 illustrates, this dissertation research provided a unique opportunity to employ a mixed-method study design to understand the organizational context, implementation effectiveness, and clinical outcomes of palliative care consults in oncology. Mixed-method study designs are increasingly used to understand the process and outcomes associated with implementation of healthcare practices.[63] Specifically, mixed-methods designs allow for the ability to get a more comprehensive picture of a research phenomenon by using both qualitative and quantitative methodologies.

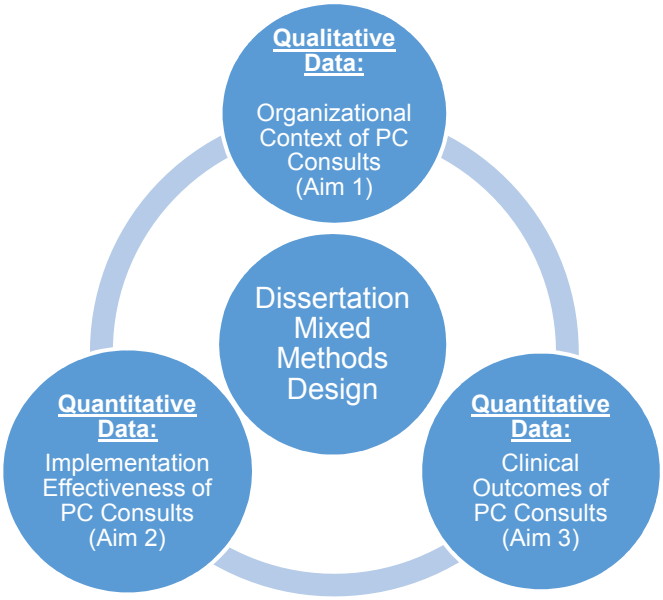

Figure 2.2. Dissertation research design.

In mixed-method studies, qualitative and quantitative data may be used together to complement and clarify or elaborate on the results of analyses.[64] In implementation research, collecting qualitative data can be useful to obtain an in-depth understanding of the organizational context for healthcare practices while quantitative data derived from secondary sources can provide measures of implementation effectiveness and clinical outcomes in real-world healthcare settings.

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CHAPTER 3. STUDY DESIGN AND METHODS

Overview and Rationale

This dissertation employed mixed-methods research design to understand the organizational context, implementation effectiveness, and clinical outcomes of palliative care consults in oncology. Aim 1 used a two-case study design of palliative care consult implementation in the medical oncology and gynecologic oncology services. Case study methods use mixed-methods to provide an in-depth analysis of the organizational context for implementation.[1] Consistent with a mixed-methods approach, quantitative data on palliative care consult uptake were used to complement the qualitative findings from key-informant interviews and to gain a comprehensive understanding of palliative care consult implementation for each of the cases.[2] In Aim 2, difference-in-difference (DID) estimation was used to longitudinally examine the impact of triggered palliative care consultation (TPCC) on palliative care consult implementation (uptake and timeliness) after controlling for underlying secular trends and other potential biases by identifying a comparison group that is similar to the treatment group but is not exposed to the treatment. The DID method is well suited for situations where implementation of a new policy or treatment occurs in a real-world context and randomization is not feasible.[3] Aim 3 addresses a challenge often encountered in observational studies. Specifically, characteristics may influence both the receipt treatment (palliative care consults) and outcomes of interest (hospice discharge and readmissions), which contributes to selection bias. To minimize the potential for selection

bias, propensity score matching was used to examine associations among inpatient palliative care consultation, hospice use (discharge), and 30-day unplanned readmissions.

Specific Aims and Hypotheses

Aim 1: To explore the organizational contextual factors associated with palliative care consult implementation across two inpatient oncology settings.

Using the Organizational Theory of Innovation Implementation, this Aim examines IPPs, implementation climate, innovation-value fit, and innovation-task fit for palliative care consults.

Aim 2: To evaluate the impact of two TPCC approaches on consult implementation in inpatient oncology.

Hypothesis 2a: TPCC supported by a single strategy will be associated with more consistent consult implementation (greater uptake) compared to usual care.
Hypothesis 2b: TPCC supported by a single strategy will be associated with improved implementation quality (decreased time to consult) compared to usual care.
Hypothesis 2c: TPCC supported by multiple strategies will be associated with greater consult uptake compared to a single strategy.
Hypothesis 2d: TPCC supported by multiple strategies will be associated with decreased time to consult compared to a single strategy.

Aim 3: To examine the effect of inpatient palliative care consults on health resource use (i.e., hospice discharge and 30-day readmissions) in oncology.

Hypothesis 3a: Inpatient palliative care consults will result in greater discharge to hospice care.
Hypothesis 3b: Inpatient palliative care consults will result in lower 30-day readmissions after discharge.

Conceptual Framework

This dissertation drew on the Klein and Sorra (1996) Organizational Theory of Innovation Implementation. Briefly, this theory posits that implementation effectiveness is a function of formal implementation policies and practices (IPPs), a positive implementation climate, perception that the innovations' use is congruent with the intended users' values, and the extent to which the innovation fits with organizational workflow (Figure 3.1).[4-7]

This theory provided an excellent fit for this dissertation for several reasons. First, it is well suited for explaining implementation effectiveness for complex innovations, which are practices perceived as new by the users in an organization and require coordinated use of multiple organizational members to benefit the organization.[5] Palliative care consults in inpatient oncology are considered a complex innovation based on the following features: (1) the integration of palliative care consults with cancer treatment is an expanding and evolving area of interest; (2) use of inpatient palliative care consults is complex, comprising multiple providers including physicians, nurses, pharmacists, chaplains, and social workers who coordinate care for inpatients receiving palliative care; and (3) implementation of inpatient palliative care consults requires extensive coordination between multidisciplinary palliative care teams and the oncology clinicians overseeing the care of a patient. *Implementation* is the action of putting the innovation (palliative care consults) to use and occurs after the decision to adopt the innovation. *Implementation effectiveness* describes the quality and consistency of the use of an innovation (palliative care consults).[10] In contrast, *innovation effectiveness* describes the benefits a health care organization ultimately derives from the implementation of an innovation (palliative care consults) and is assessed by measuring clinical outcomes, such as hospice use or hospital readmissions.[10] This dissertation will apply the Klein and Sorra theory to examine both implementation effectiveness (Aims 1 and 2) and innovation effectiveness (Aim 3) of palliative care consults.

The theory emphasizes the role of *formal IPPs* in the organization, which refer to "the array of innovation, implementation, organizational, and managerial policies, practices, and characteristics that may influence innovation use."[33] The theory postulates that formal IPPs collectively influence implementation through implementation climate. The formal IPPs were

operationalized as two TPCC approaches for palliative care consult implementation, described in detail later in this chapter. Additionally, this dissertation examined the role of *informal IPPs* (e.g., spontaneous communication and on-the-job training) as potential determinants of innovation implementation, which has been largely unexplored.[4-9]

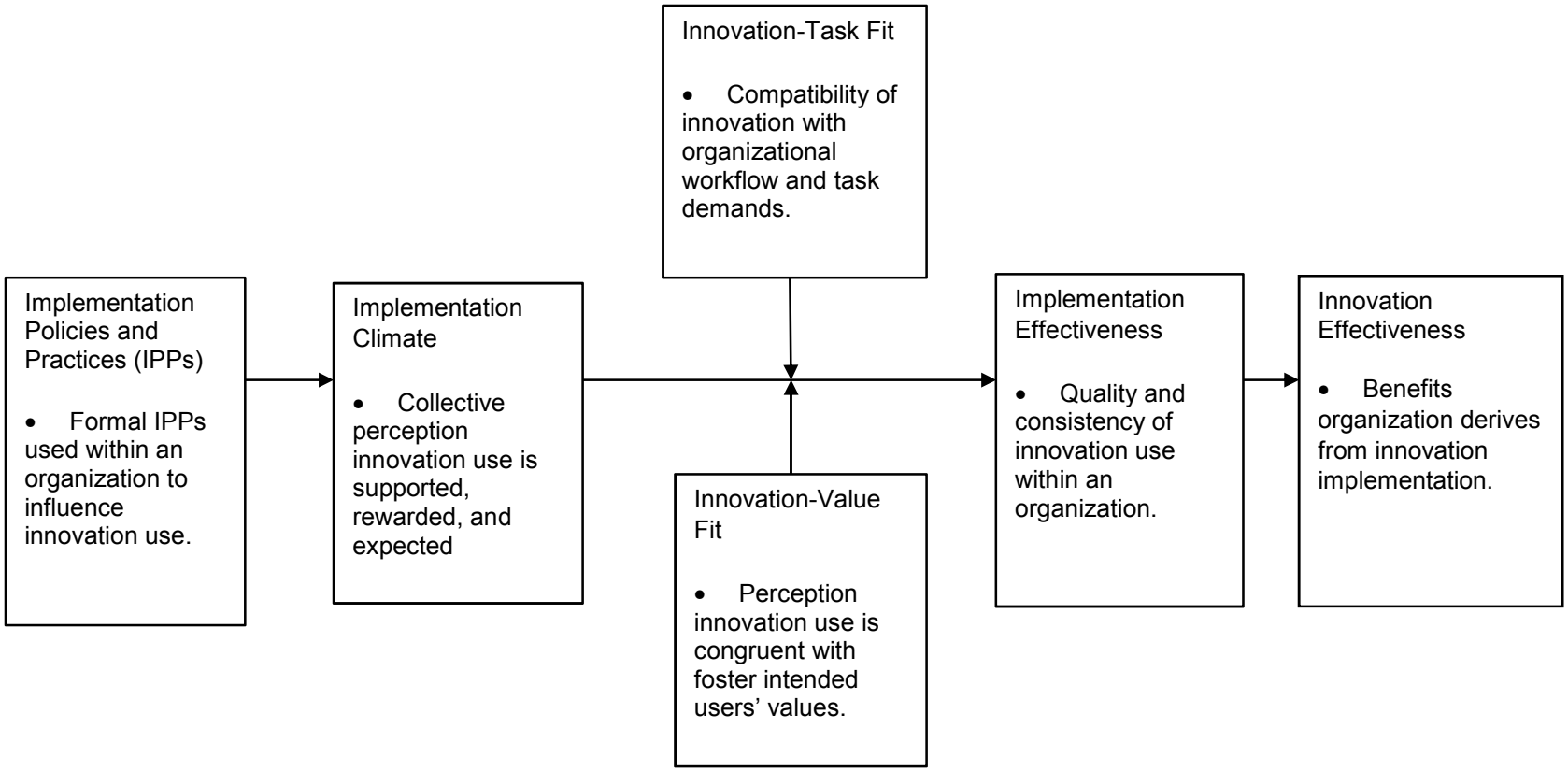

Figure 3.1. Conceptual framework, adapted from Klein and Sorra[4,5]; Helfrich et al.[6]; Weiner et al.[7]

Implementation climate is the most central construct to the theory and is conceptualized as "the collective influence of an organization's multiple implementation policies and practices organizations employ to promote innovation use."[10] It refers to the shared perception among targeted organizational members of the "extent to which their use of a specific innovation is rewarded, supported, and expected within the organization."[5] In this dissertation, implementation climate refers to clinicians' shared sense that palliative care consult use is rewarded, supported, and expected within the oncology services. In general, the more this shared sense is developed, the greater likelihood the innovation will be used consistently and with high quality.

A strong climate is necessary but not sufficient for effective innovation implementation. The association between implementation climate and implementation effectiveness may be moderated by the *innovation-values fit* and *innovation-task fit.* Innovation-values fit is "the extent to which targeted users perceive that use of the innovation will foster (or, conversely, inhibit) the fulfillment of their values,"[5] where "values" is defined as "concepts or beliefs that pertain to desirable end states or behaviors, transcend specific situations, and guide the selection and evaluation of behavior and events."[11] Innovation-task fit, which was not originally included in the theory, arose from Helfrich et al.'s[6] and Weiner et al.'s[7] prior research indicating the need to parse out the concept of innovation-value fit as encompassing not only normative values but "the extent to which an innovation is compatible with work processes, task demands, and organizational capabilities." Even if the climate for innovation implementation is strong, a weak innovation-value fit or innovation-task fit will result in resistance and impede the organizations' ability to effectively implement

the innovation. Table 3.1 summarizes the operational definitions of the conceptual framework constructs used in this dissertation.

Table 3.1. Operationalized Definitions of Conceptual Framework Constructs

Constructs	*Operational Definition*
IPPs	Two TPCC approaches for palliative care consult implementation.
Implementation Climate	Clinicians' shared perceptions that the use of palliative care consults is rewarded, supported, and expected.
Innovation-Value Fit	Extent to which clinicians perceive that use of palliative care will foster the fulfillment of their values.
Innovation-Task Fit	Compatibility of palliative care consults with organizational workflow and task demands.
Implementation Effectiveness	Palliative care consult uptake and timeliness.
Innovation Effectiveness	Effect of inpatient palliative care consults on health resource use (i.e., hospice discharge and 30-day readmissions).

Study Setting

The study was conducted in two distinct oncology services at UNC Hospitals, an 804-bed acute care facility and National Cancer Institute–designated Comprehensive Cancer Center. Gynecologic oncology is composed of teams of clinicians who provide care for patients with solid-tumor gynecological cancers. Compared to medical oncology, gynecologic oncology is a much smaller service, composed of only eight attending clinicians who specialize in gynecologic oncology and a small, tight-knit group of specialty and subspecialty residents. In contrast, medical oncology has approximately 26 attending clinicians who specialize in solid tumors and a large pool of specialty residents. The teams on both services include an attending and several house-staff clinicians (residents and medical students).

The inpatient palliative care consult service at UNC Hospitals began in 2002. The team is multidisciplinary, composed of an attending palliative clinician, two nurse practitioners, a social worker, and a chaplain; it supports pain and symptom management, spiritual/psychosocial distress, goal setting and decision-making for inpatients at all stages of illness and their families. It is available to patients only by referral of the primary treating team in the oncology services.

Description of TPCC Approaches in Inpatient Oncology

This dissertation examined the impact of two TPCC approaches on implementation of palliative care consults. TPCC began in gynecologic oncology in August 2014 and was supported by a single strategy—a one-page written guideline describing the clinical criteria (e.g., unplanned admission for symptom management, frequent readmissions, malignant small bowel obstruction) for initiating a palliative care consult posted in the residents' work area. Oncologists in gynecologic oncology developed the guideline internally, without input from palliative care service. In contrast, TPCC in medical oncology began in October 2015 and was supported by multiple strategies designed by palliative care and oncology clinicians. The clinical criteria for triggering a consult included the presence of metastatic disease and uncontrolled symptoms. A research coordinator reviewed charts for all medical oncology admissions. When a patient met the trigger criteria, the attending palliative care clinician prompted attending oncologists to consider a consult. Additional strategies included monthly training for residents in palliative care skills of advanced care planning communication and dedicated institutional funds for TPCC. Palliative care attending clinicians also functioned as champions for promoting PC consultation. Table 3.2 describes the two TPCC approaches used in the oncology services.

Table 3.2. Formal IPPs for Palliative Care Consult Implementation

TPCC supported by a single strategy *Service: Gynecologic Oncology* *Start date: August 2014*	*TPCC supported by multiple strategies* *Service: Medical Oncology* *Start date: October 2015*
• One-page written guideline of clinical criteria for initiating a consult (e.g., uncontrolled pain, nausea, vomiting, frequent readmissions).	• Training of residents in palliative care skills • Clinician prompting of eligible patients by palliative care service. • Medical chart review to identify patients with advanced cancer (i.e., metastatic or uncontrolled symptoms). • Institutional funding. • Appointed champions from PC.

Data Sources

This dissertation relies on both qualitative and quantitative data sources to accomplish its aims. Qualitative data were collected through direct observation of the inpatient medical oncology, gynecologic oncology, and palliative care services and in-person interviews with their clinicians (attendings, house-staff) from March to May 2016. Quantitative data were obtained from three sources: Carolina Data Warehouse for Health (CDW-H), UNC Palliative Care Clinical Research Database, and UNC Hospital Cancer Registry. The CDW-H is a central data repository containing clinical, research, and administrative data from the UNC Healthcare System's electronic health record system. The CDW-H contains data on patient demographics, encounters, and diagnosis codes from UNC Hospital. The data requested included age, sex, race, insurance status, date of death, admitting/discharge service, dates of service, discharge disposition. Data were obtained for all encounters with an admission and/or discharge from the gynecologic oncology and medical oncology inpatient services. Only encounters that included a diagnosis of a solid-tumor cancer based on *International*

Classification of Diseases (ICD) 9 and 10 codes were included in the dataset. Appendix A provides a complete listing of the ICD-9 and ICD-10 cancer diagnosis codes.

For the Aim 1 analysis, the CDW-H encounter data were linked to patient-level data from the UNC Palliative Care Clinical Research Database, which includes data manually abstracted from medical charts for all patients at UNC Hospital who receive a palliative care consultation. This data source provided the dates of service and oncology service line in which the palliative care consult was initiated. For Aims 2 and 3 analyses, this dataset was then augmented with patient-level information on cancer stage at diagnosis and diagnosis date obtained from the UNC Hospital Cancer Registry. All datasets were linked using the Medical Record Number (MRN), the unique patient identifier for the UNC Health Care System. Figure 3.2 summarizes each of the data sources used in this dissertation.

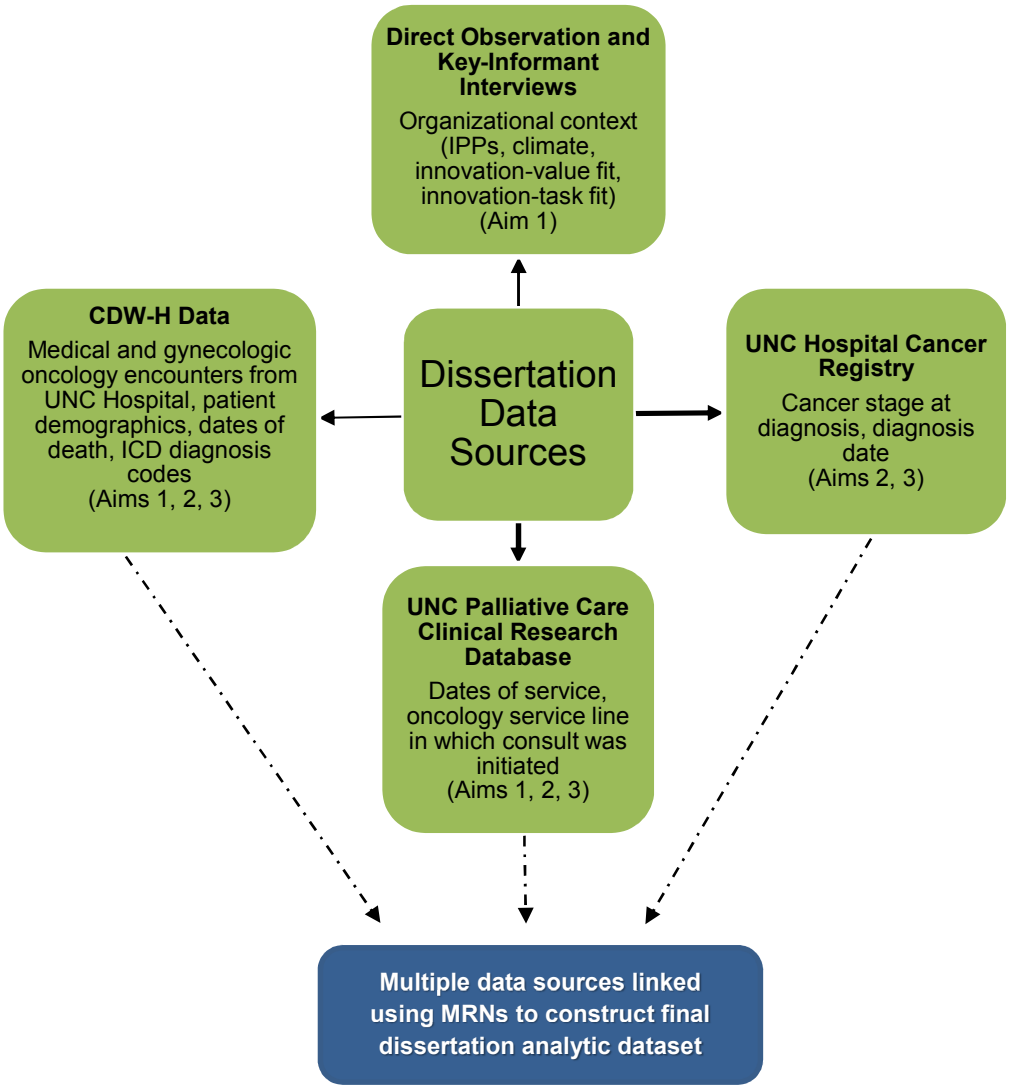

Figure 3.2 Dissertation data sources.

Study Sample and Inclusion/Exclusion Criteria

Participants for the qualitative interviews were recruited if they had provided patient care in the gynecologic oncology or medical oncology services after the formal implementation policies and practices (IPPs) were initiated. Participants were then purposively sampled according to their clinical role (e.g., attending, resident, subspecialty

resident). For all quantitative analyses, all encounters at UNC Hospital with an admission and/or discharge from the medical oncology or gynecologic oncology service with a solid-tumor cancer diagnosis based on ICD 9 and 10 diagnosis codes documented during the hospital encounter from January 1, 2010, to June 30, 2016, were included in the dataset (see Appendix A). If multiple palliative care consults occurred during a hospital encounter, only the first consult was included in the dataset. If a palliative care consult was initiated in a service other than the admitting and/or discharge service (e.g., a palliative care consult originated in medical intensive care but the admitting and/or discharge service was medical oncology), the consult was excluded. For the Aim 3 study sample, the index admission was defined as all eligible encounters included in the sample. Encounters with a discharge status of missing, "left against medical advice," or deceased were excluded as an index admission but could be considered a readmission. A readmission could also serve as an index admission for later discharge encounters.

Variables and Measurement

Aim 1 Qualitative and Quantitative Measures

A semi-structured interview guide was developed using constructs from the Organizational Theory of Innovation Implementation as a guide (Figure 3.1). During the interviews, participants were asked to describe training received in palliative care skills (IPP), incentives used by the oncology services to encourage clinicians to refer patients for palliative care consults (IPP), barriers or disincentives to palliative care consultation (implementation climate), criteria used to decide whether to refer a patient for a palliative care consult (innovation-task fit), and whether or not palliative care consultation helped achieve clinicians' priorities during the time they were rotating on the service (innovation-values fit). Participants were also asked whether there were any other major events or

changes that occurred in the oncology services in the past year that may have impacted palliative care consult implementation. For the interviews with palliative care clinicians, questions were rephrased to obtain their perceptions of the oncology services' palliative care consult implementation. A variety of probes were used to elicit thorough responses. All interviews were audio-recorded and transcribed verbatim. Appendix B includes the complete interview guide used in Aim 1.

Quantitative data on implementation effectiveness, or palliative care consult uptake, was derived from aggregated annual and monthly palliative care consult rates within the gynecologic oncology and medical oncology services. We defined uptake as completion of a palliative care consult as opposed to making a referral.

Aims 2 and 3 Outcome Variables

Table 3.3 summarizes the outcomes and measures for Aims 2 and 3 and the corresponding constructs from the conceptual framework. The primary outcome of interest for Aim 2 was consistency of palliative care consult implementation, which was measured using a binary variable for palliative care consult uptake. Similar to Aim 1, uptake was defined as completion of a consult during the encounter. To assess quality of palliative care consult implementation, a secondary outcome was time to palliative care consult after admission, defined as the number of days between admission and palliative care consultation. Using a subsample of encounters that involved a palliative care consult, we explored varying definitions of a binary variable for time to consult using clinically meaningful cutoffs: within 2 days of admission (55% of encounters involving a palliative care consult), within 7 days of admission (85%), or 14 days of admission (95%).

For Aim 3, our primary outcomes of interest were hospice discharge (inpatient or home) and 30-day unplanned all-cause readmissions. We defined readmission as an inpatient

readmission, including ED visits resulting in an admission, within 30 days of discharge. Secondary outcomes included ED visits not resulting in an admission within 30 days of discharge and a composite outcome of inpatient readmissions and ED visits within 30 days of discharge. We calculated time to readmission as the number of days between the index admission discharge date and readmission date.

Longer travel distance is an obstacle for accessing hospital care.[12] Because the data sources were unique to one hospital system, readmissions to other hospitals may be missed. To minimize the potential for measurement error in the outcomes, we used Hospital Referral Region (HRR) as a proxy for travel distance and restricted the sample to encounters with resident zip codes in the Durham, NC, HRR and neighboring Raleigh and Greensboro, NC, HRRs. (Figure 3.3).

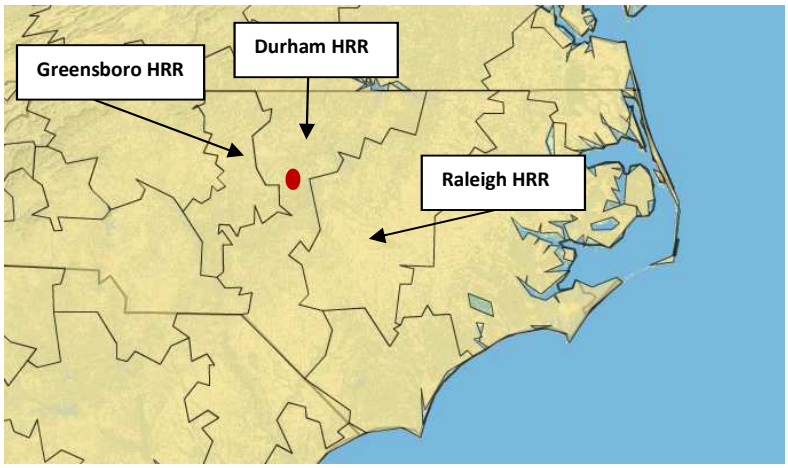

Figure 3.3. Hospital referral regions examined in Aim 3 (red dot indicates UNC Hospital).

Briefly, HRRs are regional healthcare markets for specialized medical care that require the services of a major referral center.[13] The Durham, NC, HRR consists of 15 hospitals located in central NC, including UNC Hospital; the Raleigh, NC, HRR consists of

15 hospitals; and the Greensboro, NC, HRR consist of 5 hospitals. Admissions for chemotherapy or radiotherapy (identified using ICD codes V58.xx and Z51.xx), psychiatry, or rehabilitation services were not considered readmissions because these usually indicated a planned admission.

Table 3.3. Aims 2 and 3 Outcomes and Measures

Aim	*Construct*	*Description*	*Outcome Measure*
2	Implementation Effectiveness	(1) PC Consult Uptake (2) Time to PC Consult (within 2 days, 7 days, or 14 days of admission)	(1) Binary 1=PC consult 0=No PC consult (2) Binary 1=PC consult≤2 days 0=PC consult>2 days 1=PC consult≤7 days 0=PC consult>7 days 1=PC consult≤14 days 0=PC consult>14 days
3	Innovation Effectiveness	(1) Hospice discharge (2) Unplanned all-cause 30-day readmission	Primary Outcomes: (1) Binary 1=Hospice discharge 0= Non-hospice post-acute care (2) Binary 1=inpatient readmission w/in 30 days of discharge 0=no inpatient readmission Secondary outcomes: (1) Binary 1=ED visits and inpatient readmissions w/in 30 days of discharge 0=no ED visit or inpatient readmission (2) Binary 1=ED visit w/in 30 days of discharge 0=no ED visit

Aims 2 and 3 Explanatory Variables

Table 3.4 summarizes the key explanatory variables and measures for Aims 2 and 3 and the corresponding constructs from the conceptual framework. For the single strategy vs. usual care comparison in Aim 2 (Hypothesis 2a and 2b), we included an indicator variable to capture exposure to the single strategy based on admission date (on or after 8/1/2014 through 9/30/2015), oncology service (gynecologic oncology or medical oncology), and the interaction term between these two variables. For the multiple strategies vs. single strategy comparison (Hypothesis 2c and 2d), we included an indicator variable to capture exposure to the multiple strategy based on admission date (on or after 10/1/2015 through 6/30/2016), oncology service, and the interaction term between these two variables.

For Aim 3, the explanatory variable of interest was a binary variable indicating whether or not an encounter involved a palliative care consultation. Encounters that involved a palliative care consult were included in the "treatment" group; encounters that did not involve palliative care consult were included in the "usual care" group.

Table 3.4. Aims 2 and 3 Key Explanatory Variables and measures

Aim	*Construct*	*Description*	*Explanatory Measure*
2	IPPs	(1) TPCC supported by single strategy vs usual care	(1) Pre/post TPCC indicator interacted with oncology service 1=post TPCC (8/1/2014-9/30/2015) 0=pre TPCC (1/1/2010-7/31/2014)
		(2) TPCC supported by multiple strategies vs single strategy	(2) Pre/post TPCC indicator interacted with oncology service 1= post TPCC (10/1/2015-6/30/2016) 0=pre TPCC (8/1/2014-9/30/2015)
3	Implementation Effectiveness	(1) PC Consult uptake	(1) Binary 1=PC consult ("treatment") 0=No PC consult ("usual care")

Aim 2 Covariate Selection

For Aim 2, demographic and clinical characteristics were included that may be associated with the exposure to TPCC supported by a single strategy versus multiple strategies and palliative care consult uptake. Patient demographic characteristics were extracted from the CDW-H data and included categories for race (White—reference, Black, other, missing); sex; insurance status (Medicare—reference, Medicaid, private, other public, uninsured, missing). Age was included as a continuous variable in all models.

Patient clinical characteristics were extracted from the UNC Palliative Care Clinical Research Database and CDW-H data. Clinical characteristics included: palliative care consultation in a prior hospital encounter (yes or no); hospitalization in the prior 30 days (yes or no); length of stay (calculated as number of calendar days between admission and discharge dates); discharge status (alive or deceased), and solid-tumor cancer type (digestive, breast, bone/joint, soft tissue, skin, head/neck, urological, lung/thoracic, gynecological, other/ill defined, central nervous system, missing). Because some patients may have been diagnosed with multiple cancers, more than one cancer type could be counted per encounter.

Because palliative care consultation is available to all hospitalized patients regardless of cancer stage, we extracted stage of disease from the UNC Hospital Cancer Registry and included stage as a control variable in all models. Stage was based on the American Joint Committee on Cancer staging criteria (Stage 0 or I, II or III, IV). The most recent stage diagnosed before the hospital admission date was included in the dataset. A 60-day window was added to the admission date to ensure all cancers staged soon after the admission date were captured. If a patient had multiple staged cancers, only the highest stage of disease was included in the dataset. If stage could not be ascertained, it was categorized as “missing.”

We assessed comorbidities (0, 1, 2 or more comorbidities) using the Quan et al. adaptation of the Charlson comorbidity index which includes both ICD-9 and ICD-10 codes and has been validated in inpatient settings.[14] Comorbidity ICD-9 and 10 codes were derived from the patient's problem list in the electronic health record system. The comorbidities may be added at any time the patient receives care at the institution. We searched the problem list for evidence of comorbidities 30 days before and after the admission date to ensure all comorbidities present at the time of an encounter were captured. Diagnosis of malignant disease and metastatic solid tumor were omitted from the comorbidity index. Appendix C provides a complete listing of comorbidity ICD-9 and 10 codes used in this dissertation.

Aim 3 Covariate Selection

In Aim 3, these same covariates anticipated to be associated with receipt of palliative care consults identified in Aim 2 were used to calculate a propensity score and balance the treatment (palliative care consult) and usual care (no palliative care consult) groups. The groups were also balanced on oncology service (medical oncology or gynecologic oncology) and admission year (2010–2016). Hospice discharge was excluded as a covariate because it is an outcome of the treatment and including it would obscure the estimated effect of palliative care consults on readmissions.[15] The process for calculating the propensity scores are described in the next section.

Data Analysis by Aim

Aim 1

Qualitative. Qualitative data were coded and analyzed using codes identified deductively based on the conceptual framework (Figure 3.1). All transcripts were independently coded by a second analyst with extensive experience in qualitative methods. Text was coded using a common codebook and any discrepancies in coding were reconciled

after each round of independent coding. Within each service, we assessed the degree to which each construct appeared in the data (salience) by counting the text segments assigned to the construct's code, the degree to which the construct positively or negatively affected implementation (valence), and the degree to which relationships among the constructs were supported in the conceptual framework. We also conducted a cross-case synthesis[1] to explore whether organizational determinants of palliative care consult implementation varied across the service lines. We then analyzed the data for key themes and patterns by each construct.

Quantitative. Aim 1 monthly and annual rates of palliative care consults were calculated by dividing the number of encounters that involved a palliative care consult (numerator) by the total number of encounters eligible for a consult (denominator), which was defined as all hospital admissions within each of the oncology services. A visual representation of annual and monthly trends in palliative care consult uptake was provided in the form of graphs.

Aim 2

For Aim 2, two difference-in-difference (DID) regression models were estimated. The first compared changes in outcomes before (1/1/2010–7/31/2014) and after (8/1/2014–9/30/2015) TPCC in gynecologic oncology (single strategy) to changes over the same time period in medical oncology (usual care). The second compared outcomes before (8/1/2014–9/30/2015) and after (10/1/2015–6/30/2016) TPCC in medical oncology (multiple strategies) to changes over the same time period in gynecologic oncology (single strategy). The analysis of time to palliative care consult was restricted to admissions with a palliative care consult. For each comparison, we estimated separate models for palliative care consult within 2 days, 7 days, or 14 days of admission (6 models total). The unit of analysis was the discharge encounter.

We estimated the adjusted relative risk (aRR) and 95% confidence intervals (CI) of palliative care consult uptake and time to palliative care consult using modified Poisson regression. This method has been shown to estimate the RR consistently and efficiently even in small samples.[16] Robust standard errors clustered at the patient-level were used to account for autocorrelation across encounters, because some patients may have had multiple hospitalizations. The binary outcomes for Aim 2 were modeled individually using the following DID equation:

$$\text{Count}(\mu_i) = exp(log\text{LengthOfStay}_i + \beta_0 + \beta_1 \text{Time}_t\text{>TPCC} + \beta_2\ \text{Service}_i + \mathbf{\beta_3 Time_t > TPCC * Service_i} + X_{it})$$

where *i* indicates the encounter and *t* indicates time and $\mu_i = 1$ and 0 otherwise. Associated with μ_i is a vector "X" of patient demographic and clinical covariates and year (2010–2016) as a continuous variable. The right-hand side of the equation also includes the log of length of stay as an exposure, or offset variable, to account for different observation periods. The effect of interest is identified by $\mathbf{\beta_3}$ which estimates the effect of TPCC on the probability of the outcome for inpatients with solid-tumor cancer admitted and/or discharged from the oncology services.

For the DID estimates to be valid and unbiased, the *assumption of parallel trends* must be met. For the DID estimates to be valid and unbiased, the *assumption of parallel trends* must be met. Briefly, this means the trends in palliative care consult uptake between the oncology services were the same prior to TPCC.[3] We tested for this assumption using data prior to the implementation of any TPCC strategies: 1/1/2010 to 12/31/2013. We estimated a modified Poisson regression model that controlled for the same demographic and

clinical characteristics as the models for the primary analyses in addition to: a linear time trend (admission date as a continuous variable), an indicator for oncology service, and the interaction between those two variables. Under the parallel trends assumption, the coefficient of the interaction should equal zero. We conducted our analyses using Stata version 13.0 (College Station, TX). All statistical tests were two-tailed with a critical alpha equal to 0.05.

Aim 3

To minimize the potential for selection bias, Aim 3 used propensity scores to identify encounters that did not involve a palliative care consult but were comparable to encounters that did involve a palliative care consult based on the aforementioned observed covariates.[15] A modified Poisson regression model[16] with palliative care consult as the outcome and observed covariates as predictors was used to calculate propensity scores. Encounters that involved a palliative care consult were matched 1:1 to usual care encounters using the nearest neighbor with replacement method, which provided the smallest absolute standardized difference in covariates between the groups (i.e., <10%). Any covariates with a standardized difference greater than 10% were adjusted for in the post-match analysis.

Using the propensity score matched sample, we estimated the aRR and 95% CIs of hospice discharge, discharge, 30-day unplanned all-cause readmission, and secondary outcomes (i.e., ED visits and a composite outcome of inpatient readmissions and ED visits) using modified Poisson regression models.

$$\text{Count}(\mu_i) = exp(log\text{DaysToDeath}_i + \beta_0 + \boldsymbol{\beta_1}\ \textbf{PalliativeCareConsult}_i + X_i)$$

where *i* indicates the encounter and $\mu_i = 1$ and 0 otherwise (e.g., hospice discharge or discharge to non-hospice post-acute care; readmission or no readmission). Associated with μ_i

will be a vector "X" of covariates additionally adjusted for in the post-match analysis. For the readmission analysis only, the right-hand side of the equation also includes the log of days to death after discharge (number of calendar days between discharge date to death date) as the exposure, or offset variable, to account for mortality during the 30-day readmission window. The effect of interest is identified by $\boldsymbol{\beta_1}$, which estimates the effect of palliative care consult on hospice discharge and 30-day readmissions for inpatients with solid-tumor cancer admitted and/or discharged from the oncology services.

We used robust standard errors clustered at the patient level. We included hospice discharge as a covariate in the model when examining whether the combination of palliative care consultation with hospice discharge was associated with lower 30-day readmissions. Adjusted predicted probabilities of a 30-day readmission for an encounter were then calculated to contrast outcomes for the following clinical scenarios: usual care, palliative consultation combined with hospice discharge, and palliative care consultation with discharge to non-hospice post-acute care (e.g., home with self-care or intermediate care facility). We conducted all analyses using Stata version 13.0 (College Station, TX). All statistical tests were two-tailed with a critical alpha equal to 0.05.

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CHAPTER 4. INFLUENCE OF FORMAL AND INFORMAL IMPLEMENTATION POLICIES AND PRACTICES IN PROMOTING PALLIATIVE CARE CONSULTATION IN ONCOLOGY: A MIXED-METHODS ANALYSIS

Overview

Evidence demonstrates palliative care (PC) delivered concurrently with cancer treatment improves patients' outcomes, yet integration of PC with inpatient oncology is lacking. Inpatient PC consult implementation poses a unique challenge because it occurs within complex hospital settings. To date, the Organizational Theory of Innovation Implementation has contributed important insights regarding the influence of formal implementation policies and practices (IPPs) on effective implementation of healthcare innovations, however the role of informal IPPs has been largely unexplored. Therefore, using PC consultation as a model, we examined formal and informal IPPs as organizational determinants of innovation implementation.

We used a case study design of PC consult implementation in two inpatient settings within one academic medical center: medical oncology and gynecologic oncology. We completed semi-structured interviews with inpatient medical (n=12) and gynecologic (n=10) oncology attending and house-staff clinicians using questions based on the Organizational Theory of Innovation Implementation. Quantitative data were used to assess implementation effectiveness, defined as aggregated PC consult rates within the oncology services from January 2010 to June 2016. We also interviewed four PC clinicians to gain additional insights on the organizational context for implementation.

Both oncology services exhibited variable rates of PC consult uptake over time, with temporal increases. Medical oncology employed multiple formal IPPs such as training and clinician prompting to support PC consultation and a top-down approach, yet most clinicians were unaware of the IPPs, contributing to a weak implementation climate. In contrast, gynecologic oncology employed one formal IPP (a written guideline of clinical criteria for initiating a consult) but also relied on multiple informal IPPs such as spontaneous feedback and communication; they adopted a bottom-up approach, contributing to broader clinician awareness and a strong implementation climate.

Our results contribute to emerging research on the organizational determinants of PC implementation in oncology. They provide empirical support for the influence of formal and informal IPPs as facilitators of innovation implementation, suggesting refinements to organizational theory. Future research should further investigate the role of formal and informal IPPs in shaping a strong and sustainable implementation climate, and subsequent effective implementation of innovations.

Background

Cancer patients, particularly those with advanced disease, often experience high symptom burden and poor quality of life. Evidence from several randomized trials demonstrates that palliative care (PC) delivered concurrently with cancer treatment can improve quality of care and outcomes.[1-3] However, despite numerous practice guidelines emphasizing the importance of early PC for cancer patients with advanced disease or high symptom burden,[4-7] implementation of routine PC in oncology varies across health systems and clinical settings. Prior research has indicated that uptake of PC in inpatient oncology settings is poor, with several studies finding that fewer than half of eligible cancer patients received a PC consult during hospitalization.[8-10]

Implementation of inpatient PC consults poses a challenge because it occurs within complex hospital settings, requiring substantial coordination and cooperation between multidisciplinary teams of clinicians and multiple decision-makers involved in patient care. Using a conceptual framework that focuses on organization-level, rather than patient- or provider-level, determinants of inpatient PC consults may clarify the underlying context in which implementation occurs. However, limited information exists on organizational determinants associated with effective PC consult implementation across different inpatient oncology settings.[11]

In this study, we used case study methods to examine the context for PC consult implementation in two organizational settings (medical oncology and gynecologic oncology service lines) located in a single academic medical center. We drew on the Klein and Sorra Organizational Theory of Innovation Implementation[12,13] as a guide to developing our interview guide and interpreting our results. To date, the theory has contributed to important insights regarding the influence of organizationally sanctioned formal implementation policies and practices (IPPs) on effective implementation of healthcare innovations, however the role of informal IPPs has been largely unexplored.[12-17] IPPs refer to "the array of innovation, implementation, organizational, and managerial policies, practices, and characteristics that may influence innovation use."[13] Compared to formal IPPs (e.g., training programs; guidelines, or protocols), informal IPPs such as spontaneous communication and on-the-job training require less investment in resources and can readily be adapted to the organizations' implementation needs. Informal IPPs may have other favorable characteristics, such as natural emergence from consensus among clinicians. However, less explicitly defined IPPs with no organizational mandate may have limited influence on

innovation implementation. Therefore, using PC consultation in inpatient oncology as a model, the purpose of this study was to examine formal and informal IPPs as determinants of innovation implementation.

Methods

Conceptual Framework

A complex innovation is a practice that is perceived as new by the users in the organization and requires coordinated use of multiple organizational members to benefit the organization.[13] We considered PC consults in inpatient oncology to be a complex innovation based on the following features: (1) the integration of PC consults with cancer treatment is an expanding and evolving area of interest; (2) use of inpatient PC consults is complex, comprising multiple providers including physicians, nurses, pharmacists, chaplains, and social workers who coordinate care for inpatients receiving PC; and (3) implementation of inpatient PC consults requires extensive coordination between multidisciplinary PC teams and the oncology clinicians overseeing the care of a patient. Implementation is the action of putting the innovation (PC consults) to use. The Klein and Sorra Organizational Theory of Innovation Implementation[12,13] posits that implementation effectiveness is a function of formal IPPs, a positive implementation climate, perception that the innovations' use is congruent with the intended users' values, and the extent to which the innovation fits with organizational workflow (Figure 4.1).[14,16]

Organizations can employ a variety of formal IPPs to support the use of an innovation. IPPs are cumulative, compensatory, and equifinal, meaning the more formal IPPs that an organization uses to support the innovation use the better.[13,15] The collective influence of an organization's IPPs shapes implementation climate for innovation use.[13-15] Climate refers to the shared perception among targeted organizational members of the "extent to

which their use of a specific innovation is rewarded, supported, and expected within the organization."[13] The more this shared sense is developed, the greater likelihood the innovation will be used consistently and with high quality.

A strong climate is necessary, but not sufficient, for effective innovation implementation. The association between climate and implementation effectiveness may be moderated by the innovation-values fit and innovation-task fit. Innovation-values fit is "the extent to which targeted users perceive that use of the innovation will foster (or, conversely, inhibit) the fulfillment of their values."[13] Innovation task fit, which was not originally included in the theory, arose from Helfrich et al.'s[14] and Weiner et al.'s[16] prior research indicating the need to parse out the concept of innovation-value fit as encompassing not only normative values, but "the extent to which an innovation is compatible with work processes, task demands, and organizational capabilities." Even if the climate for innovation implementation is strong, a weak innovation-value fit or innovation-task fit will result in resistance and impede the organizations' ability to effectively implement the innovation.

Study Setting

The study was conducted in two distinct oncology services at University of North Carolina (UNC) Hospitals, an 804-bed acute care facility and National Cancer Institute Comprehensive Cancer Center. Gynecologic oncology is composed of teams of clinicians who provide care for patients with solid tumor gynecological cancers. Compared to medical oncology, gynecologic oncology is a much smaller service, composed of only eight attending clinicians who specialize in gynecologic oncology and a small tight-knit group of specialty and subspecialty residents. In contrast, medical oncology has approximately 26 attending clinicians who specialize in solid tumors and a large pool of specialty residents. The teams on both services include an attending and several house-staff clinicians (residents and medical

students). The services are characterized by frequent rotation of attending clinicians and turnover of residents. For example, attending clinicians rotate every two weeks in medical oncology and every eight weeks in gynecologic oncology, while residents and students rotate monthly and subspecialty residents in gynecologic oncology rotate on a weekly basis. Each subspecialty resident in gynecologic oncology is assigned the primary responsibility for overall organization and delegation of patient care during the week they are on rotation. The medical center's inpatient PC team is interdisciplinary, composed of an attending palliative physician, two nurse practitioners, a social worker, and a chaplain; it supports symptom management, goal setting, and decision-making for inpatients and is available to patients only by referral of the primary treating team in the oncology services.

PC Consult Implementation in Oncology Services

Starting in August 2014, gynecologic oncology began using a single formal IPP—a one-page written guideline describing the clinical criteria (e.g., unplanned admission for symptom management, frequent readmissions, malignant small bowel obstruction) for initiating a PC consult posted in the residents' work area. Oncologists in gynecologic oncology developed the guideline internally, without input from PC service. Starting in October 2015, medical oncology began using multiple formal IPPs, including chart review to identify all cancer inpatients with Stage IV disease and uncontrolled symptoms, prompting for PC consultation, and monthly training for residents in PC skills of advanced care planning communication. PC attending clinicians functioned as champions for promoting PC consultation and institutional funding was secured to support these formal IPPs. All of the IPPs were led by the PC service, with significant input throughout implementation from selected oncology clinicians.

Study Design

This study used a two-case study design of PC consult implementation in the medical oncology and gynecologic oncology services. Case study methods use mixed-methods to provide an in-depth analysis of the organizational context and is well-suited for studying implementation of innovations.[18] Specifically, we explored the organizational context for PC consult implementation with qualitative data from key-informant interviews (medical oncology, gynecologic oncology, and PC clinicians). Consistent with a mixed-methods approach, quantitative data on PC consult uptake were used to complement the qualitative findings and to gain a comprehensive understanding of PC consult implementation for each of the cases.[19] We defined uptake as completion of a PC consult (as opposed to making a referral). The University of North Carolina Institutional Review Board reviewed and approved this study.

Qualitative Data Collection

One investigator (LDD) gathered qualitative data through direct observation of the inpatient medical oncology, gynecologic oncology, and PC services and in-person interviews with their clinicians (attendings, house-staff) from March to May 2016. Interview participants were recruited if they had provided patient care in the gynecologic oncology or medical oncology services after the formal IPPs were initiated. Participants were then purposively sampled according to their clinical role. Interview participants were recruited in-person and via e-mail and compensated with a $25 gift card for their time. Questions for the semi-structured interviews were developed using the Organizational Theory of Innovation Implementation as a guide. For example, participants were asked to describe training received in PC skills (IPP), incentives used by the oncology services to encourage clinicians to refer patients for PC consults (IPP), barriers or disincentives to PC consultation

(implementation climate), criteria used to decide whether to refer a patient for a PC consult (innovation-task fit), and whether or not PC consultation helped achieve clinicians' priorities during the time they were rotating on the service (innovation-values fit) (see Appendix B). Participants were also asked whether there were any other major events or changes that occurred in the oncology services in the past year that may have impacted PC consult implementation. For the interviews with PC clinicians, questions were rephrased to obtain their perceptions of the oncology services' PC consult implementation. A variety of probes were used to elicit thorough responses. All interviews were audio-recorded and transcribed verbatim.

Quantitative Data Collection

We obtained quantitative data on PC consult uptake from January 2010 to June 2016 using data from the UNC Palliative Care Clinical Research database. This database includes data abstracted from medical charts for all patients who receive PC consultation, including dates of service and oncology service line in which the PC consult was initiated. These data were then linked to all hospital stays with an admission and/or discharge from the medical oncology or gynecologic oncology service with a solid tumor diagnosis based on International Classification of Diseases 9 and 10 diagnosis codes documented during the hospital stay using data from the Carolina Data Warehouse for Health (a central data repository containing clinical, research, and administrative data from the institution electronic health record system). If multiple PC consults occurred during a hospital stay, only the first consult was included in the dataset.

Qualitative Analysis

Using codes identified deductively based on the conceptual framework (Figure 4.1), qualitative data were coded and analyzed using Atlas.ti (version 7.0). Two members of the

research team (LDD, ASC) independently coded all interview transcripts (nearly 300 pages from all three inpatient service lines) using a common codebook and reconciled codes after completion of independent coding. Within each service, we assessed the degree to which each construct appeared in the data (salience) by counting the text segments assigned to the construct's code, the degree to which the construct positively or negatively affected implementation (valence), and the degree to which relationships among the constructs were supported in the conceptual framework. We also conducted a cross-case synthesis[18] to explore whether organizational determinants of PC consult implementation varied across the service lines. We then analyzed the data for key themes and patterns by each construct.

Quantitative Analysis

PC consult uptake was derived from aggregated PC consult rates within the gynecologic oncology and medical oncology services. We calculated monthly and annual rates by dividing the number of encounters that involved a PC consult (numerator) by the total number of encounters eligible for a consult (denominator), which was defined as all hospital admissions within each of the services. We provided visual representation of annual and monthly trends in PC consult uptake in the form of graphs. A scatterplot of the monthly rates was overlaid with a fractional polynomial prediction plot to provide a flexible summary of the relationship.

Results

We analyzed data from interviews (N=26) representing three services: 12 from medical oncology, 10 from gynecologic oncology, and 4 from PC (Table 4.1). Roles represented across the interviews included attending clinicians (N=13), specialty residents (N=6), subspecialty residents (N=3), medical students (N=2), and staff (N=2). Interviews ranged from approximately 15 to 45 minutes. Results are summarized in Table 4.2. Briefly,

both services exhibited temporal increases in PC consult uptake. Medical oncology employed multiple formal IPPs to support PC consultation, yet most clinicians were unaware of the IPPs, contributing to a weak implementation climate. In contrast, gynecologic oncology employed one formal IPP but also relied on multiple informal IPPs, which contributed to broader clinician awareness and a strong implementation climate. The interviews with PC clinicians generally corroborated the findings in the oncology services.

Implementation Effectiveness

Gynecologic oncology and medical oncology services exhibited variable but increasing aggregated rates of PC consults over time. Both services had similar annual rates of PC consults in 2010, exhibited a decrease between 2011–2012 and 2012–2013, and then increased after 2013 (Figure 4.2). Starting in mid-2014, both services met or exceeded the national goal of providing PC consults to approximately 10% of all hospital admissions (although no benchmark currently exists specific to inpatient oncology).[20] Although at first glance these trends appear to be a part of a broader trajectory, Figure 4.3 indicates gynecology oncology experienced a slight increase in monthly PC consult rates in August 2014 after initiation of the single formal IPP and maintained roughly similar rates throughout the remainder of the study. In contrast, medical oncology experienced a strong upward spike in monthly PC consult rates in October 2015 following initiation of multiple formal IPPs but immediately afterward exhibited a sharp decline. Below, we explain that these trends in the services might be attributed to not only the initiation of formal IPPs but also informal IPPs, implementation climate, innovation-task fit, and innovation-values fit for PC consultation.

Implementation Policies and Practices

Medical oncology employed multiple formal IPPs to support PC consultation while gynecologic oncology employed one formal IPP; however, compared to medical oncology,

gynecologic oncology was more apt to use informal IPPs. For example, several participants reported frequent spontaneous communication and feedback between gynecologic oncology and the PC service. Participants mentioned they were particularly incentivized to use the PC service because of its quickness to respond and strong presence in gynecologic oncology. In addition, in the absence of a formal training, most PC skills were learned on-the-job through informal interactions with the PC service. One resident stated,

> It's a constant dialogue. I don't know if it's truly feedback, but the nurse practitioner or the resident, whoever's here, there's almost always one of us kind of up here on the floor, whoever's on the OR [operating room], and they [palliative care] come by and see our patients, and they sit in our workroom with us, and we talk about the patients, and they kind of tell us their thoughts, and they ask us clarifying questions.

Further, champions in gynecologic oncology were also more emergent and informal as opposed to appointed. All interview participants identified at least one attending clinician whom they considered to be a champion for PC consults, with one participant identifying the fellows and residents as emergent champions because they "do a good job at remembering to call PC." Several participants also discussed how the formal IPP (written guideline) was developed by subspecialty residents in the service by adopting an informal bottom-up approach, which was in contrast to the formal top-down approach to implementation observed in medical oncology.

Despite multiple formal IPPs in medical oncology, only 5 of 12 interview participants (all attending clinicians) were aware of the IPPs. Moreover, these participants had only a vague understanding about what the IPPs entailed. As one attending clinician commented,

"So I don't know what the automatic trigger is, but I know that a lot of our patients had palliative care consults and it was very useful." Participants in medical oncology interviews also discussed the need for more formal IPPs, including feedback mechanisms, training, and specific clinical criteria for initiating PC consults. As one resident commented, "So I guess kind of the issue is palliative care kind of consults so they'll come in and they'll see a patient and they'll give their recs. It's so separate that there's not really usually an opportunity for feedback in either direction." In contrast, several interview participants in gynecologic oncology were aware of the written guideline and spoke about it in detail; identifying specific clinical criteria that would oftentimes trigger a consult, such as frequent admissions or presence of recurrent disease.

Implementation Climate

Medical oncology employed multiple formal IPPs but most interview participants lacked awareness of the IPPs, which contributed to a weak implementation climate. For example, few in medical oncology reported that using PC consults was an expectation on the service. Similarly, medical oncology participants' comments indicated PC consultation was not always strongly supported, mentioning numerous barriers including limited availability of PC resources and increasing complexity of care as possible disincentives to their use. Further, consistent with the lack of awareness of the IPPs in medical oncology, participants' clarity about when to use PC consults and whether they had the skills and tools to play their part in making referrals was also absent on this service.

In contrast, gynecologic oncology employed only one formal IPP, instead relying on multiple informal IPPs that contributed to broader clinician awareness and a strong implementation climate. For example, although referral is ultimately up to the individual clinician, gynecologic oncology participants generally reported PC consultation was

expected. Likewise, participants' comments indicated that PC consultation was supported in their work, citing few barriers or disincentives. In particular, participants indicated clarity about when to use PC consults was strong and mentioned the formal IPP (written guideline) contributed to this clarity. Also in contrast to medical oncology, gynecologic oncology participants generally reported having the skills and tools to play their part in referring patients for consults, although some discussed needing more training and feedback from the PC service in this area.

Across both services, none reported receiving any specific recognition or rewards for PC consultation. Most participants mentioned this was not needed; better patient care was identified as the primary reward for PC consultation. However, almost all felt supported when it came to the logistics surrounding PC consultation (i.e., use of electronic health record system for referrals, paging process, talking on rounds). Many participants discussed how the electronic health record system made it easier to make PC consult referrals because the process was the same for all consult services in the hospital.

Innovation-Values Fit

Both services exhibited a strong innovation-value fit for PC consultation. Across clinician roles, PC consultation was found to be highly valued and consistent with the providing the best patient care possible. As indicated by one attending clinician, "in medical oncology, it's a complex hospital. Our people are sick. You have multiple specialists... they're all key. They're [palliative care] as key to the team as the thoracic surgeon." Each service had at least one attending state that every oncology inpatient should have a PC consult. Some students and residents spoke about the fit of PC consults with their values—the strong desire to learn and gain new skills—while attending clinicians spoke about the fit of PC consults with their commitment to educate residents. Clinicians in both services stated

that PC consults were consistent with "keeping the flow open" and being "vested" in a team-based approach to care for inpatients admitted with complex medical needs. Given that one-third of interview participants in each service reported receiving some PC training during their medical education, clinicians' strong value for PC consults may have been fostered by this prior exposure.

Although interview participants from the PC service generally echoed the findings from medical and gynecologic oncology, several indicated that PC consults may not always be consistent with oncologists' priority for chemotherapy treatment or timely discharge from the hospital.

Innovation-Task Fit

Both services reported PC consults generally fit well with their organizational tasks and workflow. Several themes may explain this finding. First, the main functions of the inpatient PC service are to address symptom management and facilitate goals of care discussions. Across both services, participants agreed that PC consults added an extra layer of support for symptom management; however, in medical oncology the emphasis was primarily on managing pain while in gynecologic oncology participants identified multiple symptoms that PC consults aided in managing. As stated by this attending clinician,

> I think it's usually many times symptom management, so if patients are having symptoms from their cancer, especially multiple symptoms from their cancer, there's pain and nausea and maybe shortness of breath and the things that we know how to do as gynecologic oncologists don't seem to maybe working the best, I think that's really probably our number one reason why we call them is for symptom control and help with that.

Likewise, both services considered there to be a strong fit if goals of care discussions were needed because clinicians face many competing demands while on-service and lack the time to have lengthier goals of care discussions with patients and their families. Participants mentioned that PC consults can help to offset this workload, however our findings across the services suggest there may be a U-shaped relationship between patient volume and innovation-task fit for PC consults. Specifically, some participants mentioned high patient volume would promote PC consultation while others commented they would be more likely to use PC consults when volume was low because there was "more time to think about individual people and some of their broader problems." Of note, participants often referred to goals of care discussions as "end-of-life care" and indicated they were most compatible only if a patient was transitioning to hospice, however this finding was more pronounced on the medical oncology service.

Second, both services reported attending clinicians' preferred roles impacted how well PC consults fit in the service, particularly as it relates to goals of care discussions. For example, in gynecologic oncology some attending clinicians mentioned wanting to conduct goals of care discussions because they are "my patients." This comment likely reflects that all clinicians on the service care for the same spectrum of cancer types. In contrast, because attending clinicians in medical oncology specialize in a variety of tumor types, they may be in a better position to discuss prognosis for one cancer type but less comfortable discussing the outlook of patients with other cancer types represented on the service. Participants identified that patient and family preferences may also affect the fit of PC consults but that this could be addressed by improving the branding of the PC service.

Third, participants in gynecologic oncology reported PC consults were compatible with workflow if they were aware the patient was already receiving PC services in the outpatient setting. As one attending clinician stated, "I have a number of my patients that I have palliative care help take care of as an outpatient… so usually they will call the consult and say what is needed." In contrast, interview participants in medical oncology were more apt to report a poor compatibility if they were unaware whether there was continuity of care with PC services in the outpatient setting. As one attending clinician expressed,

> Unfortunately what we don't have yet is a seamless process where the patients are getting these things done in the outpatient setting. And maybe they are, but I get this problem all the time, where is the documentation? It's the weekend. I can't reach the primary attending. I have to have these tough conversations now with these folks, so I did them.

Discussion

Our study provides empirical support for the role of formal and informal IPPs as determinants of PC consult implementation in inpatient oncology, suggesting refinements to organizational theory. Specifically, despite the medical oncology service's use of multiple formal IPPs, most participants were unaware of the IPPs, which contributed to a weak implementation climate. In contrast, the gynecologic oncology service employed only one formal IPP and instead relied on multiple informal IPPs, which contributed to broader clinician awareness and a strong implementation climate. Innovation-value fit and innovation-task fit (moderators of implementation climate and implementation effectiveness) were generally strong in both services.

According to the Organizational Theory of Innovation Implementation, we would expect PC consult uptake to be suboptimal in medical oncology, however both services

exhibited temporal increases. In fact, despite clinicians' lack of awareness in medical oncology, PC consult uptake increased significantly after the initiation of the formal IPPs in October 2015. This disparate finding is surprising and may be attributed to when implementation climate was assessed. Specifically, interviews were conducted several months after initiation of the formal IPPs in medical oncology and coincided with the declining uptake rates in this service observed at the end of the study (Figure 4.3). This decline may provide an indication that climate strength in medical oncology weakened over time. Accordingly, our findings from the interviews may not accurately reflect the climate strength that existed soon after the formal IPPs were initiated. Alternatively, we examined the potential for other initiatives occurring in the oncology services that may have impacted PC consult implementation. Participants in both oncology services and the PC service were asked if such initiatives had occurred in the past year, but there were no activities reported that would be expected to impact PC consult implementation.

These study findings ultimately point to a broader issue: relying solely on organizationally sanctioned formal IPPs may not be effective in creating a strong and sustainable climate for implementation in busy, complex healthcare organizations such as the academic oncology services examined in this study.[21] For example, training is a formal IPP commonly used by healthcare organizations to promote innovation use, but residents often lack the time outside of their clinical responsibilities to attend skills trainings. In addition, new groups of residents rotate through the oncology services on a frequent (though predictable) schedule. Thus, it may be important for busy healthcare organizations to develop mandatory training programs that are offered on a continuous and routine basis.[22,23]

Otherwise, as our findings indicate, training exposure will be minimal and ultimately contribute to a weakened implementation climate over time.

From a theoretical standpoint, our findings support the idea that informal IPPs may compensate or substitute for formal IPPs under certain conditions. As we observed in the gynecologic oncology service, this may be more likely to occur in smaller healthcare organizations where there is greater opportunity for social interaction and information sharing. For example, one study found small primary care practices achieved effective implementation of the patient-centered medical home using informal care teams rather than more formal care coordination.[24] Specifically, formal IPPs may influence implementation climate and subsequent effective implementation insofar as the targeted users of the innovation have the opportunity to develop a shared sense innovation use is expected, supported, and rewarded.[13] In gynecologic oncology, we found the use of informal IPPs may have played a critical role in creating that shared sense and a strong and sustainable implementation climate. For example, gynecologic oncology may have exhibited greater awareness of the written guideline because the strong presence of informal IPPs in the service continually reinforced its enactment. In particular, adopting a bottom-up approach by involving clinicians in all roles in development of the guideline created a greater sense of ownership, which may have contributed to awareness and a more positive view of the guideline. In contrast, informal IPPs may be less likely to substitute for formal IPPs in larger organizations, such as medical oncology, where fragmented intra-departmental units have limited opportunity for social interaction.[25,26] As we observed, medical oncology used multiple formal IPPs developed externally by the PC service. The absence of informal IPPs in combination with a top-down approach may have undermined clinicians' awareness of the

IPPs, which contributed to a weak shared sense that PC consultation was expected, supported, and rewarded. Future research should further investigate the role of formal and informal IPPs in shaping a strong and sustainable implementation climate, including the interplay between top-down versus bottom-up approaches and subsequent effective implementation of healthcare innovations.

Study Limitations

This study has several limitations. First, it was conducted at a single academic medical center, which limits generalizability. However, case study research, which emphasizes depth over breadth, is appropriate for the purposes of theory refinement.[27] Second, interview data were gathered after the initiation of the formal IPPs in both services. Therefore, we are unable to provide a longitudinal assessment of how the organizational context for PC consults may have changed over time or determine whether the sharp decline in PC consult uptake rates in medical oncology observed at the end of the study would persist or eventually rebound. Third, the residents we interviewed described implementation climate at the time of the interview, however had we interviewed residents soon after they had completed the PC skills training in medical oncology we may have found different climate perceptions. Finally, although development of quantitative measures of implementation climate are underway,[25] they have not been fully tested. Thus, we were unable to specify with precision how the services compared on this construct. Nevertheless, our study offers preliminary evidence for the role of both formal and informal IPPs as determinants of innovation implementation.

Conclusion

Consistent with prior studies,[14-16,28] we found the Klein and Sorra Organizational Theory of Innovation Implementation to be useful for understanding the implementation of

innovations in healthcare organizations. Importantly, this study makes a novel contribution by refining the theory to suggest IPPs can be conceptualized as formal and informal. This study also adds to the small body of implementation research adapting the theory to include innovation-task fit to provide an indication of congruence of the innovation with the organization and is a critical determinant of implementation.[14,16] However, an examination of how much the findings from this study are largely a function of other aspects of the theory, including readiness to change, management support, and/or resource availability within the service, was missing from our analysis and may warrant further investigation.

From a practical perspective, this study provides an in-depth exploration of the organizational context for PC consult implementation in inpatient oncology. To date, the role of formal IPPs on innovation implementation has garnered more attention in the innovation implementation literature than the role of informal IPPs,[12-17] but the findings from this study suggest informal IPPs for promoting effective implementation should be encouraged. As the number of inpatient PC programs continues to rise, the results from our study may help hospitals identify optimal policies and practices to accelerate the integration of inpatient PC consults into oncology practice to close the implementation gap and ensure cancer patients in need of PC receive these services.

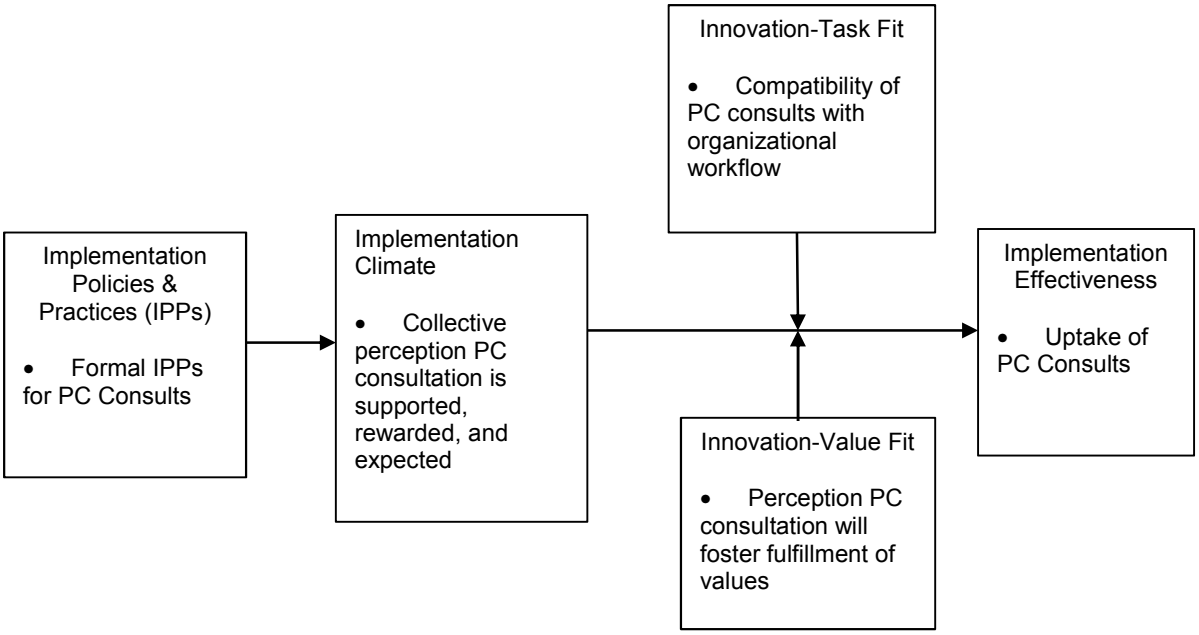
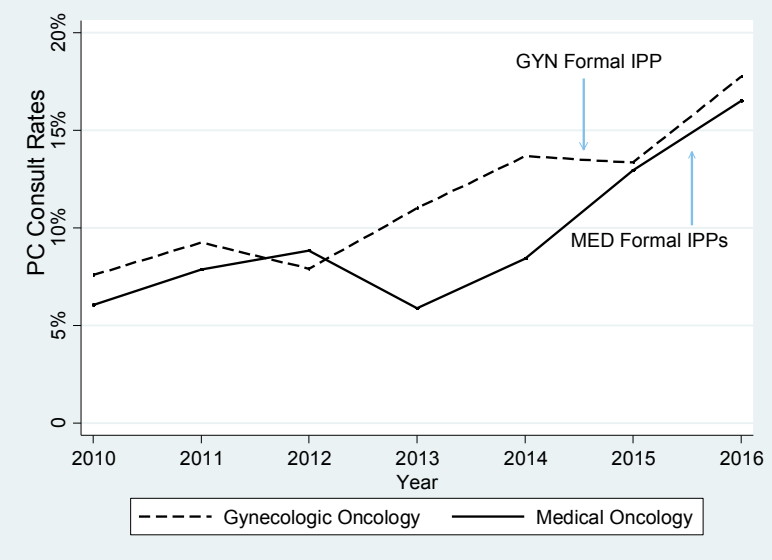


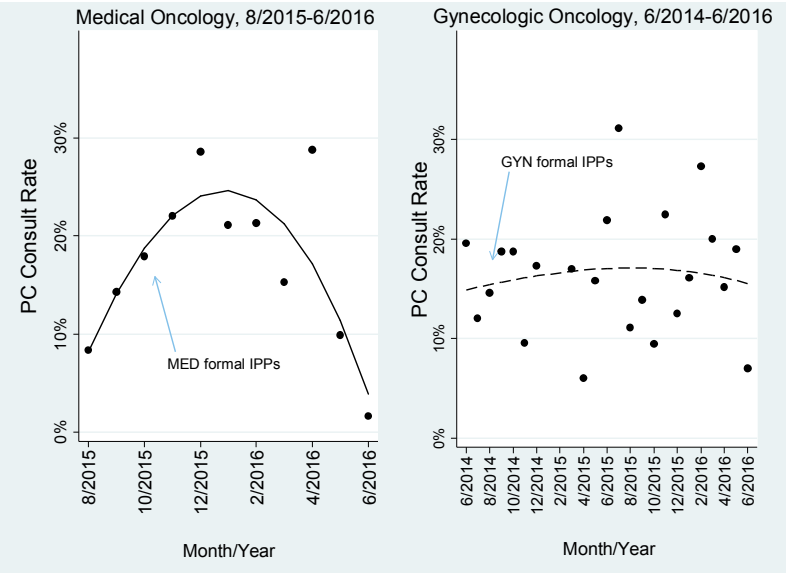
Figure 4.1. Organizational Theory of Innovation Implementation (adapted from Klein and Sorra, 1996)[12,13]



GYN: gynecologic oncology
MED: medical oncology
PC: palliative care
IPP: implementation policies and practices

The blue arrows indicate initiation of the formal IPPs in the oncology services.

Figure 4.2. Annual uptake of PC consults, 2010–2016.



*graphs start two months prior to initiation of formal IPPs; dots represent monthly consult rates
PC: palliative care
IPP: implementation policies and practices

The blue arrows indicate initiation of the formal IPPs the oncology services.

Figure 4.3. Monthly uptake of PC consults during implementation.

Table 4.1. Number and Characteristics of Key-Informant Interview Participants, by Service

Service	Medical Oncology	Gynecologic Oncology	Palliative Care
Number	12	10	4
Role	7 Attending Clinicians 3 Specialty Residents 2 Medical Students	4 Attending Clinicians 3 Subspecialty Residents 3 Specialty Residents	2 Attending Clinicians 2 Staff
Gender	5 Males 7 Females	2 Males 8 Females	3 Female 1 Male

Table 4.2. Summary of findings by Organizational Theory of Innovation Implementation Constructs

Service	IPPs	Implementation Climate	Innovation-Task Fit	Innovation-Values Fit	Implementation Effectiveness
Gynecologic Oncology	*Formal IPP:* • Written guideline describing the clinical criteria for initiating a consult. (+) *Informal IPPs:* • Spontaneous communication and feedback between the gynecologic oncology service and PC service. (+) • On-the-job training in PC skills. (+) • Emergent champions who stepped out of their prescribed role to advocate for PC consultation. (+) • 'Bottom-up' approach to implementation. (+)	*Strong climate for PC consult implementation* • PC consultation was generally expected. (+) • PC consultation was supported. (+) • No specific recognition or rewards for PC consultation. (-)	*Strong innovation-task fit for PC consults* • PC consults aided in managing multiple symptoms. (+) • PC consults helped to offset clinician workload. (+) • PC consults not always compatible with clinician preferred roles. (-) • PC consults compatible if patient receiving PC services in the outpatient setting. (+)	*Strong innovation-values fit for PC consults* • PC consults consistent with providing best patient care. (+) • PC consults fit with students/residents high-intensity value to learn. (+) • PC consults fit with attending clinicians high-intensity value to educate house-staff. (+)	*Increase in PC consult uptake*
Medical Oncology	*Formal IPPs:* • Chart review to identify cancer patients with advanced (i.e. metastatic) disease and uncontrolled symptoms. (+)	*Weak climate for PC consult implementation* • PC consultation was not an expectation. (-) • PC consultation was not always supported. (-)	*Moderate innovation-task fit for PC consults* • PC consults primarily help with managing pain. (+/-)	*Strong innovation-values fit for PC consults* • PC consults consistent with providing best patient care. (+) • PC consults fit with students/residents	*Increase in PC consult uptake*

	• Prompting by the PC service to relay information about eligible patients to attending clinicians in oncology services. (+) • Training of residents in PC skills. (+) • Appointed champions from PC service. (-) • Institutional funding. (+) • 'Top-down' approach to implementation. (-)	• No specific recognition or rewards for PC consultation. (-)	• PC consults helped to offset clinician workload. (+) • PC consults compatible if hospice was needed. (+/-) • PC consults not always compatible with clinician preferred roles. (-) • PC consults not always compatible due to lack of availability of PC services in the outpatient setting. (-)	high-intensity value to learn. (+) • PC consults fit with attending clinicians high-intensity value to educate house-staff. (+)	

IPPs: Implementation Policies and Practices
(+) = positively associated with implementation
(-) = negatively associated with implementation
(+/-) = positively and negatively associated with implementation

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CHAPTER 5. THE IMPACT OF TWO TRIGGERED PALLIATIVE CARE CONSULTATION APPROACHES ON CONSULT IMPLEMENTATION IN ONCOLOGY

Overview

Studies show palliative care delivered concurrently with cancer treatment improves outcomes, yet palliative care integration with inpatient oncology is underused. A promising approach to improve integration is a triggered palliative care consultation (TPCC). This study evaluated the impact of two TPCC approaches on consistency and quality of consult implementation, operationalized as uptake and timeliness, on solid tumor medical and gynecologic oncology services at an academic hospital.

The study timeframe was 2010-2016. TPCC in gynecologic oncology began in 2014 and was supported by a single strategy (written guideline); TPCC in medical oncology began in 2015 and was supported by multiple strategies (e.g. training, chart review). Palliative care consult information was chart abstracted and linked to hospital encounter data. We compared the effect of a single strategy vs. usual care, and multiple strategies vs. a single strategy on implementation. Difference-in-differences modified Poisson regression models evaluated whether implementation differed after TPCC; we estimated adjusted relative risk (aRR), controlling for patient demographic and clinical characteristics.

Overall, 8.8% of medical oncology and 11.0% of gynecologic oncology inpatient encounters involved palliative care consultation. In regression analyses, TPCC supported by a single strategy was associated with greater uptake vs. usual care (aRR: 1.45, $p<.05$), and

TPCC supported by multiple strategies was associated with greater uptake vs. a single strategy (aRR: 2.34, p<.001). TPCC did not impact consult timing (p>.05).

Across two inpatient oncology services, TPCC supported by multiple strategies had the greatest impact on uptake. How strategies affect sustained use of palliative care consults remains to be investigated.

Introduction

Earlier integration of palliative care with cancer treatment is associated with improved symptom control, reduced intensity of treatment, similar or improved survival, and cost savings.[1-3 4,5] Despite these known benefits, palliative care is underused; many eligible cancer inpatients do not receive a palliative care consultation.[6-9] This may be, in part, because effective implementation of palliative care consults in oncology is logistically challenging for healthcare organizations. Cancer patients are clinically complex and the provision of palliative care consults requires coordination between multidisciplinary palliative care and oncology providers.

Although there are currently no clinical guidelines regarding the timing of palliative care consultation in inpatient oncology,[10] earlier consults have greater benefit and are considered an important indicator of high-quality care.[11] The American Society of Clinical Oncology (ASCO) recommends[12] clinical triggers that alert oncology providers about patients needing palliative care to improve implementation. Triggered palliative care consultation (TPCC) is based on predetermined clinical criteria (e.g., metastatic disease, uncontrolled symptoms).[13] Although prior research has shown that TPCC improves consult implementation in the intensive care unit,[14] there is limited evidence regarding the impact of TPCC in inpatient oncology.[10,12,13]

We evaluated the impact of two TPCC approaches on consult implementation in two distinct inpatient services, solid tumor medical oncology and gynecologic oncology, at University of North Carolina (UNC) Hospitals, an 804-bed acute care facility and National Cancer Institute–designated Comprehensive Cancer Center. Theory and prior research suggest that more strategies to promote use of a clinical practice will result in greater implementation.[15,16] Therefore, we hypothesized that TPCC supported by multiple strategies (e.g., training, clinician prompting, chart review) would be associated with more consistent consult implementation (greater uptake) and improved implementation quality (decreased time to consult) compared to a single strategy (i.e., written guideline), and that TPCC supported by a single strategy would be superior to usual care.

Methods

TPCC Approaches

TPCC in gynecologic oncology began in August 2014 and was supported by a single strategy—a one-page guideline using clinical criteria to initiate a consult written by oncology clinicians in the service. The criteria included unplanned admissions for management of symptoms of uncontrolled pain, nausea or vomiting, and malignant small bowel obstruction, or need for decision support evidenced by frequent readmissions, request for hospice, or resistance to advanced care planning.

In contrast, TPCC in medical oncology began in October 2015 and was supported by multiple strategies designed by palliative care and oncology clinicians. The clinical criteria for triggering a consult included the presence of metastatic disease and uncontrolled symptoms. A research coordinator reviewed charts for all medical oncology admissions. When a patient met trigger criteria, the attending palliative care clinician prompted attending oncologists to consider a consult. Additional strategies included monthly training for

residents in palliative care skills of advanced care planning communication, champions from palliative care to promote consultation, and dedicated institutional funds for TPCC.

Data Sources

We obtained data on palliative care consults from the UNC Palliative Care Clinical Research database, which includes data abstracted from medical charts for all patients at UNC Hospital who receive a palliative care consultation. This data source provided the dates of service and oncology service line in which the palliative care consult was initiated. Using unique identifiers, we then linked these data to hospital encounter data obtained from the Carolina Data Warehouse for Health (a central data repository containing clinical, research, and administrative data sourced from the institution's electronic health record system). This data source provided admitting and discharge service and dates, discharge status, as well as clinical and demographic characteristics. The dataset was then augmented with information on patient cancer stage at diagnosis obtained from the UNC Hospital Cancer Registry. The UNC Institutional Review Board reviewed and approved this study.

Study Sample

We included admissions and/or discharges from the medical oncology or gynecologic oncology service lines from January 1, 2010, to June 30, 2016, with a solid tumor diagnosis based on *International Classification of Diseases* (ICD) 9 and 10 codes documented during the encounter (see Data Supplement). If multiple palliative care consults occurred during an encounter, we only included the first one. We excluded 69 palliative care consults that were initiated in a service other than the admitting and/or discharge service (e.g., originated in medical intensive care, but the admitting and/or discharge service was medical oncology).

Outcomes

The primary outcome, palliative care consult uptake, was a binary variable. We defined uptake as completion of a consult during the encounter. To assess quality of implementation, a secondary outcome was time to palliative care consult after admission, defined as the number of days between admission and palliative care consultation. Using a subsample of encounters that involved a palliative care consult, we explored varying definitions of a binary variable for time to consult based on the following cutoffs: within 2 days of admission (55% of encounters involving a palliative care consult), within 7 days of admission (85%), or 14 days of admission (95%).

Independent Variables

For the single strategy vs. usual care comparison, we included an indicator variable to capture exposure to the single strategy based on admission date (on or after 8/1/2014 through 9/30/2015), oncology service (gynecologic oncology or medical oncology), and the interaction term between these two variables. For the multiple strategies vs. single strategy comparison, we included an indicator variable to capture exposure to the multiple strategy based on admission date (on or after 10/1/2015 through 6/30/2016), oncology service, and the interaction term between these two variables.

Covariates

Covariates included categories for race (White – reference, Black, other, missing); sex; insurance status (Medicare – reference, Medicaid, private, other public, uninsured, missing); palliative care consultation in a prior hospital encounter (yes or no); hospitalization in the prior 30 days (yes or no); length of stay (number of calendar days between admission and discharge dates); discharge status (alive or deceased), and solid tumor cancer type (digestive, breast, bone/joint, soft tissue, skin, head/neck, urological, lung/thoracic,

gynecological, other/ill defined, central nervous system, missing). Age was included as a continuous variable. Stage of disease at diagnosis was based on the American Joint Committee on Cancer staging criteria (Stage 0 or I, II or III, IV). If stage could not be ascertained, it was categorized as "missing." We assessed comorbidity (0, 1, 2 or more comorbidities) using previously described coding algorithms.[17] Comorbidity ICD codes were derived from the patient's problem list in the electronic health record system. The comorbidities may be added at any time the patient receives care at the institution. We searched the problem list for evidence of comorbidities 30 days before and after the admission date to ensure all comorbidities present at the time of an encounter were captured.

Statistical Analysis

Within each oncology service, we describe the study sample using proportions for categorical variables and means with standard deviations for continuous variables. We examined unadjusted changes in the uptake and time to consult outcomes before and after TPCC using a Chi-square test for categorical variables and Wilcoxin rank sum test for continuous variables.

Two difference-in-difference (DID) regression models were estimated. The first compared changes in outcomes before (1/1/2010–7/31/2014) and after (8/1/2014–9/30/2015) TPCC in gynecologic oncology (single strategy) to changes over the same time period in medical oncology (usual care). The sample for the single strategy vs. usual care comparison included 8,652 admissions. The second compared outcomes before (8/1/2014–9/30/2015) and after (10/1/2015–6/30/2016) TPCC in medical oncology (multiple strategies) to changes over the same time period in gynecologic oncology (single strategy); this sample for this comparison included 2,614 admissions.

The analysis of time to palliative care consult was restricted to admissions with a palliative care consult: 746 admissions for comparing use of a single strategy vs. usual care and 361 admissions for comparing multiple strategies vs. single strategy. For each comparison, we estimated separate models for palliative care consult within 2 days, 7 days, or 14 days of admission (6 models total). The unit of analysis was the discharge encounter.

We estimated the adjusted relative risk (aRR) and 95% confidence intervals (CI) of palliative care consult uptake and time to palliative care consult using modified Poisson regression.[18] Robust standard errors clustered at the patient level were used to account for autocorrelation across encounters, because some patients may have had multiple hospitalizations. In all models, we control for demographic and clinical characteristics listed under covariates and a linear time trend (year as a continuous variable). Length of stay was included as an exposure variable to account for different observation periods.

For the DID estimates to be valid and unbiased, the *assumption of parallel trends* must be met. Briefly, this means the trends in palliative care consult uptake between the oncology services were the same prior to TPCC.[19] We tested for this assumption using data prior to the implementation of any TPCC strategies: 1/1/2010 to 12/31/2013. We estimated a modified Poisson regression model that controlled for the same demographic and clinical characteristics as the models for the primary analyses in addition to a linear time trend (admission date as a continuous variable), an indicator for oncology service, and the interaction between those two variables. Under the parallel trends assumption, the coefficient of the interaction should equal zero. We conducted our analyses using Stata version 13.0 (College Station, TX). All statistical tests were two-tailed with a critical alpha equal to 0.05.

Results

Demographic and Clinical Characteristics

Table 5.1 describes the clinical and demographic characteristics of the sample by oncology service. We identified a total of 9,760 encounters with an admission and/or discharge from the oncology services between January 1, 2010, and June 30, 2016. Of these, 5,873 (60%) of encounters were from the medical oncology. Compared to medical oncology, the gynecologic oncology sample was older and more likely to be White, female, and privately insured. The gynecologic oncology sample was also more likely to have had palliative care consultation in a prior hospital encounter and have been hospitalized in the prior 30 days. The medical oncology sample was more likely to have a diagnosis of Stage IV cancer, one or more comorbidities, and a discharge status of deceased ($p<.05$).

Unadjusted Changes in Palliative Care Consult Implementation

Palliative Care Consult Uptake. The unadjusted changes in the outcomes are presented in Table 2. Overall, 8.8% (n=515) of medical oncology encounters and 11.0% (n=427) of encounters in gynecologic oncology involved a palliative care consult. Within each service, there was a significant increase in palliative care consult uptake after TPCC. Specifically, TPCC supported by multiple strategies in medical oncology was associated with an increase in consult uptake from 7.6% between 1/1/2010 and 9/30/2015 to 18.4% between 10/1/2015 and 6/30/2016 ($p<.05$). Similarly, TPCC supported by a single strategy in gynecologic oncology was associated with an increase in consult uptake from 9.3% between 1/1/2010 and 7/30/2014 to 15.3% between 8/1/2014 and 6/30/2016 ($p<.05$).

Time to Palliative Care Consult. In medical oncology, the mean number of days from admission to palliative care consult decreased significantly after TPCC from 3.8 to 2.8 ($p<.05$), however no significant differences in mean number of days were found in

gynecologic oncology after TPCC. Likewise, across both services, TPCC did not have a significant effect on the timing of consults (i.e., within 2 days, 7 days, or 14 days of admission) ($p>.05$).

Adjusted Changes in Palliative Care Consult Implementation

After adjustment for covariates, there was no significant difference in the trends in palliative care consult uptake between oncology services prior to TPCC (i.e., assumption of parallel trends was met) ($p=.20$). Tables 3 and 4 show the results from the adjusted DID estimates. TPCC supported by a single strategy in gynecologic oncology was associated with greater consult uptake compared to usual care (aRR: 1.45, 95% CI: 1.05-2.01, $p<.05$), and TPCC supported by multiple strategies in medical oncology was associated with greater consult uptake compared to a single strategy (aRR: 2.34, 95% CI: 1.57-3.49, $p<.001$). Across all comparisons, the DID estimates showed no significant association between TPCC and time to consult ($p>.05$).

Discussion

We examined the impact of two TPCC approaches on consult implementation in inpatient oncology. We found that TPCC supported by a single strategy was associated with greater consult uptake compared to usual care, and TPCC supported by multiple strategies was associated with greater consult uptake compared to a single strategy. Although we were unable to directly compare use of multiple strategies in medical oncology to usual care, it can be inferred from these findings that TPCC supported by multiple strategies would have the largest impact on consult uptake. To date, investigations of the use of TPCC for consult implementation in oncology inpatient settings are limited;[10,12,13] the few extant studies examining this issue have reported unclear evidence for TPCC. For example, among hospitalized patients with advanced cancer, Rocque et al. found TPCC had minimal impact

on consult uptake,[20] while Adelson et al. found TPCC doubled rates of consultation.[21] Notably, both studies were limited by small sample sizes, short durations, and being conducted only in medical oncology services. No prior studies have considered the relative effectiveness of TPCC supported by a single strategy versus multiple strategies, yet this information is critical to enhancing the implementation of palliative care consults in oncology. Our study advances prior research by examining the impact of TPCC supported by a single strategy or multiple strategies in two inpatient oncology services—gynecologic oncology and solid tumor medical oncology. In addition, the availability of multiple years of data from a large number of hospitalizations allowed for robust DID methods to account for underlying secular trends or other events that may have affected palliative care consult implementation.[19]

Overall, we found 10% of encounters (8.8% in medical oncology and 11.0% in gynecologic oncology) involved a palliative care consultation. Our palliative care consultation rate was comparable to what has been reported in similar cohorts of hospitalized cancer patients,[8,22] although variable rates have been reported ranging from 5% of patients hospitalized with head and neck cancer[23] to 24% in an inpatient gynecologic oncology service.[24] Notably, there is no benchmark regarding rates of palliative care consultation in inpatient oncology. By establishing benchmark criteria, hospitals could leverage this information to determine the current rate of palliative care consultation, decide whether TPCC is needed, and evaluate the impact of TPCC on uptake.[25]

Contrary to our hypothesis, TPCC did not result in earlier timing of consultation that would be expected to enhance quality of care outcomes. In fact, among encounters that involved a palliative care consult, just over half of encounters across both oncology services

involved early palliative care consults (within two days of admission). These findings are consistent with a prior study of TPCC for advanced cancer patients in an emergency department; that study found patients received palliative care consultation within an average of three days of admission and no effect of TPCC on timing.[26] Given our findings, any improvements in timing resulting from TPCC would have been minimal and required a substantially larger sample size to detect any significant differences. Considering earlier palliative care consults are considered an important indicator of high-quality care,[11] additional efforts are needed to develop clinical guidelines regarding timing of consultation in inpatient oncology and examine the potential impact of quality improvement efforts, such as lean methodology,[27] to improve timeliness of consults.

There are several limitations of this study. First, it occurred at a single academic hospital with a well-established palliative care service, which limits generalizability. Nonetheless, our findings may extend to similar large hospital settings seeking to improve implementation of palliative care consults. Second, we lacked data on prior hospice referral or do-not-resuscitate status, however we adjusted for several covariates that reflected health status, which minimized the likelihood of obtaining biased estimates. Third, the time to palliative care consult analysis was conducted in a small subsample of encounters in the oncology services, which minimized our statistical power to detect differences across the groups. Finally, TPCC may have impacted important aspects of implementation quality that we were unable to measure.[28] For example, we were unable to assess quality of the consult (e.g., provision of both symptom management and advanced care planning, skill with which the consult was done). Future research should consider investigating the effect of TPCC on these additional quality indicators.

Despite these limitations, our study has important implications. Inpatient palliative care programs are increasingly available, yet many eligible cancer inpatients do not receive palliative care. In light of the recent ASCO guideline[12] underscoring that oncology services should consider using clinical triggers, our study findings are timely and add to the growing evidence base indicating TPCC can promote the use of palliative care for cancer inpatients. Of note, a recent National Comprehensive Cancer Center survey suggested that inpatient palliative care programs using TPCC may be constrained by workforce limitations in their ability to respond to all patients in need.[29] When deciding whether to use TPCC and standardize delivery of palliative care, clinicians' desire to provide these services will need to be balanced by availability of trained workforce that can deliver quality palliative care. As our findings indicate, TPCC supported by multiple strategies had the greatest impact on consult uptake, however a single strategy may provide adequate support to improve the integration of palliative care in inpatient oncology. How the strategies affect the sustained use of palliative care consults remains to be investigated.

Table 5.1. Study Sample Characteristics, By Oncology Service

Demographic and Clinical Characteristics	Medical Oncology (n=5,873)	Gynecologic Oncology (n=3,887)
Age, mean (SD)	57.4 (13.8)	59.4(14.1)
Race, n (%)		
Black	1,661 (28.3)	984(25.3)
White	3,622 (61.7)	2,607(67.1)
Other	515 (8.8)	212(5.4)
Missing	75 (1.3)	84(2.2)
Sex, n (%)		
Female	2,872(48.9)	3887(100.0)
Insurance, n (%)		
Medicare	2,240(38.1)	1,638(42.1)
Medicaid	1,286(21.9)	551(14.2)
Other Public	293(5.0)	70(1.8)
Private	1,704(29.0)	1,353(34.8)
Uninsured	131(2.2)	124(3.2)
Missing	219(3.7)	151(3.9)
Cancer Type, n (%)		
Digestive: Yes	2,185(37.2)	1,159(29.2)
Breast: Yes	700(11.9)	46(1.2)
Bone/Joint: Yes	1,532(26.1)	110(2.8)
Soft Tissue: Yes	245(4.2)	43(1.1)
Skin: Yes	257(4.4)	23(0.6)
Head/Neck: Yes	336(5.7)	0(0)
Urological: Yes	484(8.2)	69(1.8)
Lung/Thoracic: Yes	2,326(39.6)	260(6.7)
Gynecological: Yes	49(0.8)	2,618(67.3)
Other/Ill Defined: Yes	1,151(19.6)	431(11.1)
CNS: Yes	1,017(17.3)	76(1.9)
Missing: Yes	358(6.1)	452(11.6)
Cancer Stage at Diagnosis, n (%)		
0 or I	513(8.7)	585(15.1)
II or III	1,596(27.2)	1,218(31.3)
IV	1,792(30.5)	531(13.7)
Missing	1,972(33.6)	1,553(39.9)
Comorbidities: Charlson Index, n (%)		
0	4,123(70.2)	3,078(79.2)
1	1,087(18.5)	519(13.4)
>=2	663(11.3)	290(7.5)
Length of Stay, mean days (SD)	6.1(5.7)	6.4(6.7)
PC consultation in a prior hospital encounter, n (% Yes)	200(3.4)	269(6.9)
Hospitalized in Prior 30 days, n (% Yes)	1,304(22.2)	988(25.4)
Discharge Status, n (% Deceased)	235(4.0)	64(1.7)

Abbreviations: PC, Palliative care, SD, standard deviation, CNS, Central Nervous System

Table 5.2. Unadjusted Changes in Palliative Care Consult Implementation

Outcome Measures	Medical Oncology		Gynecologic Oncology	
	Before Initiation of TPCC (1/1/2010-9/30/2015) (n=5,260)	**After Initiation of TPCC (10/1/2015-6/30/2016) (n=613)**	**Before Initiation of TPCC (1/1/2010-7/30/2014) (n=2,779)**	**After Initiation of TPCC (8/1/2014-6/30/2016) (n=1,108)**
PC consult uptake, n (% Yes)	402 (7.6)	113 (18.4)‡	258 (9.3)	169 (15.3)‡
Time to PC consult, mean days from admission (SD)*[a]	3.8 (4.2)	2.8 (3.2)†	4.5 (6.5)	3.7 (5.6)
PC consult within 2-days, n (% Yes)*	216(53.7)	67(59.3)	141(54.5)	102(60.4)
PC consult within 7-days, n (% Yes)*	345(85.8)	104(92.0)	221(85.7)	149(88.2)
PC consult within 14-days, n (% Yes)*	388(96.5)	112(99.1)	240(93.0)	162(95.9)

*Calculated only for subsample of encounters that involved a palliative care consult
[a]Calculated using Wilcoxin rank sum test
Abbreviations: PC, palliative care, TPCC, triggered palliative care consultation, SD, standard deviation
†: Significant at the p=.05 level
‡: Significant at the p=.01 level

Table 5.3. Changes (difference-in-difference) in Palliative Care Consult Implementation Associated with TPCC: Single Strategy vs. Usual Care

Outcome Measures	N	Adjusted Relative Risk	95% Confidence Interval
PC Consult Uptake	8,652	**1.45‡**	**1.05-2.01**
Time to PC Consult (percentile)	746		
Within 2-days (55th)		1.13	0.69-1.87
Within 7-days (85th)		0.96	0.69-1.34
Within 14-days (95th)		0.97	0.74-1.28

Abbreviations: PC, palliative care, TPCC, triggered palliative care consultation
†: Significant at the p=.05 level
‡: Significant at the p=.01 level
NOTE. All regression analyses controlled for differences in age, race, sex, insurance, cancer type, cancer stage, PC consultation in a prior hospital encounter, hospitalization in prior 30 days, comorbidities, discharge status, and a linear time trend. Length of stay was included as an exposure variable.

Table 5.4. Changes (difference-in-difference) in Palliative Care Consult Implementation Associated with TPCC: Multiple Strategies vs. Single Strategy

Outcome Measures	N	Adjusted Relative Risk	95% Confidence Interval
PC Consult Uptake	2,614	**2.34‡**	**1.57-3.49**
Time to PC Consult (percentile)	361		
Within 2-days (55th)		1.23	0.67-2.24
Within 7-days (85th)		1.12	0.74-1.70
Within 14-days (95th)		1.05	0.74-1.49

Abbreviations: PC, palliative care, TPCC, triggered palliative care consultation
†: Significant at the p=.05 level
‡: Significant at the p=.01 level
NOTE. All regression analyses controlled for differences in age, race, sex, insurance, cancer type, cancer stage, PC consultation in a prior hospital encounter, hospitalization in prior 30 days, comorbidities, discharge status, and a linear time trend. Length of stay was included as an exposure variable.

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CHAPTER 6. INPATIENT PALLIATIVE CARE CONSULTATION AND 30-DAY READMISSIONS IN ONCOLOGY

Overview

Prior research indicates that hospice and palliative care delivered in outpatient settings are associated with reduced hospital readmissions for cancer patients. However, little is known about how inpatient palliative care affects readmissions in oncology. The objective of this study was to examine associations among inpatient palliative care consultation, hospice use (discharge), and 30-day readmissions among patients with solid tumor cancers.

We identified all live discharges from a large tertiary cancer hospital between 2010 and 2016. Palliative care consult data were abstracted from medical charts and linked to hospital encounter data. Propensity scores were used to match palliative care consult to usual care encounters. Modified Poisson regression models estimated adjusted relative risk (aRR) and 95% confidence intervals (CI) of 30-day readmissions and hospice discharge. We compared predicted probabilities of readmission for palliative care consultation with hospice discharge, without hospice discharge, and usual care.

Of 8,085 eligible encounters, 753 involved a palliative care consult. The likelihood of having a 30-day readmission did not differ between palliative care consult and usual care groups ($p>.05$). However, the palliative care consult group was more likely than usual care to have a hospice discharge (aRR = 4.09, 95% CI: 3.07-5.44). The predicted probability of 30-day readmission was lower when palliative care consultation was combined with hospice discharge compared to consultation with discharge to non-hospice post-acute care or usual care ($p<.001$).

The effect of inpatient palliative care on readmissions in oncology is largely driven by hospice enrollment. Strategies that combine palliative care consultation with hospice discharge may decrease hospital readmissions and improve cancer care quality.

Introduction

Many cancer patients experience poor symptom control and aggressive treatment near the end of their lives, including hospitalizations and emergency department (ED) visits, with limited medical benefits.[1-4] Unplanned 30-day hospital readmission rates as high as 27% have been reported in patients with cancer.[5] Reducing unplanned 30-day readmissions is important to patients and healthcare organizations seeking to lower overall healthcare costs and avoid financial penalties under the federal Hospital Readmissions Reduction Program.[6] Although cancer hospitals currently are excluded from this penalty, frequent hospital readmissions and ED visits remain important for oncology patients and are well-accepted indicators of poor-quality care for cancer patients near the end of life.[1,7] Prior research indicates hospice use is associated with reduced hospital readmissions among cancer patients,[3,5] yet conversations about hospice often do not occur between cancer patients and their providers.[8] As a result, cancer patients frequently do not enroll in hospice or are referred late in the disease trajectory.[9]

Palliative care has also been shown to decrease hospitalizations and ED visits among cancer patients when delivered in outpatient settings.[10-13] In inpatient settings, palliative care reduces the intensity of hospital treatment, and thus reduces the cost of hospital care.[14,15] However, less is known about how inpatient palliative care affects readmissions in oncology. Therefore, using a propensity-matched cohort from a large tertiary cancer hospital, we examined associations among inpatient palliative care consultation, hospice use (discharge), and 30-day unplanned readmissions. We hypothesized that inpatient palliative care

consultation would be associated with greater hospice discharge and reduced 30-day readmissions. To further understand the mechanism by which inpatient palliative care may reduce readmissions, we also explored whether inpatient palliative care consultation combined with hospice discharge was associated with reduced 30-day readmissions.

Methods

Sample

We conducted a retrospective cohort study of all patients who were admitted and/or discharged from the medical oncology or gynecologic oncology service lines at University of North Carolina (UNC) Hospitals (an 804-bed acute care facility and National Cancer Institute-designated Comprehensive Cancer Center) from January 1, 2010, to June 30, 2016. We included all live discharges with a solid-tumor diagnosis documented during the hospital stay based on *International Classification of Diseases* (ICD) 9 and 10 codes (see Data Supplement). If multiple palliative care consults occurred during an encounter, we only included the first one. We excluded 69 palliative care consults that were initiated in a service other than the admitting and/or discharge service (e.g., originated in medical intensive care but the admitting and/or discharge service was medical oncology).

The unit of analysis was the discharge encounter for hospitalization. All eligible encounters included in the sample were considered to be an index admission. Encounters with a discharge status of missing, "left against medical advice," or deceased were excluded as an index admission but could be considered a readmission. A readmission could also serve as an index admission for subsequent discharge encounters.

UNC Hospital Inpatient Palliative Care Consultation Service

The inpatient palliative care consult team service at UNC Hospital began in 2002. The team is interdisciplinary, composed of an attending palliative physician, two nurse

practitioners, a social worker, and a chaplain. Palliative care clinicians provide expert pain and symptom management, supportive services for spiritual/psychosocial distress, goal setting, and decision-making for inpatients at all stages of illness and their families. Consultation is available to patients by referral of the inpatient treating physician.

Data Sources

We obtained data on palliative care consults from the UNC Palliative Care Clinical Research database, which includes data abstracted from medical charts for all patients at UNC Hospital referred for palliative care consultation. This data source provided dates of service and referring oncology service. Using unique identifiers, we linked these data to hospital encounter data obtained from the Carolina Data Warehouse for Health (a central data repository containing clinical, research, and administrative data sourced from the institution electronic health record system; CDW-H). This data source provided admitting and discharge service and dates, discharge status, as well as clinical and demographic characteristics. The dataset was then augmented with information on patient cancer stage at diagnosis as a proximate indicator of disease extent during hospitalization obtained from the UNC Hospital Cancer Registry. The UNC Institutional Review Board reviewed and approved this study.

Measures

Outcomes. Our primary outcomes were hospice discharge (inpatient or home) and 30-day unplanned all-cause readmissions. We defined readmission as an inpatient episode, including ED visits resulting in an admission, within 30 days of discharge. Secondary outcomes included ED visits not resulting in an admission within 30 days of discharge and a composite outcome of inpatient readmissions and ED visits within 30 days of discharge. We calculated time to readmission as the number of days between the index admission discharge date and readmission date.

Longer travel distance is an obstacle for accessing hospital care.[16] As such, because our data sources were unique to only one hospital system, readmissions for patients whose residence was further away might be missed. To minimize potential measurement error, we used Hospital Referral Region (HRR) as a proxy for travel distance and restricted the sample to encounters with resident zip codes in the Durham, Raleigh, and Greensboro, North Carolina, HRRs. Admissions for chemotherapy or radiotherapy (identified using ICD codes V58.xx and Z51.xx), psychiatry, or rehabilitation services were not considered readmissions because these usually indicated a planned admission.

Independent variable. The independent variable was whether or not an encounter involved a palliative care consultation. Encounters that involved a palliative care consult were included in the "treatment" group; encounters that did not involve palliative care consult were included in the "usual care" group.

Covariate selection. We used propensity score matching (see below) to balance treatment and usual care groups on the following clinical and demographic covariates: race (White, Black, other, missing); sex; insurance status (private, Medicare, Medicaid, other public, uninsured, missing); palliative care consultation in a prior hospital encounter; hospitalization in the prior 30 days; solid-tumor cancer type (digestive, breast, bone/joint, soft tissue, skin, head/neck, urological, lung/thoracic, gynecological, other/ill defined, central nervous system, missing), oncology service (medical oncology or gynecologic oncology), and admission year. Age was included as a continuous variable. Stage of disease at diagnosis was based on the American Joint Committee on Cancer staging criteria (0 or 1, 2 or 3, 4). If stage could not be ascertained, it was categorized as "missing." We assessed comorbidity illness (0, 1, 2 or more comorbidities) using previously described coding algorithms.[17]

Comorbidity ICD codes were derived from the patient's problem list in the electronic health record system. The comorbidities in the electronic health record may be added any time patients receive care at the institution and are not associated with a specific encounter. We searched the problem list for evidence of comorbidities 30 days before and after the admission date to ensure all comorbidities present at the time of an encounter were captured.

Propensity Score

To minimize the potential for selection bias, propensity scores were used to identify encounters that did not involve a palliative care consult but were comparable to encounters that did involve a palliative care consult based on the aforementioned observed covariates.[18] We used a modified Poisson regression model[19] with palliative care consult as the outcome and observed covariates as predictors to calculate propensity scores. Length of stay (number of calendar days between admission date to discharge date) was included as an exposure variable in the model to account for different observation periods. Robust standard errors clustered at the patient level were used to account for autocorrelation across encounters because some patients may have had multiple hospitalizations. Encounters that involved a palliative care consult were matched 1:1 to usual care encounters using the nearest neighbor with replacement method, which provided the smallest absolute standardized difference in covariates between the groups (i.e., <10%). Any covariates with a standardized difference greater than 10% were additionally adjusted for in the post-match analysis.

Statistical Analysis

Using the propensity score matched sample, we estimated the adjusted relative risk (aRR) and 95% confidence intervals (CI) of hospice discharge, 30-day unplanned all-cause readmission, and secondary outcomes (i.e., ED visits and a composite outcome of inpatient readmissions and ED visits) using modified Poisson regression models. For the readmission

analysis, we included days to death after discharge (number of calendar days between discharge date to death date) as the exposure to account for mortality during the 30-day readmission window. We used robust standard errors clustered at the patient level. We included hospice discharge as a covariate in the model when examining whether the combination of palliative care consultation with hospice discharge was associated with lower 30-day readmissions. Adjusted predicted probabilities of a 30-day readmission for an encounter were then calculated to contrast outcomes for the following clinical scenarios: usual care, palliative consultation combined with hospice discharge, and palliative care consultation with discharge to non-hospice post-acute care (e.g., home with self-care or intermediate care facility). We conducted our analyses using Stata version 13.0 (College Station, TX). All statistical tests were two-tailed with a critical alpha equal to 0.05.

Results

Sample

There were 9,760 discharge encounters from the medical oncology or gynecological oncology inpatient services. Of these, 1,341 had resident zip codes outside of the Durham, Raleigh, and Greensboro HRRs and 334 had a discharge status of missing, "left against medical advice," or deceased. Of the 8,085 eligible discharge encounters, 753 involved a palliative care consult (Figure 6.1); 753 usual care propensity scored matched encounters were found (n=1,506), representing 1,081 distinct patients across the treatment and usual care groups. On average, patients had 2.4 discharges from the oncology inpatient services during the study period.

The demographic and clinical characteristics of the unmatched and matched samples are presented in Table 6.1. The sample was predominantly White, male, and insured by Medicare. The mean age was around 60. Most encounters originated from the medical

oncology service. The unmatched sample indicated that compared to usual care, the palliative care consult group was more likely to be male, have a diagnosis of certain cancer types, have a palliative care consult in a prior hospital encounter, and be hospitalized in the prior 30 days. After matching, characteristics between the palliative care consult and usual care groups were similar (absolute standardized difference of less than 10%). However, the palliative care consult group remained significantly more likely than usual care to have a palliative care consult in a prior hospital encounter (15.6% vs. 9.8%) and hospitalization in the prior 30 days (30.2% vs. 24.2%). Therefore, we adjusted for these covariates for in the post-match analysis.

Associations among Inpatient Palliative Care Consultation, Hospice Discharge, and 30-Day Readmissions

Table 6.2 shows rates of hospice discharge and 30-day readmissions using the matched sample. Overall, inpatient readmission rates were high, with 21% and 25.5% of encounters resulting in a readmission within 30-days of discharge in the palliative care consult and usual care groups, respectively. However, the ED visit rates without admission within 30-days of discharge were only 3.9% and 5.7% for the palliative care consult and usual care groups, respectively.

In the adjusted analysis, the likelihood of having an inpatient readmission, ED visit, or composite outcome of an inpatient readmission and ED visit within 30 days of discharge did not significantly differ between the palliative care consult and usual care groups ($p>.05$). However, the palliative care consult group was significantly ($p<0.001$) more likely than usual care to have a hospice discharge (38% vs 9.2%; aRR = 4.09, 95% CI: 3.07-5.44) (Table 6.2). The adjusted predicted probability of an inpatient readmission was significantly ($p<0.001$) lower when palliative care consultation was combined with hospice discharge (5.8%),

compared to usual care (25.3%) or palliative care consultation with discharge to non-hospice post-acute care (29.4%). Likewise, the predicted probability of an inpatient readmission or ED visit was significantly ($p<0.001$) lower when palliative care consultation was combined with hospice discharge (8.9%), compared to usual care (31%) or palliative care consultation with discharge to non-hospice locations (34%). Across all comparisons, we found no differences ($p>.05$) in the predicted probability of an ED visit (Table 6.3).

Discussion

This study examined associations among inpatient palliative care consultation, hospice use, and 30-day unplanned readmissions among patients with solid tumors admitted to oncology services. After propensity score matching, we found palliative care consult and usual care groups had similar likelihoods of 30-day readmissions, including any return to acute care, defined as inpatient readmission or ED visit. However, consistent with our hypothesis, the palliative care consult group was over four times more likely than usual care to have a hospice discharge. This finding is consistent with prior research indicating earlier and more frequent hospice use among cancer patients when specialty palliative care augments oncology care.[20-24] When examined more closely, palliative care consultation combined with hospice discharge had a much lower probability of inpatient readmission or ED visit (combined) compared to palliative care consultation in the absence of hospice discharge or usual care. This was also true for inpatient readmissions. Our findings extend prior research demonstrating the effect of inpatient palliative care consultation on readmissions is largely driven by hospice enrollment;[25-27] we provide important insights into the mechanism by which inpatient palliative care consultation may reduce 30-day readmissions in oncology. For example, using a propensity score matched sample, Tangeman et al. found a similar likelihood of 30-day readmissions among inpatient palliative care and

usual care patients. However, only 1.1% of inpatient palliative care patients discharged to hospice experienced a readmission compared to 6.6% of usual care patients ($p<.01$).[27] Likewise, among patients who received an inpatient palliative care consultation, Enguidanos et al. found that patients discharged home with self-care were 3.7 times more likely to be readmitted within 30-days of discharge compared to patients discharged with hospice or home-based palliative care ($p<.05$).[25] Thus, our study adds to evidence supporting outpatient palliative care services, including hospice, as support for patients with serious illness to manage their persistent symptom distress and rapid changes in health. Additional research elucidating the relationship between inpatient palliative care consultation, continuity of care in the outpatient setting, and readmissions in oncology is needed.

The findings also speak to the importance of enhancing collaboration and care coordination between inpatient palliative care and hospice or other outpatient palliative care specialty services. Cancer patients near the end-of-life are often faced with the decision to pursue comfort treatment and transition to hospice. Palliative care teams play an active role in patients' decision-making process about hospice enrollment, including dispelling myths that hospice hastens death or is appropriate only in the finals days of life.[28] As our findings suggest, inpatient palliative care consultations are key to initiating goals of care and advanced care planning discussions in order to bridge these difficult transitions from hospitalization to hospice for cancer patients.

There are several limitations to this study. First, it was conducted at a single academic medical center with an established inpatient palliative care consultation service. As such, this limits generalizability. Second, we only included readmissions to one hospital system, which may underestimate readmissions. We attempted to address this limitation by including

resident zip codes and neighboring HRRs as a proxy for travel distance. Of note, we conducted the analysis on the full sample and the findings were similar. Third, although selection bias was minimized through propensity score matching, we cannot rule out the possibility of unobserved confounding. Instrumental variables could potentially address unobserved confounding, but we were unable to identify a valid instrumental variable for this sample. Fourth, we lacked data on the "active ingredients" of palliative care consultations (e.g., goals of care and treatment decision-making, symptom management, or other elements important in the choice for hospice). Identifying components of palliative care consultation and their delivery by specialty palliative care versus oncology providers is an important area for future research.

Despite these limitations, this study makes an important contribution to understanding the role of inpatient palliative care consultation in mitigating use of low benefit, high cost treatments by increasing hospice use and reducing 30-day readmissions in oncology. To date, little is known about how hospitals can best achieve reductions in readmissions in oncology.[3,29,30] However, studies focusing on associations between inpatient palliative care consultation and both hospice use and 30-day readmissions in oncology are limited.[31] Using a large sample of hospitalizations across multiple cancer types, our study is the first to demonstrate inpatient palliative care consultation can achieve a significant decrease in 30-day readmissions in oncology mostly through combining consultation with hospice discharge. Considering prior research which shows cancer inpatients underuse palliative care services,[20,32,33] our findings have important implications for the need to develop strategies that promote palliative care consultation and earlier introduction of hospice in inpatient oncology.

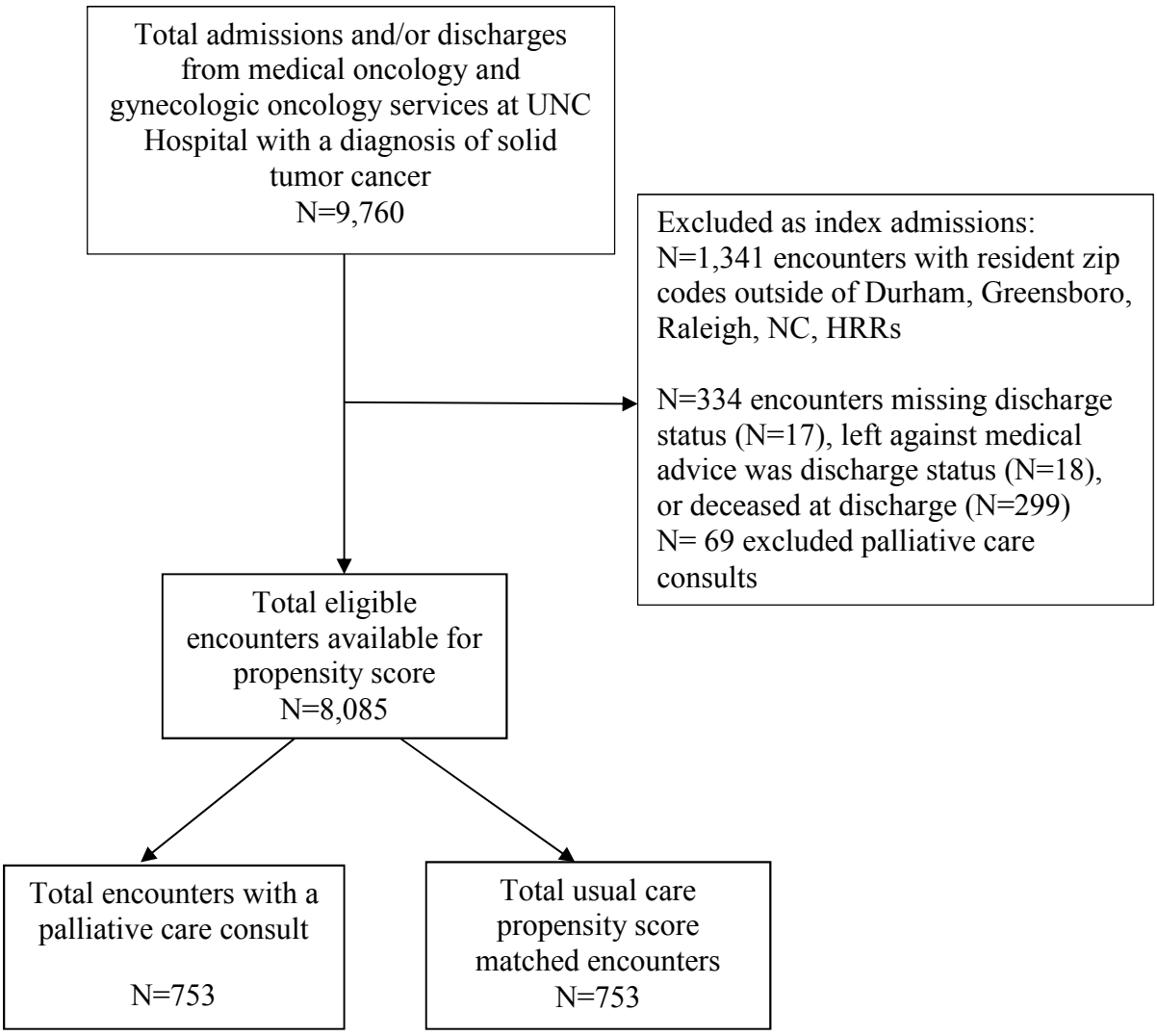

Figure 6.1. Study sample flow diagram.

Table 6.1. Description of Sample by Palliative Care Consult Status, Matched (N=1,506) and Unmatched (N=8,085)

		Unmatched		Matched	
Variables	**PC Consulted (n=753)**	**Usual Care (n=7,332)**	**Absolute Standardized Difference (%)**	**Usual Care (n=753)**	**Absolute Standardized Difference (%)**
Age, mean (SD)	58.6	58.5	0.4	59.3	5.6
Race (%)					
White	60.3	62.2	3.9	58.2	4.3
Black	29.6	28.8	1.7	29.9	0.6
Other	8.0	7.5	1.7	9.3	5.0
Missing	2.1	1.5	4.5	2.6	4.0
Sex: Female (%)	24.2	31.9	17.2	27.5	7.4
Insurance (%)					
Medicare	41.7	40.6	2.2	44.5	5.6
Medicaid	18.3	19.1	2.1	16.7	4.1
Other Public	3.7	2.9	4.7	3.3	2.2
Uninsured	1.8	2.6	5.1	1.8	0.0
Private	30.3	31.0	1.7	29.3	2.0
Missing	4.1	3.8	1.7	4.4	1.4
Cancer Type (%)					
Digestive: Yes	46.5	32.4	29.0	47.9	3.0
Breast: Yes	6.4	7.9	6.1	7.2	3.1
Bone/Joint: Yes	23.6	16.3	18.5	23.2	1.0
Soft Tissue: Yes	2.5	2.8	1.9	2.0	3.3
Skin: Yes	5.6	2.5	15.6	4.5	5.4
Head/Neck: Yes	1.5	3.5	13.2	1.6	0.9
Urological: Yes	5.8	5.4	2.1	5.7	0.6
Lung/Thoracic: Yes	31.3	25.7	12.4	28.9	5.3
Gynecological: Yes	30.0	27.3	5.9	26.2	8.5
Other/Ill Defined: Yes	23.7	15.4	21.2	22.8	2.4
CNS: Yes	12.6	10.8	5.6	12.3	0.8
Missing: Yes	5.4	8.8	13.0	4.0	5.7
Cancer Stage (%)					
0 or 1	8.6	11.3	9.0	9.4	2.8
2 or 3	33.5	29.1	9.8	35.4	4.0
4	23.6	24.3	1.6	23.1	1.2
Missing	34.1	35.3	2.4	32.1	4.2
Comorbidities: Charlson Index (%)					
0	70.9	72.9	3.6	66.0	9.7
1	18.1	16.7	4.0	20.5	6.3
>=2	10.8	10.4	1.5	13.5	8.6
Length of Stay, mean days (SD)	9.6 (8.9)	-	-	10.5 (9.2)	
Days to death post discharge, mean days (SD)†	13.9 (8.5)	-	-	14.0 (8.2)	-
PC Consulted During a Prior Hospitalization: Yes (%)*	15.6	3.9	40.2	9.8	20.0

Hospitalized in Prior 30 days: Yes (%)*	30.2	22.5	17.6	24.2	13.9
Service (%)					
Medical	53.5	60.8	14.8	56.6	6.2
Oncology	46.4	39.2	14.8	43.4	6.2
Gynecologic Oncology					
Year of Encounter (%)					
2010	10.8	16.3	16.1	10.6	0.6
2011	15.5	18.3	7.4	15.0	1.4
2012	13.6	15.9	6.5	14.6	2.6
2013	12.8	16.2	9.4	13.5	1.9
2014	15.4	13.4	5.7	16.1	1.9
2015	17.1	12.5	13.0	16.1	3.0
2016	14.6	7.4	23.3	14.1	1.7

Abbreviations: PC, palliative care, SD standard deviation, CNS, Central Nervous System
*Covariates with standardized difference >10% were adjusted for in the post-match analysis.
† Calculated for 349 encounters in the matched sample where a death date was recorded within 30 days of discharge date.

Table 6.2. Associations among Palliative Care Consultation, Hospice Discharge, and 30-Day Readmissions in Inpatient Oncology

Outcome Variables	**Palliative Care Consulted (n=753)**	**Usual Care (n=753)**	**Adjusted Relative Risk (95% CI)**
Discharge to hospice, n (%)	286 (38.0)	69 (9.2)	4.09 (3.07-5.44)‡
Inpatient readmission 30 days after discharge, n (%)	158 (21.0)	192 (25.5)	0.93 (0.76-1.13)
ED visit 30 days after discharge, n (%)	29 (3.9)	43 (5.7)	0.76 (0.46-1.24)
Inpatient readmission or ED visit 30 days after discharge, n (%)	187 (24.8)	235 (31.2)	0.89 (0.75-1.07)

Abbreviations: ED, emergency department, CI, confidence interval
Note. Regressions adjusted for palliative care consult in a prior hospital encounter and hospitalization in the prior 30-days.
†p<.001

Table 6.3. Adjusted Predicted Probabilities and 95% CIs of 30-day Readmission Outcomes in Inpatient Oncology: Palliative Care Consultation Combined with Hospice Discharge vs. Discharge to Non-Hospice Post-Acute Care and Usual Care

Outcome Variables	Usual Care (N=753)	Palliative Care Consulted (without hospice) (N=753)	Palliative Care Consulted (with hospice) (N=753)
Inpatient readmission 30 days after discharge	25.3% (0.22-0.29)	29.4% (0.25-0.33)	5.8% (0.03-0.09)†
ED visit 30 days after discharge	5.5% (0.04-0.07)	4.6% (0.03- 0.06)	2.9% (0.01-0.05)
Inpatient readmission or ED visit 30 days after discharge	31.0% (0.27-0.35)	34.0% (0.30-0.38)	8.9% (0.05-0.126)†

Abbreviations: ED, emergency department
Note. regression adjusted for hospice discharge, palliative care consult in a prior hospital encounter, hospitalization in the prior 30-days.
†p<.001

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CHAPTER 7. SUMMARY OF FINDINGS AND IMPLICATIONS FOR POLICY, PRACTICE, AND RESEARCH

Summary of Findings

The purposes of this research were to: (1) gain a greater understanding of the organization-level determinants associated with effective palliative care consult implementation in oncology and (2) examine whether inpatient palliative care consults improved health resource use (i.e., greater hospice discharge and reduced readmissions). The first study used a two-case study design and mixed-methods approach to examine the organizational context for palliative care consult implementation in two organizational settings (medical oncology and gynecologic oncology service lines). We drew on the Klein and Sorra Organizational Theory of Innovation Implementation[1,2] as a guide for developing our interview guide and interpreting our results. To date, the theory has contributed to important insights regarding the influence of organizationally-sanctioned formal implementation policies and practices (IPPs) on effective implementation of healthcare innovations, however the role of informal IPPs has been largely unexplored.[1-6] We used palliative care consultation in inpatient oncology as a model to examine formal and informal IPPs as determinants of innovation implementation.

Our study was the first to provide an in-depth exploration of the organizational context for palliative care consult implementation in inpatient oncology. The study's key finding was empirical support for the role of formal and informal IPPs as determinants of PC consult implementation in inpatient oncology. Specifically, despite the medical oncology service's use of multiple formal IPPs (e.g., training, clinician prompting, chart review, top-

down approach), most participants were unaware of the IPPs, which contributed to a weak implementation climate. In contrast, the gynecologic oncology service employed only one formal IPP (i.e., written guideline) and instead relied on multiple informal IPPs (e.g., spontaneous feedback/encouragement, on-the-job training, bottom-up approach), which contributed to broader clinician awareness and a strong implementation climate. Although preliminary, this study makes a novel contribution by refining the Organizational Theory of Innovation Implementation to suggest that IPPs can be conceptualized as formal and informal. Specifically, relying solely on organizationally sanctioned formal IPPs may not be effective in creating a strong and sustainable climate for implementation in busy, complex healthcare organizations such as the academic oncology services examined in this dissertation.[7] From a theoretical standpoint, our findings support the idea that informal IPPs may compensate or substitute for formal IPPs. For example, spontaneous feedback/encouragement among clinicians could provide instrumental social support that substitutes for a formal training program. However, this substitution may be more likely to occur in smaller healthcare organizations where there is greater opportunity for social interaction and information sharing. Finally, this study also added to the existing literature demonstrating the utility of this theory for understanding the implementation of innovations in healthcare organizations.[3-5,8]

The second study used difference-in-difference estimation to further examine the organization-level determinants of palliative care consult implementation in inpatient oncology. A promising organizational approach for promoting implementation is triggered palliative care consultation (TPCC). For the second study, the single formal IPP employed in gynecologic oncology and multiple formal IPPs employed in medical oncology described

previously were operationalized as two TPCC approaches for palliative care consult implementation. To evaluate the impact of the two TPCC approaches on uptake and timeliness of consult implementation, we linked palliative care consult data abstracted from medical charts to hospital encounter data. We hypothesized that TPCC supported by multiple strategies in medical oncology would be associated with greater uptake and decreased time to consult compared to a single strategy in gynecologic oncology. We also hypothesized that TPCC supported by a single strategy would be superior to usual care (i.e., pre-TPCC initiation in medical oncology service). The adjusted analyses showed that TPCC supported by a single strategy in gynecologic oncology was associated with greater palliative care consult uptake compared to usual care (aRR 1.45, $p<.05$), and TPCC supported by multiple strategies in medical oncology was associated with greater palliative care consult uptake compared to a single strategy (aRR 2.34, $p<.001$). Across all comparisons, we found no association between TPCC and time to palliative care consult ($p>.05$).

The third study used a propensity matched cohort to examine associations among inpatient palliative care consultation, hospice use (discharge), and 30-day unplanned readmissions. We hypothesized that inpatient palliative care consultation would be associated with greater hospice discharge and reduced 30-day readmissions compared to "usual care" (no palliative care consultation). To further understand the mechanism by which inpatient palliative care may reduce readmissions, we also examined whether inpatient palliative care consultation combined with hospice discharge (inpatient or home) was associated with reduced 30-day readmissions. Secondary outcomes included ED visits not resulting in an admission within 30 days of discharge and a composite outcome of inpatient readmissions and ED visits within 30 days of discharge. In the adjusted analysis, the likelihood of having a

30-day readmission did not significantly differ between the palliative care consult and usual care groups (p>.05). However, the palliative care consult group was significantly (p<0.001) more likely than the usual care group to have a hospice discharge (38% vs 9.2%; aRR = 4.09). The adjusted predicted probability of 30-day readmission was significantly lower when palliative care consultation was combined with hospice discharge compared to usual care or palliative care consultation with discharge to non-hospice locations (p<.001). Our findings extend prior research demonstrating the effect of inpatient palliative care consultation on readmissions is largely driven by hospice enrollment; [9-11] we provide important insights into the mechanism by which inpatient palliative care consultation may reduce 30-day unplanned readmissions in oncology.[9-11]

Practice Implications

The main findings from this dissertation were that TPCC improved consult implementation in oncology and that inpatient palliative care consults leading to hospice discharge resulted in reduced 30-day readmissions. However, the findings from the first study suggest healthcare systems should consider the organizational context for palliative care consult implementation to identify the optimal strategies for integrating palliative care consults into oncology practice. Specifically, the second study suggested that TPCC supported by multiple strategies had the greatest impact on uptake. On the other hand, in certain contexts (i.e., healthcare settings led by a small and unified team) a single-strategy approach may provide adequate support for creating a strong implementation climate for palliative care consults and subsequent effective implementation.

In addition, to address high cost of hospital readmissions, in 2010 the Affordable Care Act included a provision for Centers for Medicare and Medicaid Services (CMS) to reduce its payments to hospitals with excessive readmissions under the Hospital

Readmissions Reduction Program.[12] Under this program, hospitals are fined for high 30-day readmissions rates. Although CMS currently excludes cancer diagnoses from this penalty and there is no standardized definition of an avoidable hospitalization within the context of cancer,[13] frequent readmissions and emergency department visits among cancer patients are well-accepted indicators of poor-quality care for cancer patients near the end of life.[14,15] As our findings suggest, inpatient palliative care programs in oncology are key to initiating goals of care and advanced care planning discussions in order to bridge these difficult transitions from hospitalization to hospice for cancer patients, thereby reducing 30-day readmissions and attaining better quality cancer care.

Policy Implications

The findings from the second study showed 8.8% of medical oncology and 11.0% in gynecologic oncology encounters involved a palliative care consultation, which is consistent with the national goal to provide palliative care consults to approximately 10% of all hospitalized patients.[16] Our palliative care consultation rate was also comparable to what has been reported in similar cohorts of hospitalized cancer patients,[17,18] although variable rates have been reported ranging from 5% of patients hospitalized with head and neck cancer[19] to 24% in an inpatient gynecologic oncology service.[20] However, no benchmark criteria for rates of palliative care consultation currently exists specific to inpatient oncology. Benchmarking refers to comparing clinical performance of a practice to an external standard or requirement.[21] From a policy perspective, by establishing benchmark criteria, hospitals could leverage this information to determine the current rate of palliative care consultation, decide whether TPCC is needed, and evaluate the impact of TPCC on consult uptake.[22]

In addition, contrary to our hypothesis, TPCC did not result in earlier timing of consultation that would be expected to enhance quality of care outcomes. Although there are

currently no clinical guidelines regarding the timing of palliative care consultation in inpatient oncology,[23] earlier consults have greater benefit and are considered an important indicator of high-quality care.[24] Additional efforts are needed to develop such guidelines and examine the potential impact of quality improvement efforts, such as lean methodology,[25] to improve timeliness of consults.

Finally, access to inpatient palliative care consults in oncology can be further strengthened by developing a well-trained palliative care workforce.[26] In particular, TPCC has the potential to more efficiently allocate scarce resources in a healthcare system, which is often an issue given the workforce shortage of palliative care specialists.[27] Alternatively, TPCC could increase demand beyond the ability of existing palliative care programs to respond and thus compromise quality of care. As such, policy mechanisms are needed that support increased funding and support for palliative medicine fellowship training programs or development of new structures by which practicing oncologists can obtain additional training in palliative medicine.[27]

Research Implications

There are a number of areas for future research that arose from this dissertation. The first study indicated more research is needed investigating refinement of the Organizational Theory of Innovation Implementation to include both formal and informal IPPs in shaping a strong implementation climate and subsequent effective implementation of healthcare innovations. For example, to increase generalizability of these findings, this work would need to be conducted in multiple locations and across diverse clinical practice settings. Future research could also include a quantitative measure of implementation climate, which would allow for a more precise comparison of this construct across healthcare organizations. In addition, although the second study did not find an association between TPCC and timing

of consultation, TPCC may have influenced other important aspects of implementation quality that we were unable to measure.[28] For example, we were unable to assess quality of the consult (e.g., provision of both symptom management and advanced care planning, skill with which the consult was done). Future research should consider investigating the effect of TPCC on these additional quality indicators. How the strategies affect the sustained use of palliative care consults also remains to be investigated. The findings from the third study add to evidence supporting outpatient palliative care services, including hospice, as support for patients with serious illness to manage their persistent symptom distress and rapid changes in health. Additional research elucidating the relationship between inpatient palliative care consultation, continuity of care in the outpatient setting, and readmissions in oncology is needed. Finally, this study lacked data on the "active ingredients" of palliative care consultations, which might include goals of care and treatment decision-making, pain and symptom management, or other elements important in the choice for hospice. Components of palliative care consultation and their delivery by specialty palliative care physicians versus oncology providers is an important area for future research.

Conclusions

The overall objectives of this research were to determine whether TPCC could achieve effective palliative care consult implementation in oncology and to examine the effect of palliative care consults on health resource use. This was accomplished by pursuing three aims that used mixed-methods to explore the organizational context, implementation effectiveness, and clinical outcomes of palliative care consults in oncology. Using implementation of inpatient palliative care consults as a model, we found evidence for the role of both formal and informal IPPs as determinants of innovation implementation, suggesting refinements to organization theory. Further, we found TPCC is an effective

organizational approach for promoting inpatient palliative care consult implementation in oncology, with TPCC supported by multiple strategies having the greatest impact on uptake. Finally, inpatient palliative care consults leading to hospice discharge resulted in reduced 30-day readmissions. Our results can be used to inform new policies and clinical practices that close the palliative care implementation gap in oncology and improve outcomes for cancer patients.

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APPENDIX A. CANCER DIAGNOSIS CODES

Cancer Type	ICD-9 Code	ICD-10 Code
Digestive System	Colorectal: 154.0 154.1 154.2 154.3 154.8 153.0 153.1 153.2 153.3 153.4 153.5 153.6 153.7 153.8 153.9 197.4 197.5 Other Digestive: 150.0 150.1 150.2 150.3 150.4 150.5 150.8 150.9 151 151.0 151.1 151.2 151.3 151.4 151.5 151.6 151.8 151.9 152 152.0 152.1 152.2 152.9 155 155.0 155.1 156 156.0 156.1 156.2 156.9 157 157.0 157.1 157.2 157.3 157.4 157.8 157.9 158 158.0 158.8 158.9 159 159.8 159.9 197.6 197.7 197.8	Colorectal: C17.0 C17.1 C17.2 C18.0 C18.1 C18.2 C18.3 C18.4 C18.5 C18.7 C18.8 C18.9 C19.0 C20 C20.0 C21.0 C21.1 C21.8 C78.4 C78.5 Other Digestive: C15.3 C15.5 C15.9 C16.0 C16.3 C16.4 C16.6 C16.8 C16.9 C22.0 C22.1 C22.9 C23.0 C23 C24.0 C24.1 C24.9 C25.0 C25.1 C25.2 C25.3 C25.4 C25.7 C25.9 C32.0 C78.6 C78.7 C78.89
Breast	174.0 174.1 174.2 174.3 174.4 174.5 174.6 174.8 174.9 175.9	C50.212 C50.311 C50.411 C50.412 C50.511 C50.512 C50.812 C50.911 C50.912 C50.919 C79.81
Urological	185 186.0 186.9 187.4 187.6 187.9 188.0 188.2 188.4 188.6 188.7 188.8 188.9 189.0 189.1 189.2 189.3 198.0 198.1	C61 C62.11 C62.90 C62.92 C64.1 C64.2 C64.9 C66.1 C67.2 C67.4 C67.9 C68.0 C79.00 C79.01 C79.11 C79.19
Bones & Joints	170.0 170.1 170.2 170.3 170.4 170.6 170.7 170.9 198.5	C40.01 C41.0 C41.2 C41.4 C41.9 C79.51 C79.52
Soft Tissue	171.0 171.2 171.3 171.4 171.5 171.6 171.7 171.8 171.9 176.1 176.2 176.0 176.4 164.0 164.1 164.2 164.3 164.9 197.1	C38.0 C38.1 C45.0 C45.1 C45.7 C45.9 C48.0 C48.1 C48.2 C48.8 C49.0 C49.21 C49.22 C49.3 C49.4 C49.5 C49.6 C49.9 C78.1
Skin	172.2 172.3 172.4 172.5 172.6 172.7 172.8 172.9 173.3 173.4 173.5 173.6 173.7 173.8 198.2	C43.30 C43.20 C43.39 C43.4 C43.51 C43.59 C43.60 C43.61 C43.70 C43.71 C43.72 C43.9 C44.101 C44.119 C44.221 C44.329 C44.40 C44.42 C44.520 C44.529 C44.629 C44.90 C44.91 C79.2
Head and Neck	140.0 140.9 141.0 141.2 141.4 141.6 141.8 141.9 142.0 142.2 142.9 143.1 144.0 144.8 144.9 145.0 145.2 145.3 145.4 145.5 145.6 145.8 145.6 145.9 146.0 146.7 146.8 146.9 147.1 147.8 147.9 148.0 148.1 148.8 148.9 149.0 149.8 161.8 161.9 195.0	C01 C02.9 C04.9 C06.9 C09.9 C10.8 C10.9 C11.9 C13.2 C13.9 C76.0 C32.8 C32.9
Gynecological	180.0 180.1 180.8 180.9 181 182.0 182.1 182.8 183.0 183.2 183.4 183.8 183.9 184.0 184.1 184.4 184.8 184.9 198.6	C51.9 C52 C53.0 C53.9 C54.1 C54.9 C55 C56.1 C56.2 C56.9 C57.00 C57.01 C57.02 C57.4 C79.60 C79.61 C79.62
Lung/Thoracic	160.0 160.1 160.2 160.3 160.4 160.5 160.8 160.9 161.0 161.1 161.2 162.0 162.2 162.3 162.4 162.5 162.8 162.9 163.0 163.9 197.0 197.2 197.3	C34.00 C34.01 C34.10 C34.11 C34.12 C34.2 C34.30 C34.31 C34.32 C34.80 C34.81 C34.90 C34.91 C34.92 C78.00 C78.01 C78.02 C78.2 C78.39 C31.0 C31.1 C32.1 C32.2 C79.31 C79.32
CNS	191.0 191.1 191.2 191.3 191.4 191.6 191.7 191.8 191.9 198.3 198.4 192.1 192.2	C69-C72 C79.40 C79.49
Other/Ill Defined	190.1 190.6 190.7 190.9 193 194.0 194.3 195.1 195.2 195.3 195.5 195.8 196.0 196.1 196.2 196.3 196.5 196.8 196.9 198.7 199.0 199.1 199.2	C73-C75 C76.1 C76.2 C76.3 C77.0 C77.1 C77.2 C77.3 C77.4 C77.5 C77.8 C77.9 C79.70 C79.71 C79.72 C79.82 C79.89 C79.9 C80.0 C80.1

APPENDIX B. SEMI-STRUCTURED INTERVIEW GUIDE

I. Implementation Policies and Practices (IPPs) refer to the plans, practices, structures, and strategies that an organization employs to put the innovation into place to support innovation use.

- How do oncologists decide whether or not to refer a patient for inpatient palliative care consult at UNC Hospital?
  Probe: What role do oncologists play?
  Probe: What role do the palliative care clinicians play?
  Probe: What kinds of issues come up in obtaining an inpatient palliative care consult?

- What are the criteria you use to decide on whether to refer a patient for an inpatient palliative care consult?
  Probe: Who else is involved in that decision?

- Have you received any education or training with regard to palliative care skills?
  Probes: Who provides it (UNC Hospital? Med E or gynecologic oncology?) How often?

- Do you receive feedback on your performance regarding patient referrals for inpatient palliative care consults?
  Probes: What kinds of feedback do you receive? How do you get that feedback? How often do you get it?

- What approaches or incentives are used by the inpatient Med E (solid tumor) (or gynecologic oncology) services to encourage you to refer patients for an inpatient palliative care consult?

II. Implementation Climate refers to organizational members' shared perceptions of implementation policies and practices in terms of their meaning and significance for innovation use.

- Do you feel that referring patients for PC consult is something that is expected in the inpatient Med E (solid tumor) (or gynecologic oncology) services, or are there no expectations (meaning you can do it or not do it; it's up to you)?

- Do attending oncologists feel that there are major barriers or disincentives to referring patients for an inpatient palliative care consult? How about oncology residents and fellows? [for residents and fellows: Do you feel there are major barriers or disincentives to referring patients for an inpatient PC consult?)
  Probe: What are some of the barriers (technological, EHR related)?
- Do attending oncologists have a clear idea of why a patient should be referred for an inpatient palliative care consult? How about oncology residents and fellows? [for residents and fellows: do you have a clear idea of why a patient should be referred for an inpatient PC consult?]

Probe: How clear of an idea is it?

- Do attending oncologists know how inpatient palliative care consults work and what they entail (e.g., who's responsible for what)? How about oncology residents and fellows? [for residents and fellows: do you know how inpatient PC consults work and what they entail?]

  Probe: How do they work?

  Probe: What do they entail?

- Do attending oncologists know what they personally are supposed to do when referring a patient for inpatient palliative care consult and how they are supposed to do it? How about oncology residents and fellows? [for residents and fellows: do you know what you are personally supposed to do when referring a patient for inpatient PC consult and how you are supposed to do it?]

  Probe: How do you know what you are supposed to do?

  Probe: How do you know how to do it?

- Do attending oncologists feel they have the knowledge, skills, and tools they need to play their part in referring patients for inpatient palliative care consults? Do attending oncologists feel that the residents and fellows has the knowledge, skills, and tools they need to play their part in the referring patients for inpatient palliative care consults? [Ask the questions conversely for residents and fellows].

  Probe: Do the knowledge, skills, and tools you have help you? In what ways?

  Probe: Do you have what you need?

- Do attending oncologists feel enthusiastic about inpatient palliative care consults? How about oncology residents and fellows? [for residents and fellows: do you feel enthusiastic about inpatient PC consults?]

  Probe: How enthusiastic are they?

- Do attending oncologists here feel recognized and rewarded for referring patients for inpatient PC consults? How about oncology residents and fellows? [for residents and fellows: do you feel recognized and rewarded for referring patients for inpatient PC consults?]

  Probe: What kinds of rewards or recognition do oncologists receive?

  Probe: How are the rewards or recognition provided (e.g. by whom?)

III. Innovation-Values Fit refers to the extent to which targeted employees perceive that innovation use will foster the fulfillment of their values. Values are concepts or beliefs that (a) pertain to desirable end-states or behaviors, (b) transcend specific situations, and (c) guide the selection and evaluation of behavior and events.

- When you are on-service in Med E (solid tumor) (or gynecologic oncology) services, what are your top priorities?

  Probes: Delivering guideline concordant care? Timeliness of PC consults? Making sure no one dies? Making sure patient gets out of the hospital? Communication with patients' outpatient oncologist? Making sure people are doing what they are supposed to be doing?

  Probe: Does referral to inpatient PC consults help you achieve your priorities or get in the way of your priorities?

- What do <u>you</u> perceive your role to be while you are on service in Med E (solid tumor) (or gynecologic oncology)?

  Probe: Is referral to inpatient PC consults consistent with your perceived role or does it conflict with your perceived role?

IV. Rival activities are events or actions that compete with the innovation for attention, resources, or both.

- Have any major events or changes occurred in the medical/gynecologic oncology service in the past year that may have impacted referrals for PC consultation? If so, what? What impact has this event or change had?

V. Innovation champion

- Are there particular oncologists in medical/gynecologic oncology who really stand out as champions of referring patients to inpatient palliative care consults? What do they do as champion? (By champion, I mean someone who goes above and beyond the call of duty, someone who is personally invested in improving quality of care for cancer patients)

APPENDIX C. COMORBIDITY DIAGNOSIS CODES

Condition	ICD-9 Codes	ICD-10 Codes
Acute Myocardial Infarction	410, 412	I21, I22, I252
Congestive Heart Failure	428, 39891, 40201, 40211, 40291, 40401, 40403, 40411, 40413, 40491, 40493, 4254, 4255, 4257, 4258, 4259	I43, I50, I099, I110, I130, I132, I255, I420, I425, I426, I427, I428, I429, P290
Peripheral Vascular Disease	0930, 4373, 440, 441, 4431, 4432, 4438, 4439, 4471, 5571, 5579, V434	I70, I71, I731, I738, I739, I771, I790, I792, K551, K558, K559, Z958, Z959
Cerebrovascular Disease	36234, 430, 431, 432, 433, 434, 435, 436, 437, 438	G45, G46, I60, I61, I62, I63, I64, I65, I66, I67, I68, I69, H340
Dementia	290, 2941, 3312	F00, F01, F02, F03, G30, F051, G311
Chronic Pulmonary Disease	4168, 4169, 5064, 5081, 5088, 490, 491, 492, 493, 494, 495, 496, 500, 501, 502, 503, 504, 505	J40, J41, J42, J43, J44, J45, J46, J47, J60, J61, J62, J63, J64, J65, J66, J67, I278, I279, J684, J701, J703
Rheumatologic Disease	4465, 7100, 7101, 7102, 7103, 7104, 7140, 7141, 7142, 7148, 725	M05, M32, M33, M34, M06, M315, M351, M353, M360
Peptic Ulcer Disease	531, 532, 533, 534	K25,K26, K27, K28
Mild Liver Disease	07022, 07023, 07032, 07033, 07044, 07054, 0706, 0709, 5733, 5734, 5738, 5739, V427, 570, 571	B18, K73, K74, K700, K701, K702, K703, K709, K713, K714, K715, K717, K760, K762, K763, K764, K768, K769, Z944
Diabetes without Complications	2500, 2501, 2502, 2503, 2508, 2509	E100, E101, E106, E108, E109, E110, E111, E116, E118, E119, E120, E121, E126, E128, E129, E130, E131, E136, E138, E139, E140, E141, E146, E148, E149
Diabetes with Complications	2504, 2505, 2506, 2507	E102, E103, E104, E105, E107, E112, E113, E114, E115, E117, E122, E123, E124, E125, E127, E132, E133, E134, E135, E137, E142, E143, E144, E145, E147
Hemiplegia or paraplegia	342, 343, 3341, 3440, 3441, 3442, 3443, 3444, 3445, 3446, 3449	G81, G82, G041, G114, G801, G802, G830, G831, G832, G833, G834, G839
Renal disease	582, 585, 586, V56, 5830, 5831, 5832, 5834, 5836, 5837, 5880, V420, V451, 40301, 40311, 40391, 40402, 40403, 40412, 40413, 40492, 40493	N18, N19, N052, N053, N054, N055, N056, N057, N250, I120, I131, N032, N033, N034, N035, N036, N037, Z490, Z491, Z492, Z940, Z992
Moderate or severe liver disease	4560, 4561, 4562, 5722, 5723, 5724, 5728	K704, K711, K721, K729, K765, K766, K767, I850, I859, I864, I982
AIDS/HIV	042, 043, 044	B20, B21, B22, B24

APPENDIX D. AIM 2 SUPPLEMENTAL DATA

Supplemental Table 1. Changes (difference-in-difference) in Palliative Care Consult Implementation Associated with Triggered Palliative Care Consultation: Single Strategy vs. Usual Care

	Adjusted Relative Risk	95% Confidence Interval
Effects of TPCC on PC consult uptake (No=ref)	**1.45‡**	**1.05-2.01**
Age	1.00	0.99-1.00
Race (White = ref)		
Black	1.02	0.88-1.19
Other	1.03	0.77-1.39
Missing	1.53	0.98-2.39
Sex (Female = ref)	0.84	0.68-1.02
Insurance (Medicare = ref)		
Medicaid	0.90	0.72-1.12
Other Public	1.55†	1.09-2.20
Uninsured	1.16	0.74-1.81
Private	0.96	0.80-1.16
Missing	1.05	0.71-1.54
Cancer Type (No=ref for all types)		
Digestive	1.45‡	1.24-1.69
Breast	0.89	0.67-1.17
Bone/Joint	1.48‡	1.22-1.80
Soft Tissue	0.72	0.47-1.11
Skin	1.50†	0.02-1.08
Head/Neck	0.90	0.50-1.63
Urological	0.97	0.69-1.34
Lung/Thoracic	1.27‡	1.06-1.52
Gynecological	0.88	0.71-1.09
Other/Ill Defined	1.42‡	1.20-1.69
CNS	1.23	0.99-1.52
Missing	0.91	0.65-1.26
Cancer Stage at Diagnosis (Stage 0 or 1 = ref)		
Stage 2 or 3	1.27	0.98-1.65
Stage 4	1.27	0.96-1.66
Missing	1.11	0.87-1.45
PC consultation in a prior hospital encounter (No = ref)	2.74‡	2.19-3.41
Hospitalized in Prior 30 days (No = ref)	1.27‡	1.09-1.49
Charlson comorbidity (0 = ref)		
1	1.07	0.90-1.28
>=2	1.02	0.80-1.29
Discharge Status (Alive = ref)	1.49	1.16-1.92

PC: Palliative care
TPCC: Triggered palliative care consultation
CNS: Central nervous system
†: Significant at the p=.05 level
‡: Significant at the p=.01 level
Note. Regression analyses also controlled for a linear time trend. Length of stay was included as an exposure variable.

Supplemental Table 2. Changes (difference-in-difference) in Palliative Care Consult Implementation Associated with Triggered Palliative Care Consultation: Multiple Strategies vs Single Strategy

	Adjusted Relative Risk	95% Confidence Interval
Effects of TPCC on PC consult uptake (No=ref)	**2.34‡**	**1.57-3.49**
Age	0.99	0.99-1.00
Race (White = ref)		
Black	1.02	0.83-1.26
Other	1.28	0.90-1.81
Missing	0.87	0.35-2.17
Sex (Female = ref)	0.98	0.75-1.29
Insurance (Medicare = ref)		
Medicaid	0.73	0.52-1.04
Other Public	1.15	0.72-1.84
Uninsured	--	--
Private	0.78	0.59-1.03
Missing	0.84	0.49-1.43
Cancer Type (No=ref for all types)		
Digestive	1.74‡	1.42-2.12
Breast	0.81	0.53-1.24
Bone/Joint	1.78‡	1.39-2.29
Soft Tissue	0.82	0.52-1.29
Skin	1.58‡	1.15-2.19
Head/Neck	1.05	0.51-2.19
Urological	1.41†	1.01-1.98
Lung/Thoracic	1.54‡	1.22-1.94
Gynecological	1.22	0.85-1.76
Other/Ill Defined	1.42‡	1.13-1.79
CNS	1.31	0.89-1.93
Missing	1.05	0.66-1.69
Cancer Stage at Diagnosis (Stage 0 or 1 = ref)		
Stage 2 or 3	1.31	0.88-1.94
Stage 4	1.02	0.67-1.56
Missing	0.86	0.58-1.27
PC consultation in a prior hospital encounter (No = ref)		
	1.53‡	1.13-2.08
Hospitalized in Prior 30 days (No = ref)	1.14	0.89-1.47
Charlson comorbidity (0 = ref)		
1	1.06	0.81-1.40
>=2	1.35†	1.00-1.81
Discharge Status (Alive = ref)	1.49†	1.04-2.13

PC: Palliative care
TPCC: Triggered palliative care consultation
CNS: Central nervous system
†: Significant at the p=.05 level
‡: Significant at the p=.01 level
Regression analyses also controlled for a linear time trend. Length of stay was included as an exposure variable.