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What's in a Message? The Impact of Patient-Clinician Email Message Content on Patient Health Outcomes and Healthcare Utilization

Dawn M. Heisey-Grove
Virginia Commonwealth University

WHAT'S IN A MESSAGE? THE IMPACT OF PATIENT-CLINICIAN EMAIL MESSAGE CONTENT ON PATIENT HEALTH OUTCOMES AND HEALTHCARE UTILIZATION

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A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Health Related Sciences at Virginia Commonwealth University.

by

Dawn Heisey-Grove, Ph.D. (c), M.P.H.
Master of Public Health, Boston University School of Public Health, 2001
Bachelor of Science, University of Maryland College Park, 1997

Director: Jonathan DeShazo, Ph.D., M.P.H.
Associate Professor and Blick Scholar, Health Administration, Department of Health Administration

Virginia Commonwealth University
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Abstract

WHAT'S IN A MESSAGE? THE IMPACT OF PATIENT-CLINICIAN EMAIL MESSAGE CONTENT ON PATIENT HEALTH OUTCOMES AND HEALTHCARE UTILIZATION

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Major Director: Jonathan DeShazo, PhD, Associate Professor and Blick Scholar, Health Administration

Introduction

In the upcoming chapters, we present our study findings as three papers ready for submission to peer-reviewed journals. The first paper describes the associations between taxa and the characteristics of the patients and clinic staff who exchange those messages. The second paper explores the associations between those taxa and patients' healthcare utilization. The third paper presents associations between taxa and patient health outcomes for diabetes and hypertension. We conclude with how the three papers are related and highlight the importance of this research.

Across the three papers, we reference a theory-based taxonomy we developed specifically for secure messaging. A number of researchers have created taxonomies to classify secure message content. Although these contained common themes, many were used only once or twice in published research and few classified content generated by clinic staff. We built our taxonomy upon commonly used themes from these existing classification systems. In contrast with other researchers, however, we leveraged theoretical constructs to group taxa and identify the concepts within messages that must be present for logical linkages between message content and patient outcomes. To identify why patients might outreach to

clinicians during times of uncertainty, we referenced Mishel's Uncertainty in Illness Theory (Mishel, 1988, 1999). We leveraged the framework developed by Street, Makoul, Arora, and Epstein (2009) to highlight patient task-oriented requests that might manifest in secure messages (e.g., to support self-care, satisfaction), and clinician-generated content that might support improved patient health outcomes. Our three papers present the first reports using this taxonomy and are the first to explore associations between taxa, patient outcomes, and the senders' and receivers' characteristics.

We sampled patients with diabetes and/or hypertension to demonstrate that our taxonomy could be applied to different health conditions, and to highlight any differences in taxa use based on health condition. We included threads initiated and completed between January 1 and December 31, 2017. Our study included 2111 patients, of whom 49 percent initiated 7346 threads that included 10163 patient-generated messages and 8146 messages generated by 674 unique clinic staff (hereafter referred to as clinician-generated messages).

Patient and Clinic Staff Characteristics Associated with Message Content

In the first paper, we described the coding process and interrater and intrarater reliability derived from that process, and then presented our findings on the characteristics of the senders and receivers associated with selected taxa. We estimated both unadjusted and adjusted differences in characteristics associated with the use of each taxon. We assessed taxon use as a dichotomous variable that was positive if the patient or clinician sent or received at least one message coded with the selected taxon. For patient-generated taxa, we explored associations with the characteristics of the sender (which types of patients sent these taxa) and receiver (which types of clinic staff received these types of content). Similarly, we explored the associations between clinician-generated taxa and the characteristics of the sender (what types of clinic staff sent these taxa) and receiver (what types of patients were the recipients of this content). We created separate regression models for patient characteristics (demographic, geographic, health condition and status, and thread volume) and staff characteristics (staff type, specialty, and message volume). Our patient-level analyses included only the 1031 patients who initiated message threads using the patient portal.

Our analyses found differences in taxa use by patients' age, sex, race, health condition and status, and distance from clinic. Younger patients and females were less likely to share certain types of information with clinic staff (clinic updates among younger patients OR=0.77; 95% CI: 0.65-0.91; self-reporting biometrics by women OR=0.78; 95% CI: 0.62-0.98). Use of certain types of task-oriented requests varied by age (younger patients' prescription refills OR=0.77; 95% CI: 0.65-0.90 and scheduling requests OR=1.41; 95% CI: 1.19-1.68) and race (black vs white requests for preventive care appointments OR=2.68; 95% CI: 1.30-5.51, requests for a new or changed prescription OR=0.72; 95% CI: 0.53-0.98, and laboratory or other diagnostic procedures OR=0.66; 95% CI: 0.46-0.95). Younger and uninsured patients were less likely to receive medical guidance from clinic staff (OR=0.84; 95% CI: 0.71-0.99 and OR=0.21; 95% CI: 0.06-0.72, respectively), but patients with public payers were two times more likely to receive medical guidance compared to patients with private payers (95% CI: 1.27-3.24). Females were less likely to receive confirmation that requests were fulfilled (OR=0.81; 95% CI: 0.68-0.97).

These findings highlight differences in how patients used secure messaging to communicate with their clinic staff, which could result in differential access to care. Further, the differences in taxa use by clinic staff by patients' characteristics might further exacerbate existing disparities in care and highlight opportunities for training and education to reduce these discrepancies.

Healthcare Services Utilization Associated with Message Content

The Street, Makoul, et al. (2009) framework highlights access to care as an intermediate outcome in the pathway between health outcomes and communication functions such as information exchange, enabling self-care, and making decisions. Patients reported that effective communication delivered through secure messaging prevented unnecessary appointments (Alpert, Markham, Bjarnadottir, & Bylund, 2019); however, prior studies that explored links between secure messaging and healthcare utilization only considered message volume, not what was said in those messages. Our second paper is the first to explore whether content is associated with healthcare utilization. We measured utilization in four ways: number of outpatient visits, number of emergency department visits, number of inpatient visits, and medication adherence. We created separate medication adherence dichotomous variables for diabetes and hypertension, based on having an average condition-specific medication possession ratio greater than 0.8 (Clifford, Perez-Nieves, Skalicky, Reaney, & Coyne, 2014; Khunti, Seidu, Kunutsor, & Davies, 2017; Krass, Schieback, & Dhippayom, 2015; Schulz et al., 2016). We measured our independent variables as the taxon prevalence among patient- or clinician-generated taxa, as appropriate. Our covariates included the patient characteristics described in the first paper. To estimate incidence rate ratios for the three visit dependent variables, we conducted Poisson regressions with robust variance estimation (Hilbe, 2014). We estimated the odds of medication adherence associated with each taxon using logistic regression.

In unadjusted analyses, we found that patients who initiated message threads had higher numbers of outpatient visits ($p<0.0001$) and better hypertension medication adherence ($p<0.01$), compared to patients who did not initiate threads. Among patients who initiated message threads, we identified a positive association between emergency department visits and prevalence of request denials from clinic staff (IRR=1.18; 95% CI: 1.03, 1.35) and patients' requests for follow-up appointments (IRR=1.15; 95% CI: 1.07-1.23), as well as between clinic non-response and the number of outpatient visits (IRR=1.02; 95% CI: 1.00, 1.03). We identified an inverse association between hypertension medication adherence and patients' appointment reschedule requests (OR=0.87; 95% CI: 0.79-0.96). These findings highlight opportunities for future research about the use of secure messaging to influence care delivery and access to care.

Patient Health Outcomes Associated with Message Content

Patients whose uncertainty in their illness is addressed experience less stress, leading to better health outcomes (Mishel, 1988). Through appropriate communication functions with clinicians, patients develop better understanding of their condition and how to manage it and may have improved access to care and self-care skills, which leads to better outcomes (Street, Makoul, et al., 2009). Our third paper describes the first study to assess the types of message content associated with improved health outcomes. We examined changes in patients' glycemic index (A1C) for patients with diabetes and changes in diastolic (DBP) and systolic blood pressure (SBP) among patients with hypertension, comparing patients who sent or received messages with selected taxa to (1) those who sent other types of messages and (2) those who did not initiate threads in 2017. We measured outcome changes as the difference between baseline (the last measured value in 2016) and endpoint (the first measured value reported in 2018) measures. Similar to the analyses conducted for Paper 2, our independent variables were the prevalence of each taxon by patient, where the denominator was the number of patient- or clinician-generated taxa, as appropriate for the selected taxon. Analyses included only patients with the selected condition: 811 patients with diabetes only, 787 patients with hypertension only, and 513 patients with both conditions. We used linear regression to identify associations between the outcomes and each taxon.

In unadjusted analyses, we found that patients who initiated threads had lower endpoint A1Cs ($p<0.05$) and larger declines in A1Cs ($p=0.01$) compared to patients who did not initiate threads. We observed improvements in A1C among patients who sent information seeking messages (β=-0.07; 95% CI: -0.13, -0.00). We also observed improved SBP associated with clinic non-response to patients' threads (β=-0.30; 95% CI: -0.56, -0.04), staff acknowledgement and fulfillment of patients' requests (β=-0.30; 95% CI: -0.58, -0.02), and patients' complaints (β=-4.03; 95% CI: -7.94, -0.12). Poorer outcomes were associated with information sharing messages among patients with diabetes (β=0.08; 95% CI: 0.01, 0.15), and deferred information sharing by clinic staff among patients with hypertension (SBP β=1.29; 95% CI: 0.4-2.19). In addition, among patients with either condition, we observed positive associations between outcome and patient- and clinician-generated appreciation and praise messages with effect sizes ranging from 0.4 (A1C) to 5.69 (SBP). These findings demonstrate associations between outcomes and message content and further emphasize the need for training and education of clinic staff on appropriate use of secure messaging to prevent exacerbation of health disparities due to differential communication delivered through this modality.

Conclusion

We identified patient characteristics associated with patients' use of taxa; not surprisingly, patients' use of taxa varied by age, sex, and race. Taxa use varied by clinic staff characteristics consistent with the triage systems employed by most healthcare organizations (Heyworth et al., 2013; Ozkaynak et al., 2014; Wooldridge, Carayon, Hoonakker, Musa, & Bain, 2016). We also identified differences in staff's taxa use based on the characteristics of the patient to whom they were sending the message. We further identified associations between taxa and healthcare utilization and health outcomes. If certain types of patients use taxa less frequently, and these taxa are associated with better outcomes or more appropriate utilization, then that presents opportunities to target those populations for education to shift their use of secure messaging. Further, if clinician-generated message content is associated with improved outcomes and clinic staff are not equitably sharing that content with all patients, there is an opportunity for education and training. Our research is a set of first-of-its-kind analyses that highlight differences in taxa use by both patients and clinicians and demonstrates the associations between those taxa and patient outcomes. Healthcare administrators and clinic staff should be aware of these associations and consider mitigation strategies to improve equitable secure messaging use by their staff and across their patient populations.

The studies shared several limitations discussed in more detail in the papers themselves. These limitations included a need for more specificity in the taxa definitions and more rigorous coding processes, the lack of temporal indicators in the analysis, and limited patient and clinical characteristics. The analyses that incorporated A1C measurements suffered from significant missing data. Sample size for some taxa was limited so that the algorithms did not converge. The analyses were based on single taxa, which represented only one component of the overall thread discussion. Finally, our message sample included only those messages saved to patients' charts, which likely led to an underrepresentation of taxa and clinic non-response.

We highlighted a number of opportunities for future research across the three studies. Consideration should be given to refining taxa definitions and applying more rigorous coding practices, incorporating temporal elements into the analyses to provide context and support assessments of causality, adding relevant covariates such as message reading level or patients' health literacy levels, and exploring other proximal and intermediate outcomes identified in the Street, Makoul, et al. (2009)

framework. We also strongly recommend examining the impact of taxa pairings: analyses that consider the call-and-response nature of the full conversation occurring within the thread.

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1. Introduction

This study's primary objective is to create, validate, and apply a theory-based classification system, or taxonomy, that permits identification of the types of patient-clinician secure electronic mail communications associated with changes in health outcomes and in healthcare services utilization. A list of acronyms and definitions of key concepts can be found in Appendices A and B, respectively.

1.1 Background

In 2001, the Institute of Medicine (IOM) noted that improvements were needed in health care safety, efficiency, timeliness, and effectiveness, as well as in the delivery of equitable patient-centered care (Institute of Medicine, 2001). Patient-centered care is generally interpreted as care that considers patients' values and preferences while fostering bidirectional information sharing to support shared decision-making (Epstein, Fiscella, Lesser, & Stange, 2010). Most commonly, the associations between improved patient health outcomes and the factors highlighted in the IOM are indirect, such as those between patient-centered care, patient satisfaction, improvements in patients' understanding of their condition, and improved longevity and quality of life (Epstein et al., 2005; Street, Makoul, et al., 2009).

The 2001 IOM report also highlighted that health information technology (IT) could help address many of the challenges identified in the report, if implemented properly. In fact, a recent literature review found that health IT may promote patient engagement and empowerment by improving patients' preparation for, and recall of, clinical encounters (Rathert, Mittler, Banerjee, & McDaniel, 2017). Eighty-nine percent of Americans have internet access (Anderson, Perrin, & Jiang, 2018) and may therefore be able to access and use health IT when available to support their care. One example of patient-accessible health IT is secure messaging (SM), defined by the Centers for Medicare & Medicaid Services (CMS) as "any electronic communication between a provider and patient that ensures only those parties can access the communication. This electronic message could be email or the electronic messaging function of a PHR [personal health record], an online patient portal, or any other electronic means" (Centers for Medicare and Medicaid Services, 2012, p. 54032). To send a secure message, patients log into a secure patient portal, select a clinician with whom to communicate, and type and send their message. This process verifies the identities of both sender and receiver and allows the secure exchange of protected health information (PHI). In addition, the securely exchanged messages may become part of the patient's medical record.

Access to, and use of, secure messaging is becoming more common. More than half of all ambulatory care physicians reported sharing secure messages with patients (Heisey-Grove, Patel, & Searcy, 2015) and the majority of hospitals reported having the capability to exchange secure messages with patients (Henry, Pylypchuk, & Patel, 2016). The proportion of patients reporting they communicated online (email or internet) with a healthcare provider increased from 7 percent in 2003 to 30 percent in 2013 (Tarver et al., 2018). Over a three-year period, Cronin, Davis, et al. (2015) reported an increase in SM threads (inclusive of the initial message and all responses) of almost 350 percent, from approximately 108,000 in 2008 to 484,000 in 2010. Similarly, Shimada et al. (2013) noted an eight-fold increase in secure messaging adoption among primary care patients over a two-year study period. Secure messaging now accounts for a significant proportion of patient encounters: of the 1.2 million outpatient encounters (clinic visits and secure messages) at a large university medical center in 2010, almost 40 percent occurred as secure messages (Cronin, Davis, et al., 2015).

In contemplating a shift to a different form of communication such as secure messaging, consideration must be given to the limitations of that communication modality. Although empathy with the patient is a commonly-identified component of patient-centered communication, emotions are frequently difficult to express and commonly misinterpreted in email communication (Byron, 2008). Written forms of communication may also present challenges for older patients and individuals with low health literacy. There is value, however, in these alternate forms of communication: the IOM noted that they provide opportunities for patients to follow-up with their clinician between visits (Institute of Medicine, 2001), which is a convenience important to many patients with chronic conditions. For example, more than half of patients with diabetes had a phone encounter and four in ten used secure messaging between clinical visits (Lyles, Grothaus, Reid, Sarkar, & Ralston, 2012).

A secure message thread—inclusive of the initial message and all responses—is most comparable to a patient-clinician communication exchange held during an office visit. The individual messages that constitute a message thread are typically short, although patient-generated messages were, on average, 2-3 times longer than clinician-generated messages (Alpert, Dyer, & Lafata, 2017; Mirsky, Tieu, Lyles, & Sarkar, 2016b; Roter, Larson, Sands, Ford, & Houston, 2008; Sittig, 2003). Twenty-one studies evaluated patient-generated content and although the content classifications were not consistent across the different studies, between a quarter and half of patient-generated messages included information-seeking content. Much less is known about clinician-generated message content: six studies reported on clinician-generated message content and a third did not classify the content itself but rather described the degree to which the messages contained patient-centered communication and the level of medical decision-making involved in developing the message.

Most secure message threads were patient-initiated (i.e., the patient sent the first message) (Chung, Panattoni, Chi, & Palaniappan, 2017; Harris, Haneuse, Martin, & Ralston, 2009; Zhou, Kanter, Wang, & Garrido, 2010). Patients appreciated the convenience of outreaching to clinicians according to the patients' schedules as well as the ease afforded by secure messaging to submit medication refill requests, manage appointments, and receive test results (Anand, Feldman, Geller, Bisbee, & Bauchner, 2005; Crotty, Tamrat, Mostaghimi, Safran, & Landon, 2014; North, Crane, Stroebel, et al., 2013). They also reported higher satisfaction with care when using secure messaging (Houston, Sands, Jenckes, & Ford, 2004; C.-T. Lin, Wittevrongel, Moore, Beaty, & Ross, 2005).

Crotty et al. (2014) found that most patient-generated messages were sent to the patients' primary care clinicians. Typically, clinical practices triage messages through a team of nurses, physician assistants, pharmacists, and physicians; physicians generally respond only to the more complicated messages (Heyworth et al., 2013; Ozkaynak et al., 2014; Wooldridge et al., 2016). Although there are mixed opinions about the impact of secure messaging to the clinical workflow (Heyworth et al., 2013; Hoonakker, Carayon, & Cartmill, 2017; Ozkaynak et al., 2014; Wooldridge et al., 2016), clinician-identified benefits of secure messaging included improvements in patient access, more direct and focused communication, improved efficiency including avoidance of phone tag, improved communication between visits, and improved patient engagement, satisfaction, and trust (Nazi, 2013; Wade-Vuturo, Mayberry, & Osborn, 2013).

Communication that provides information at a level that patients can understand leads to better diagnoses, development of appropriate treatment and self-care plans, improvements in patients' adherence to those plans, and evidence-based decision-making that leads to improved health outcomes (Street, Makoul, et al., 2009). Providing patients these types of communication between office visits as secure messages may further improve health outcomes and appropriately reduce some healthcare utilization. Research to date has not demonstrated a consistent association between secure messaging use and healthcare utilization. There is moderate supporting evidence of associations between message use and selected patient outcomes (e.g., glucose levels in patients with diabetes), but less so among other outcomes (e.g., diastolic and systolic blood pressure among patients with hypertension) (Goldzweig et al., 2012). Research has focused primarily on quantifying messages (i.e., message volume and intensity); few studies characterized message content, and those that did used inconsistent categories from taxonomies that were not theory-based and did not attempt to link the content classifications to patient outcomes.

Chapters 2, 4, and 5 include further detail from these literature reviews that identified several critical gaps in the current knowledge around secure messaging:

- Absence of a standard taxonomy for secure message content analyses;
- Inconsistent information about which patient populations use secure messaging;
- Lack of consistent information regarding the association between secure message use and healthcare utilization; and
- Some inconsistencies in the associations identified between secure messaging use and selected health outcomes.

Although research to date has not considered associations between secure messaging content and outcomes of interest, doing so may provide greater clarity in the factors listed above. In addition, because the secure message content analyses conducted thus far did not utilize the same taxonomy, they provide limited comparability. A theory-based taxonomy developed specifically for secure messaging should permit comparisons of message content across healthcare environments and may provide a better understanding of which patients and clinicians use secure messaging and how they are using it, and ultimately lead to appropriate reductions in healthcare services use.

1.2 Study Goals and Research Questions

This study's primary objective is to create, validate, and apply a standardized taxonomy for secure messages that permits identification of patient-clinician electronic mail communications associated with improved health outcomes and reductions in healthcare services. Table 1-1 lists the project goals and corresponding objectives (a crosswalk of these goals and objectives to the research questions and hypotheses is available in Appendix C). To achieve the primary objective, a taxonomy (i.e., a classification system; see Appendix B for definitions) will be created and used to characterize a selected set of secure messages. Content analysis will assign taxa (i.e., taxonomic codes) to message content. A series of analyses will leverage those assigned codes to identify any associations between message content, patient outcomes, and healthcare utilization.

Table 1-1.

Project Goals and Objectives

Goals	Objectives
Create a taxonomy to classify secure message content	Develop a theory-based taxonomy to classify secure messages based on a literature review
Describe which patients and clinicians are using secure messaging based on taxa	Conduct descriptive analysis based on taxonomy of a sample of secure messaging, including frequencies by taxon and patient and clinical characteristics
Understand which types of secure messages, if any, are associated with changes in healthcare utilization and health outcomes among patients with hypertension and diabetes	• Analyze patient utilization of healthcare services associated with different message taxa • Analyze patient outcomes associated with different message taxa

This study will yield significant benefits, including:

- A validated, theory-based taxonomy with a theoretical basis that supports standardized analyses of message content and interpretation of impact based on message taxa;

- Opportunities for development of targeted interventions that encourage secure messaging adoption and use based on an understanding of different patient populations' use of secure messaging; and
- Information to support appropriate resource allocation to secure messaging response based on a clearer understanding of message types linked to improved outcomes and reduced healthcare utilization.

The final products of this research include three manuscripts ready to submit to peer-reviewed journals. Table 1-2 presents the research questions that will be addressed with this study and identifies in which of the proposed papers each question will be addressed; Appendix C displays the associated hypotheses for each research question and aligns the research questions with the study's goals and objectives. The first paper will describe the theoretical basis, development, and validation of the taxonomy. It will also present descriptive statistics of the patients and clinicians who exchanged secure messages by the taxonomy's categories (i.e., taxa; refer to Appendix B for a comprehensive list of definitions). The second paper will explore associations between the secure message taxa and patient healthcare utilization, using the significant patient and clinician characteristics identified during the Paper 1 analyses. The third paper will explore associations between the secure message taxa and patient health outcomes. Papers 2 and 3 will use linear regression to identify statistically relevant associations between secure message taxa and the outcomes of interest.

Table 1-2.

Research Questions for Each Proposed Paper

Research Questions	**Research Paper**
Among patients with hypertension and/or diabetes, does taxon use vary by patient demographic characteristics or clinician characteristics?	1
Which patient-generated and clinician-generated message taxa are associated with reduced office and/or emergency department visits, or improved medication adherence?	2
Which patient-generated and clinician-generated message taxa are associated with improved glycemic levels and blood pressure control?	3

1.3 Theoretical Basis

This study draws on the Uncertainty in Illness theory (UIT) (Mishel, 1988), Social Information Processing (SIP) theory (Walther, 1992a), the hyperpersonal model of computer-mediated communication (Walther, 1996), and the framework for clinician-patient communication and improved health outcomes (Street, Makoul, et al., 2009). Chapter 2 highlights the use of the UIT to frame the taxonomy; Chapter 3 leverages the UIT and other theories to demonstrate why message content should be associated with patient outcomes.

The UIT describes factors that contribute to a patient's uncertainty and coping strategies that might incentivize them to outreach to their clinician (Mishel, 1988). Computer-mediated communication theories (SIP and the hyperpersonal model) describe why technology-mediated communication such as secure messaging might appeal to patients and clinicians as a form of communication (Walther, 1992a, 1996). Finally, the context for the linkage between secure messaging and patient outcomes evolves from the Street, Makoul, et al. (2009) framework that describes how patient-clinician communication supports patients' health outcomes. Chapter 3 includes a conceptual model based on these theories that predicts which patient-initiated messages might indicate uncertainty and which types of clinician-generated responses might serve to reduce uncertainty. The model also identifies direct and indirect pathways to changes in patients' outcomes as a result of the electronic message communication.

1.4 Study Sample

This study will employ a non-experimental retrospective cohort design using a study population derived from patients of the Virginia Commonwealth University (VCU) Health System. The study population will include a stratified random sample of adult patients ($\geq$18 years) with diabetes, hypertension, or both conditions who had at least one ambulatory care visit per year between 2016 and 2018 and who were registered with the VCU Health patient portal. Patients who met the inclusion criteria will be stratified based on their use of secure messaging in the VCU Health patient portal. Because other studies have identified internet access as a mediator of SM use (Graetz, Gordon, Fung, Hamity, & Reed,

2016) and the available secondary data do not capture that information, the population will be limited to only those VCU Health patients who registered with the online patient portal. Analyses will also include information on the clinicians with whom the selected patients exchanged secure messages, to control for any potential confounders introduced by the clinicians' type or clinical specialty. All messages exchanged between the randomly selected patients and their clinicians during the 2017 calendar year will be included in this study.

1.5 Methodology

Content analysis—a systematic review of text that converts the narrative into codes that can be quantified and from which inferences can be made (Krippendorff, 2019)—is critical to measuring the levels of uncertainty within patient-generated messages and classifying clinicians' responses to those messages. Published research reported differences in secure message use by patient and clinician characteristics, although the findings were inconsistent across studies and those studies were based on message volume and thread intensity rather than message content. Some of these differences might be explained by exploring the types of content exchanged based on patients' and clinicians' characteristics. This will be accomplished in the Research Paper 1 by applying the taxonomic codes (i.e., taxa; refer to Appendix B for definitions) to the sampled messages using content analysis.

Taxa will be assigned to messages by two coders following a process described in Chapter 2. The first paper will include descriptive analyses of the patient demographics and health status, and clinician characteristics (e.g., type such as physician, medical assistant, advanced practice nurse; clinical specialty), associated with each taxon (i.e., a single taxonomic code).

The unit of analysis for all study analyses is the patient. Research Papers 2 and 3 will leverage the coded dataset to explore associations between message codes (i.e., taxa) and selected outcomes. These papers will use the aggregated counts for each taxon for the independent variables. Linear regression will identify associations between the frequency of secure message taxa and the outcomes of interest. The second paper's outcomes explore healthcare utilization, which will be captured in parallel with the secure messages (i.e., during 2017 calendar year) and include the number of office visits, number of emergency department visits, and medication possession ratio. More detail is provided on the methods for Research Papers 2 in Chapter 4.

Analyses for the third paper will examine whether there is an association between taxa and patient health outcomes (changes in glycemic levels among patients with diabetes or changes in diastolic or systolic blood pressure among patients with hypertension). The baseline measurement will be the last measured value taken in 2016; the outcome measure will be the first measured value taken in 2018. Additional detail on the methodology for this paper is available in Chapter 5.

1.6 Overview of Upcoming Chapters

The remaining chapters and content provide more detailed information about the background for the study and the proposed research. The chapters are ordered to provide context to each of the three proposed papers.

- **Research Paper 1: Taxonomy Development and Descriptive Statistics**: Chapter 2 describes the research paper's aims, research questions, and hypotheses. Also included in Chapter 2 is a literature review that shares information about what is currently known about secure messaging content and patients' and clinicians' use of secure messaging. The literature review is followed by the theoretical basis for the taxonomy. Chapter 2 concludes with a description of the taxonomy and proposed methodology for the content and descriptive analyses.
- **Theoretical Basis for Research Papers 2 and 3**: Chapter 3 describes in detail the theoretical basis for the second and third research papers, including content on uncertainty coping strategies, similarities between electronic and face-to-face communication, and the patient-centered communication framework.
- **Research Paper 2: Secure Messaging Taxa and Healthcare Utilization**: Chapter 4 will follow a similar format as Chapter 2, in that it leads with the study aims, research questions, and hypotheses, followed by a literature review on patient-clinician communication and associations between secure messaging and patients' use of healthcare services. The concluding methods section of Chapter 4

includes a description of the study's dependent and independent variables and the analytic methods proposed for use in the study.

- **Research Paper 3: Secure Messaging Taxa and Health Outcomes**: Chapter 5 describes the study aims, research questions, and hypotheses; and reviews the available literature on secure messaging use and patient health outcomes. Although much of the methodology is shared between the second and third research papers, Chapter 5 describes the dependent variables that are unique to this study and briefly reviews the shared methodology.

2. Research Paper 1: Taxonomy Development and Descriptive Statistics

2.1 Introduction

The goal of the first research paper is to describe the theoretical basis for the taxonomy and report on descriptive statistics associated with the taxa, or content codes (see Appendix B for definitions). Addressed through this work is the question: Among patients with hypertension, diabetes, or both conditions, does taxon (i.e., a single content code) use vary by patient or clinician characteristics? To address this question, this paper will describe the development of a theoretically-grounded taxonomy developed for this research. No published works to date used a theoretically-based taxonomy, yet theory provides the basis for associations, assumptions, and constraints for research (Bacharach, 1989). Content analysis will be used to assign taxa to message content of selected patient-initiated message threads, inclusive of both patient- and clinician-generated messages. The study's hypothesis is that use of taxa will vary by patient and clinician characteristics; descriptive statistics of taxa by patient and clinician characteristics will be reported (see Appendix C for a complete crosswalk of the study's goals, objectives, research question, and hypotheses).

This chapter describes the published literature and theoretical basis for the proposed research, as well as a description of the taxonomy rationale and the proposed methodology. Sections 2.2 and 2.3 describe who among patients and clinicians, respectively, are using secure messaging to communicate and how they are using it. Section 2.4 describes what is currently known about the content of secure messages being exchanged between patients and clinicians. The final sections describe the theoretical basis for the taxonomy (Section 2.5), the proposed taxonomy (Section 2.6), these study population (Section 2.7), the proposed methodology for the first research paper (Section 2.8), and study limitations (Section 2.9).

2.2 Patients' Use of Secure Messaging

Access to secure messaging frequently occurs via a patient portal in which patients log in using a unique user name and password to verify their identity. Patient portals have different functionalities, the availability of which vary by organization. In addition to secure messaging, patient portals may include medication refill requests, appointment scheduling, and laboratory results or other medical record viewing. Secure messaging was commonly identified as one of the most preferred patient portal functionalities among patients (Ralston et al., 2013; Robinson, Davis, Cronin, & Jackson, 2016).

Hoonakker et al. (2017) found that half of surveyed patients reported SM to be a facilitator in their efforts to communicate with their clinical team. Barriers to use included forgetting log-ins or passwords (Lam et al., 2013); doubts about the reliability of the messaging function or prior bad experiences (Wade-Vuturo et al., 2013); concern about imposing on clinicians' time (Sieck et al., 2017); and perceived resistance to use of messaging among clinical staff (Haun et al., 2014). Generally, however, patients reported satisfaction with secure messaging functionality (Haun et al., 2017; Houston et al., 2004; Lam et al., 2013; Liederman & Morefield, 2003; Rief et al., 2017).

Convenience was cited by many patients as a reason for using secure messaging (Haun et al., 2017; Nazi, 2013). Between one-quarter and half of patient-generated messages were sent after-hours and on weekends (Anand et al., 2005; Crotty et al., 2014; C.-T. Lin et al., 2005; North, Crane, Stroebel, et al., 2013). Other motivating factors reported by patients, in order of importance, included the ease with which they could make prescription refill requests, manage appointments, and receive test results; and the ability to ask medication and health-related questions (Haun, Patel, Lind, & Antinori, 2015). Patients reported that message responses were generally of higher quality and felt less rushed when compared to phone communication (Rief et al., 2017). Most patients adhered to secure message guidelines that stipulated the modality should only be used for non-urgent issues (C.-T. Lin et al., 2005; North, Crane, Stroebel, et al., 2013; Shimada et al., 2017).

Many patients expressed intention to send messages to their clinicians if given the opportunity (Haun et al., 2015; Schickedanz et al., 2013). In addition, patients seemed receptive to receiving and reading the messages sent to them: the vast majority of messages sent to patients were read within three days and fewer than five percent were not read within three weeks (Crotty et al., 2015). The majority of patients expressed few if any concerns about privacy (Seth, Abu-Abed, Kapoor, Nicholson, & Agarwal, 2016).

Most message threads—which includes the initiating message and all responses to that first message—were patient-initiated (i.e., the patient sent the first message; see Appendix B for definitions) (Chung et al., 2017; Harris et al., 2009; Zhou et al., 2010). While the median number of messages sent by patients ranged between 1.5 and 9.46 messages a year (Bergmo, Kummervold, Gammon, & Dahl, 2005; North, Crane, Chaudhry, et al., 2013; Shimada, Allison, Rosen, Feng, & Houston, 2016; Sittig, 2003; P. C. Tang, Black, & Young, 2006), some patients demonstrated higher message volume (the number of messages during the study period) and intensity (the number of threads sent during the study period). North, Crane, Chaudhry, et al. (2013) found 16 percent of patients sent more than five messages, four percent sent more than ten messages, and one percent sent more than twenty messages. Chung et al. (2017) noted that more than a quarter of patients sent five or more messages and that these heavy messaging users had more in-office visits than both secure message users with less frequent messaging habits and patients who did not use secure messaging. Long-term users of secure messaging were not different from patients with limited experience (North, Crane, Chaudhry, et al., 2013).

Clinicians' patterns of secure message communication had an impact on patients' use of the functionality: patients were more likely to initiate messages if their clinicians responded quickly and had a higher overall response rate (Wolcott, Agarwal, & Nelson, 2017). Patients whose clinicians initiated more message threads were also more likely to initiate their own threads. Trust in clinicians also increased the likelihood that Caucasian patients would use secure messaging, although this was not true among patients of other races or ethnicities (Lyles et al., 2013).

Crotty et al. (2014) found that most patient-generated messages were sent to patients' primary care clinicians. Within the primary care field, internal medicine and obstetrics and gynecology received the most messages (Cronin, Davis, et al., 2015). Clinical responses to patient-generated messages were frequently triaged through a clinical response team that might include nurses (registered, licensed practical, or advanced practice), physician assistants, pharmacists, and physicians (Heyworth et al., 2013; Ozkaynak et al., 2014; Wooldridge et al., 2016). Effective workflow design may be critical to gaining acceptance of SM among clinical teams, as workflows facilitating this team-based approach to response may be complicated and confusing (Wooldridge et al., 2016). For example, on some clinical response teams the nurses, physician assistants, and pharmacists responded to most of the messages and only sent messages with the most complex content to the teams' physicians (Garrido, Meng, Wang, Palen, & Kanter, 2014; Heyworth et al., 2013; Hoonakker et al., 2017; Wooldridge et al., 2016).

An observational study of primary care physicians found that half the studied population reported that SM improved their clinical workflow and reported positive perceptions about secure messaging's ability to reduce adverse drug events (Heyworth et al., 2013). A separate study, however, noted that more than half of the surveyed clinical response team cited a lack of usability in the response workflow and that the patient-clinician communication flow was more challenging following the introduction of SM (Hoonakker et al., 2017). In that same study, physicians were equally likely to report SM as both a barrier and facilitator to communication and information flow with patients. In contrast, non-physician clinic staff were more likely to report SM as a facilitator to communication and information flow with patients. Other benefits cited by clinicians included improvements in access, more direct and focused communication, improved efficiency including avoidance of phone tag, improved communication between visits, and improved patient engagement, satisfaction, and trust (Nazi, 2013; Wade-Vuturo et al., 2013). Clinicians did, however, note concerns over workload as SM use increased among patients (Nazi, 2013).

Consistent with the concern over work burden, the number of messages received by clinicians appears to have increased over time: a recent study indicated the daily number of messages received by clinical response teams averaged 4.8 messages (range 2-12) (Garrido et al., 2014), while older studies reported that clinicians received, on average, between 0.5 to 1.3 messages per day (Byrne, Elliott, & Firek, 2009; Sittig, 2003). Clinical teams sent an average of 5.6 messages a day (Garrido et al., 2014). Most responses were sent within a median range of 2.5 and 7.2 business hours from receipt of the initial message (North, Crane, Stroebel, et al., 2013; P. C. Tang et al., 2006). Estimates of the time needed to respond to patient messages ranged between 3.5 and 15 minutes (Anand et al., 2005; C.-T. Lin et al., 2005; Zhou et al., 2010); this time is not reimbursed by most health insurance plans. By estimating productivity in terms of Relative Value Units; however, physicians who used SM averaged 11 percent more visits and $95 a day more than their counterparts who did not use SM (Liederman, Lee, Baquero, & Seites, 2005).

In summary, less is reported about clinicians' use of SM compared to patients' use. Clinicians' use varies by clinician specialty; typically, messages are triaged so that only the most complex are responded to by physicians. Clinicians' use of secure messaging impacts patients' use so any research that explores associations between patient outcomes and SM should consider the impact of clinicians' characteristics in the analyses.

2.3 Secure Messaging Content

demonstrates how secure message use varies by patients' characteristics. Some of these differences may be mediated by internet access: Graetz et al. (2016) noted that statistical differences in age, income, and race, no longer existed after adjustment for internet access (denoted as asterisks in Clinicians' patterns of secure message communication had an impact on patients' use of the functionality: patients were more likely to initiate messages if their clinicians responded quickly and had a higher overall response rate (Wolcott, Agarwal, & Nelson, 2017). Patients whose clinicians initiated more message threads were also more likely to initiate their own threads. Trust in clinicians also increased the likelihood that Caucasian patients would use secure messaging, although this was not true among patients of other races or ethnicities (Lyles et al., 2013).

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In summary, less is reported about clinicians' use of SM compared to patients' use. Clinicians' use varies by clinician specialty; typically, messages are triaged so that only the most complex are responded to by physicians. Clinicians' use of secure messaging impacts patients' use so any research that explores associations between patient outcomes and SM should consider the impact of clinicians' characteristics in the analyses.

2.4 Secure Messaging Content

). Only differences in sex and education were positively associated with secure message usage after controlling for patients' access to the internet.

In summary, patients appreciated messaging functionality and found it useful. Published studies highlighted differences in use across a variety of patient characteristics, but those findings were not consistent across studies. Examining use by type of message content, as is proposed for Research Paper 1, may provide context to some of those differences.

2.5 Clinicians' Use of Secure Messaging

Most published literature explored the characteristics of the patients using secure messaging rather than clinicians' use; this section reviews what was published about clinicians' use of SM.

Table 2-1.

Patient Characteristics Associated with Secure Message Use

Patient Characteristic	**Positive Association with SM Use**	**References**
Age	Mixed results:	
	• Older patients	• Cronin, Davis, et al. (2015); P. C. Tang et al. (2006)
	• Younger patients*	• Chung et al. (2017); Graetz et al. (2016); Haun et al. (2015); North, Crane, Stroebel, et al. (2013); Price-Haywood, Luo, and Monlezun (2018); Shimada et al. (2016); Tarver et al. (2018); White, Moyer, Stern, and Katz (2004)
	• No association	• Wade-Vuturo et al. (2013)
Technology use	Computer use	Reed, Graetz, Gordon, and Fung (2015)

Education	Mixed results:	
	• No association	• Wade-Vuturo et al. (2013)
	• Higher levels of education	• Graetz et al. (2016); Haun et al. (2015); Tarver et al. (2018); White et al. (2004)
Health literacy	Mixed results:	
	• No association	• Haun et al. (2015)
	• Adequate health literacy	• Smith et al. (2015)
Home location	Urban location	Tarver et al. (2018)
Income	Mixed results:	
	• Higher income*	• Graetz et al. (2016); Haun et al. (2015); Price-Haywood et al. (2018)
	• No association	• Wade-Vuturo et al. (2013)
Health insurance	• Privately insured	• Price-Haywood et al. (2018); Shimada et al. (2016); Tarver et al. (2018)
	• Higher out-of-pocket expenses	• Reed et al. (2015)
Primary language	English speakers	Schickedanz et al. (2013)
Race	Mixed results:	
	• Caucasian*	• Chung et al. (2017); Cronin, Davis, et al. (2015); Haun et al. (2015); Masterman, Cronin, Davis, Shenson, and Jackson (2016); North, Crane, Stroebel, et al. (2013); Price-Haywood et al. (2018); Shimada et al. (2016)
	• Caucasian and Asian	• White et al. (2004)
	• Minority status	• Haun et al. (2015)
Sex	Mixed results:	
	• No association	• Haun et al. (2015); Wade-Vuturo et al. (2013)
	• Female	• Chung et al. (2017); Cronin, Davis, et al. (2015); Haun et al. (2015); North, Crane, Stroebel, et al. (2013); Price-Haywood et al. (2018); Reed et al. (2015); Shimada et al. (2016); Tarver et al. (2018)
	• Male	• Masterman et al. (2016); Smith et al. (2015)

*Mediated by internet access (Graetz et al., 2016)

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2.6 Secure Messaging Content

This section summarizes published findings about the content within the messages exchanged between patients and clinicians. A message thread (see Appendix B for definitions) is most comparable to a patient-clinician communication exchange held during an office visit. The number of secure message threads sent in a study period is referred to as intensity. Patients who used SM participated in an average of five threads (Chung et al., 2017). Most message threads were resolved within three days. Harris et al. (2009) best described message volume (defined as the number of messages sent during the study period), within their population: 96 percent of all threads contained fewer than five messages; less than one percent contained more than ten messages.

Individual messages were typically short. Patients' messages were generally longer (average 106-139 words) than clinicians' (average 39-64 words) (Alpert et al., 2017; Mirsky et al., 2016b; Roter et al., 2008; Sittig, 2003). Although the majority of clinician-generated messages were written on a reading level that was interpretable by the patient, almost three in ten threads included a clinical response that was more than three Flesch-Kincaid Grade Levels (FKGL) above the patient's (Mirsky et al., 2016b). Most communication was evaluated as formal, concise, and courteous (White et al., 2004). In contrast to office visits, patients were more likely to ask questions in SM communication than clinicians: fewer than 10 percent of clinician-generated messages included a question, while more than a quarter of patient-generated messages included at least one question (Roter et al., 2008).

P. C. Tang et al. (2006) evaluated whether physician responses to patient-initiated messages met CMS' criteria for Evaluation and Management (E&M) levels 2-4 reimbursement. Their analysis explored whether the messages included history-taking (e.g., chief complaint, review of body systems, and past medication history), medical decision, and diagnostic management options. The details of whether the evaluated messages included each of these components was not presented in their paper; rather, they noted that 22 percent met E&M level 2 criteria; none met levels 3 or 4 criteria. Overall, the majority (62 percent) of the medical decision-making required of clinicians when responding was deemed straightforward and most of the risk was minimal or low (Robinson, Valentine, Carney, Fabbri, & Jackson, 2017).

Twenty-one studies reported content analyses of secure messages; only one analyzed the association between the message content and healthcare utilization, and none examined the association between message content and patient health outcomes. Among the studies that did examine message content, there was inconsistent application of classification systems (i.e., taxonomies). Table 2-2 lists twenty of the publications that classified message content with a description of the reported categories. This list emphasizes the lack of taxonomic consistency that makes it difficult to compare findings.

Table 2-2.

Summary of Publications Reporting Classifications of Secure Messaging Content

Patient-Generated Message Taxa (% of messages, when available)	Clinician-Generated Message Taxa (% of messages, when available)	Reference
• RFI about medication/treatment (26%) • RFI about symptoms/diseases (22%) • RFA regarding medications/treatments (20%)	N/A	Sittig (2003) analyses of one-month of SM sent to five clinicians (no N provided)
• Schedule appointments (20%) • Refill medications (15%) • Medication questions (14%) • Test results request (12%) • Report feeling ill (8%) • Assistance interpreting test results (3%)	N/A	Ross, Moore, Earnest, Wittevrongel, and Lin (2004) analysis of 63 messages sent by 13 patients
• Information updates (41.4%) • Prescription renewal request (24.2%) • Health questions (13.2%) • Messages about medical tests (10.9%) • Referral requests (8.8%) • Other (thank you, apologies, nonmedical, study-related) (8.8%) • Appointment requests (5.4%) • Information seeking (4.8%) • Billing (0.3%)	N/A	White et al. (2004) analysis of a 10% sample of 3007 SMs sent by 1000 patient accounts (n=273)
• Medical questions (53%) • Medical update (25%) • Subspecialty update (11%) • Administrative request (11%)	• Medical guidance (63%) • Phone call (10%) • Prescription (16%) • Subspecialty reference (2%) • Administrative paperwork (5%) • Appointment (4%)	Anand et al. (2005) analyses of 81 messages to pediatricians, sent by pediatric patients' parents
• Health-related problem or test result request (46%) • Prescription refill (20%) • Appointment scheduling request (11%) • Sick note renewals (7%) • Referral request (2%) • Multiple requests (4%)	N/A	Bergmo et al. (2005) analyses of 147 messages; noted that 10% could not be classified
• Medication (24%) • Other medical question (15%) • General chronic symptom or health condition (12%) • Recent office visit (7%) • General adult symptom (5%) • 11 other taxa (each < 5%)	N/A	Liederman et al. (2005) provided frequencies based on patient selection of message meaning from drop-down list in patient portal (n=6,731)

• Administrative requests (42%)
  o Appointment request (50%)
  o Prescription refill (47%)
  o Referral request (8%)
• Clinical messages (58%)
  o Biomedical concern (42%)
	N/A	C.-T. Lin et al. (2005) review of 175 administrative requests and 239 clinical messages sent by 95 patients

Patient-Generated Message Taxa (% of messages, when available)	Clinician-Generated Message Taxa (% of messages, when available)	Reference
◦ Request test information (17%) ◦ Psychosocial concern (9%) ◦ Request test action (7%) ◦ Urgent message (3%) ◦ Medication question (1%)		
• Updates on clinical condition or simple questions about health (48%) • Questions about medications (19%) • Questions about test results (7%)	N/A	P. C. Tang et al. (2006) review of 120 patient-initiated medical advice messages
• Biomedical information • Lifestyle information • Questions • Administrative instructions • Emotionally responsive • Compliments • Criticisms • Social talk	• Biomedical information • Lifestyle information • Questions • Administrative instructions • Emotionally responsive • Compliments • Criticisms • Social talk	Roter et al. (2008) analysis of 74 messages generated by patients (n=40) and physicians (n=34)
• Medication renewal (33%) • Information update (19%) • Other (15%) • Medical tests (13%) • Healthcare question (12%) • Referral request (8%) • Urgent issue (1%)	N/A	Byrne et al. (2009) analysis of 200 randomly sampled messages
• Ongoing medical problem or care plan (75%) • Report change in condition (16%) • Discuss laboratory results (14%) • Discuss new condition (12%) • Discuss change in prescription dosing (11%) • Discuss need for new prescription (10%)	N/A	Zhou et al. (2010) analyses of 556,339 message threads with 630,807 messages
• General medical questions and medication management most common	N/A	Heyworth et al. (2013) identified these categories as part of an observational study of clinical SM workflow processes (n=42)
• Medication renewal, request, or question (37%) • Symptom (new or recurrent) (23%) ◦ New symptom with <24-hour duration (3%) ◦ New symptom with >24-hour duration, or recurrent symptom (20%) • Test requested, desired, or negotiation-ordered test (20%) • Medical question, additional information, or correction (7%) • Referral request (7%)	N/A	North, Crane, Stroebel, et al. (2013) coding of a random select of 323 SM

Patient-Generated Message Taxa (% of messages, when available)	Clinician-Generated Message Taxa (% of messages, when available)	Reference
• Acknowledgement or thanks (6%) • Request for form completion (5%) • >1 issue (9%)		
• Clinical information needs (12%) • Medical needs (72.1%) • Logistical needs (22%) • Social needs (23%) • Other (3%)	N/A	Cronin, Fabbri, Denny, and Jackson (2015) coding of 1,000 randomly selected patient SMs
• Administrative action (5%) • RFA: Appointments (7%) • RFA: Labs, x-rays, or other studies (13%) • RFA: Medication or treatment (7%) • RFA: Referral to other physicians/non-physicians (13%) • RFI: Appointment (2%) • RFI: Medications or treatments (5%) • RFI: Symptoms (9%) • RFI: Tests or diagnostic procedures (9%) • RFI: Third party payer (2%) • Other information requests (4%)	• Prescription • Appointment • Information/clarification • Medical guidance • Administrative paperwork • Phone call • Specialist consult • Unknown • Dosage change • Medical examination	Mirsky, Tieu, Lyles, and Sarkar (2016a) classified 56 SM requests from 22 patients; the clinician classifications apply to the actions taken in response to the patient requests
• Solution seeking • Expressions of concern • Administrative requests	• No patient-centered language (42%) • Partnership building (36%) • Supportive talk (22%)	Alpert et al. (2017) analyses of 58 SM threads; qualitative analysis of patient SMs only

• Medical needs (70%)
  o Appointments/scheduling (24%)
  o Problems (18%)
  o Prescriptions (16%)
  o Interventions (13%)
  o Tests (12%)
  o Follow-up (10%)
  o Personnel/referrals (6%)
  o Management (1%)
  o Medical equipment (<1%)
• Logistical needs (30.0%)
• Informational needs (15.4%)
• Social needs (12.4%)
	• Complexity of medical decision-making:
	  o Minimal (10.3%)
	  o Low (50.4%)
	  o Moderate (38.9%)
	  o High (0.03%)
		Robinson et al. (2017) coding of 500 SM threads between patients and surgeons; taxa are not mutually exclusive

• Medication renewal/refill (47%) • Scheduling (18%) • Medication issue (13%) • Health issue (13%) • Test result or issue (11%) • Referral (7%) • Administrative (6%) • 7 other taxa (each < 5%)	N/A	Shimada et al. (2017) analyses of 945 SMs
• Medical communications (72.4%) • Informational communications (12.4%) • Logistical communications (24.9%) • Social communications (27.9%)	N/A	Sulieman et al. (2017) coding of 3000 SMs as part of a gold standard data set; taxa are not mutually exclusive
• Health update (48.8%) • Requested information regarding treatment or care plans (22.5%) • Prescription refill (22.0%)	• Information provision (72.8%) • Giving care instructions or action steps (30.5%) • Orientation to procedures, treatments,	Hogan et al. (2018) analyses of 711 messages included in 384 threads sent by 292 patients and 205 clinicians

Patient-Generated Message Taxa (% of messages, when available)	Clinician-Generated Message Taxa (% of messages, when available)	Reference
• Symptoms information seeking (16.1%) • Test results information seeking (13.7%) • Proactive nature where patient took initiative to ask questions (23.9%) • Opinion seeking (15.5%) • Gratitude (7.0%) • Acknowledge receipt (1.6%)	or preventive behaviors (26.3%) • Information seeking (5.6%) • Ask about symptoms (3.3%) • Previous treatment plans (3.0%)	

RFA=Request for action; RFI=Request for information

The study that associated message content with healthcare utilization is not included in Table 2-2 because although it classified patient-generated message content, it was not based on a taxonomy; rather, the researchers used machine learning to identify frequently-occurring word clusters and associated those clusters with medication adherence (Yin et al., 2018). Yin et al. (2018) identified 200 clusters of words, ten of which were positively associated with patients' discontinuation of hormone therapy within the first five years of the regimen. Words were ranked by degree of similarity and clusters included terms such as (this list is not exhaustive) x-ray, marrow, ekg, echo; or diarrhea, headache, chills, and vomiting. As such, this study's findings represent a way to identify common language used by patients with a specific health condition relative to a specific treatment regimen and may not be generalizable to patients with other conditions or treatments.

Of the studies listed in Table 2-2, only six classified clinicians' responses (Alpert et al., 2017; Anand et al., 2005; Hogan et al., 2018; Mirsky et al., 2016a; Robinson et al., 2017; Roter et al., 2008). Two-thirds of those studies applied a taxonomy that specifically described clinicians' message content (Anand et al., 2005; Hogan et al., 2018; Mirsky et al., 2016a; Roter et al., 2008). The other two studies catalogued the degree to which the clinicians' responses included patient-centered communication and the level of medical decision-making involved in the response (Alpert et al., 2017; Robinson et al., 2017).

In addition to the taxonomies identified in Table 2-2, several studies included language indicative of a content analysis without an explicit description of such an analysis. For example, Crotty et al. (2014) noted that prescription and appointment message requests were excluded from their analysis, which indicates that they had some mechanism to elucidate message content. They did not, however, describe how they distinguished between those message types.

Two taxonomies were reported in multiple publications. The Taxonomy of Requests by Patients (TORP; see Appendix Table E- 1), created by Kravitz, Bell, and Franz (1999), was referenced by several studies, none of which applied the TORP in its entirety and most of which modified the taxonomy in some way (Anand et al., 2005; C.-T. Lin et al., 2005; Mirsky et al., 2016a, 2016b; Shimada et al., 2017; Sittig, 2003). The TORP was developed to classify patient telephone communications, which may be why the researchers did not use it as conceived but instead opted to use variations on its structure.

In contrast, researchers from Vanderbilt University Medical Center described a self-created "consumer health taxonomy" (Appendix Table E-2) used solely to classify secure messages (Cronin, Fabbri, et al., 2015; Robinson et al., 2016; Sulieman et al., 2017). Cronin, Fabbri, et al. (2015) reported the first use of this consumer health taxonomy and indicated that "two to three" individuals coded the initial set of 1000 messages (Cronin, Fabbri, et al., 2015, p. 1862); however, no information was provided on inter-rater reliability. Sulieman et al. (2017) reported that a 3000-message data set was coded using the consumer health taxonomy but similarly did not report on inter-rater reliability. Sulieman's work explored whether secure message coding could be automated using a form of natural language processing; in the discussion the researchers reported that a lack of precision in the informational classifier (under 50 percent) may indicate a need for improvements in the taxonomy.

In summary, secure message content was classified in a number of ways with few taxonomies being reused by other researchers, and none reused in their entirety. The majority of efforts to date focused on classifying patient-generated messages. Only one study associated outcomes with message content and did so using a machine-learning strategy specific to breast cancer rather than a theory-based taxonomy that might be applied to multiple health conditions.

2.7 Theoretical Basis for Taxonomy

Although the taxonomies reviewed in Section 2.4 shared some common themes, none had a theoretical basis. Theory provides rationale for the associations being explored in research and identifies constraints on researchers' assumptions. This study therefore leverages selected constructs from the Uncertainty in Illness Theory (UIT) to support its taxonomy development (Mishel, 1988). The taxonomy draws from the uncertainty antecedent constructs described in the UIT to identify secure messages that might be indicative of patients' uncertainty (Mishel, 1988).

This following sub-sections provide details about the constructs Mishel identifies as uncertainty antecedents—those factors that cause and influence patients' uncertainty in illness. These antecedent constructs are the basis around which the proposed taxonomy will identify content likely indicative of uncertainty. Mishel's theory includes other constructs to describe how the patient appraises uncertainty and copes with it; Chapter 3 discusses these in more detail. Only the UIT antecedent constructs are used to support the proposed taxonomy development. This section (Section 2.5) describes the selected UIT constructs; the following section (2.6) demonstrates how these constructs are applied to create the proposed taxonomy.

2.5.1 UIT introduction. The UIT was first published by Merle Mishel in 1988 (Mishel, 1988). The theory describes uncertainty as a cognitive state that occurs when patients are unable to make sense or find meaning in illness-related events. Mishel defines uncertainty as "the inability to structure meaning" around "what will happen, what the consequences of an event are, and what the event means" (Mishel, 1988, p. 225). She notes uncertainty may result from ambiguity in symptom manifestation, complexity of treatment or administration of care, unpredictability around the course of illness or illness severity, and lack of information about symptoms, diagnosis, treatment, prognosis, or other factors associated with the illness. Uncertainty is presented as a neutral cognitive state in the UIT, being neither good or bad, and is considered separately from emotions (McCormick, 2002; Mishel, 1988, 1990). Patients may opt to reduce uncertainty if they perceive it as a source of danger. If, however, the patient perceives it as an opportunity (e.g., an uncertain prognosis may offer hope), he or she may try to maintain the current state of uncertainty.

The theoretical basis of the UIT were works by Lazarus (1974) on stress and coping, in which uncertainty is identified as one source of stress; the eight dimensions of uncertainty identified by Norton

(1976); and finally, descriptions of uncertainty as a complex cognitive stressor (Bower, 1978; Lazarus, 1974; Shalit, 1977). Mishel refined the UIT in 1990 as the Reconceptualized Uncertainty in Illness Theory (RUIT) (Mishel, 1990). The RUIT addressed individuals with chronic illness: due to the long-term ongoing nature of chronic illness, an individual may experience uncertainty that infringes on other areas of his or her life. Studies of chronic patients found that over time, uncertainty remained high and relatively unchanged among patients with cancer and cardiovascular disease (Haisfield-Wolfe et al., 2012; Mast, 1998; Mauro, 2008; Parker et al., 2013; Suzuki, 2012; Wong & Bramwell, 1992). According to the RUIT, individuals managing continuous long-term uncertainty can modify their view of life and better manage the stressors, ambiguities, and unpredictability to achieve a new “steady state.” In this steady state, the patient’s uncertainty is better managed, and the patient feels a return to self-mastery relative to their condition.

The UIT components and constructs were not altered in the RUIT; rather, the interpretation of the adaptation construct was modified to reflect the chronic patient’s achievement of that new steady state. In studies on patients with hepatitis C and prostate cancer, for example, Bailey (2010; 2014) described different uncertainty trajectories among patients depending on how their condition progressed: a certain level of illness was maintained throughout the study period but uncertainty increased if the condition recurred and uncertainty decreased if better diagnostic tests were received than expected. Since the RUIT did not alter the original UIT constructs, the references throughout this paper will refer to the UIT.

Since their initial publication, the UIT and RUIT have been the theoretical basis for numerous studies. Although the primary condition studied is cancer (brain, breast, colorectal, gynecologic, prostate, renal, and head and neck) (Galloway & Graydon, 1996; Haisfield-Wolfe et al., 2012; L. Lin et al., 2015; Mishel & Sorenson, 1991; Parker et al., 2013; Suzuki, 2012), the theory has been used to support research on biliary cirrhosis, cardiovascular disease, Crohn’s disease, chronic obstructive pulmonary disease (COPD), diabetes, endometriosis, epilepsy, fibromyalgia, hepatitis C, human immunodeficiency virus infection (HIV), incontinent ostomy, menopause, multiple sclerosis, schizophrenia, spinal cord injury, and rheumatoid arthritis (Amoako, Skelly, & Rossen, 2008; Anema, Johnson, Zeller, Fogg, & Zetterlund, 2009; Baier, 1995; D. E. Bailey et al., 2010; J. M. Bailey & Nielsen, 1993; Brashers et al., 2003; Christman et al., 1988; Diiorio, Faherty, & Manteuffel, 1991; Hoth et al., 2015; Lasker, Sogolow, Olenik, Sass, & Weinrieb, 2010; Lemaire, 2004; Lemaire & Lenz, 1995; Mauro, 2008; Niv et al., 2017; Riemenschneider, 2015; Wineman, Durand, & Steiner, 1994).

Figure 2-1 depicts the UIT's three primary components, as well as the UIT's constructs. The components are: (1) factors that influence a patient's level of uncertainty (*antecedents*); (2) a patient's evaluation of uncertainty risk (*appraisal*); and (3) coping strategies to manage the uncertainty (*coping*). At a high level, patients' experiences of uncertainty regarding their illness (*stimuli frame*) are influenced by their cognitive capacity and supportive resources (*structure providers*). Patients then evaluate that uncertainty (*appraisal*) as either danger or opportunity. The result of that appraisal dictates which coping mechanisms and adaptation are appropriate.

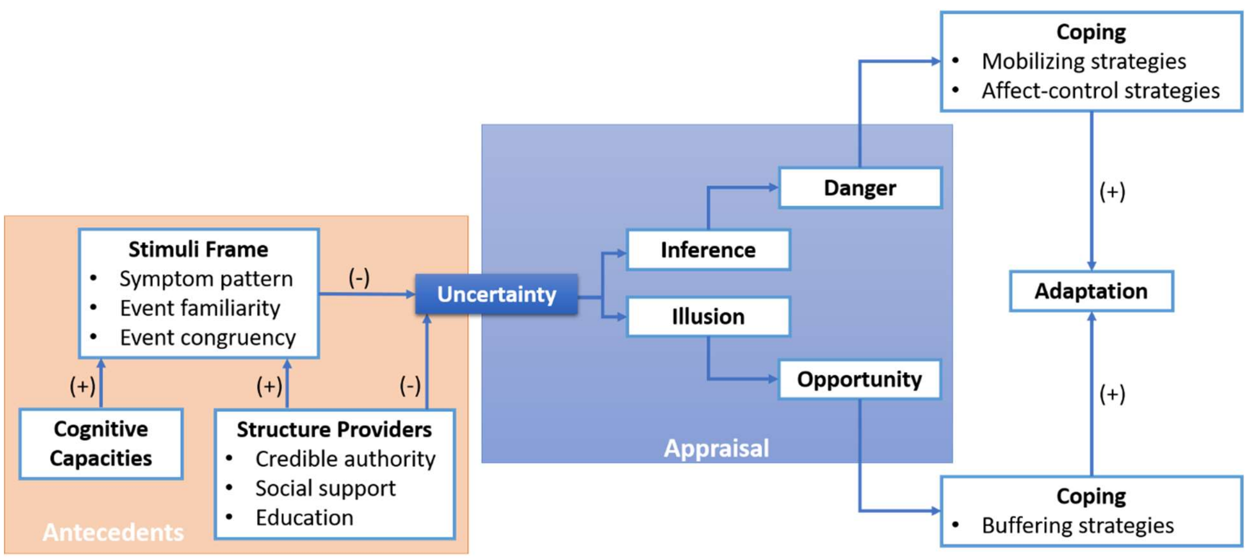

Figure 2-1. Mishel's Uncertainty in Illness Model

Note: The positive and negative symbols indicate the direction of the association between the constructs. Reprinted with permission from "Uncertainty in Illness," by M.H. Mishel, 1988, *Journal of Nursing Scholarship, 20,* p. 226. Copyright 1988 by John Wiley and Sons.

The focus of this study's taxonomy is to identify messages that might be indicative of patient uncertainty. As such, Mishel's uncertainty antecedents provide context to what factors contribute to patients' uncertainty during their illnesses. The theoretical focus of Research Paper 2 will therefore be on Mishel's uncertainty antecedents.

2.5.2 Uncertainty antecedents. Uncertainty antecedents—located on the left side of Figure 2-1—influence patients' degree of uncertainty. Table 2-3 lists the three uncertainty antecedent constructs, which include the stimuli frame and the patient's cognitive capacity and structure providers. Structure providers, defined as those factors that influence the patient's ability to process events in the stimuli frame, directly influence both uncertainty and the stimuli frame. Cognitive capacity, however, directly influences the patient's ability to understand factors in the stimuli frame. Each of these terms is also defined in Appendix B for reference.

Table 2-3.

Descriptions of Uncertainty Antecedents

Antecedent Primary Constructs	Description
Stimuli frame	Factors influencing patient's uncertainty: • Event congruency • Event familiarity • Symptom pattern
Cognitive capacity	Patient's ability to process information
Structure providers	Factors influencing patient's ability to process events in stimuli frame: • Education • Credible authority • Social support

2.5.2.1 Stimuli frame. The first of the three antecedent constructs is the stimuli frame, which encompasses the illness-related factors that foster uncertainty. These factors include symptom patterns, event familiarity, and event congruency. The patient's cognitive capacity and structure providers moderate the uncertainty that arises because of the stimuli frame factors. Table 2-4 describes the stimuli frame constructs at a high-level; further detail on each follows the table.

The first uncertainty antecedent within stimuli frame is symptom pattern. When symptoms conform to a pattern, there is less inconsistency that the patient must manage during their illness. Several studies reported a positive association between symptom pattern and uncertainty (more variability in symptom pattern meant more uncertainty) (Anema et al., 2009; Lemaire, 2004; Middleton, LaVoie, & Brown, 2012). Increased breathlessness among patients with COPD, for example, was associated with

Table 2-4.

Descriptions of Stimuli Frame Constructs

Stimuli Frame Constructs	Areas of Focus	Examples of Uncertainty Sources
Symptom pattern	• Can the patient identify a pattern among their symptoms? • Are the patient's symptoms inconsistent in appearance, severity, number, location, or duration? • Can the patient distinguish which symptoms are associated with a specific health condition?	• New symptoms • Absence of symptoms (e.g., patient is in remission or diagnosis is based solely on laboratory tests) • Symptoms flare or are exacerbated
Event familiarity	• Is the patient comfortable with the healthcare setting, situation, or treatment? • Is the event habitual? • Does the event contain cues that the patient can recognize? • Does the patient know the rules and routines for the treatment or procedure?	• New events • Complex events • Changes in routine
Event congruency	• Does the event conform to the patient's expectations?	Misalignment between expectations and reality

increased levels of uncertainty (Hoth et al., 2013).

A vague symptom pattern may make it difficult for a patient to understand whether, for example, a treatment is working because they cannot see clear evidence of the effects. Lack of clarity in the manifestation and association of the symptoms with the health condition, therefore, serves to increase uncertainty. A patient must also be able to differentiate symptoms from each other and be able to discern which symptoms are associated with their condition (Mishel & Braden, 1988). Among patients with more comorbid conditions and therefore a larger potential set of symptoms that must be monitored and aligned, uncertainty was higher (D. E. Bailey et al., 2010; D. E. Bailey et al., 2009). Patients' perception of their health status was negatively associated with uncertainty: among patients who reported better health, uncertainty was low (Heinrich, 2003).

The importance that patients place on a symptom may impact the level of uncertainty they experience. Symptom distress, which factors in not only the severity of the symptom but the importance the patient puts on the symptom, was positively associated with uncertainty among patients with head and neck cancers and endometriosis (Haisfield-Wolfe et al., 2012; Lemaire, 2004). When patients felt they understood their condition (i.e., perceived knowledge), they reported lower levels of uncertainty (Lemaire, 2004; Lemaire & Lenz, 1995)

The second concept within stimuli frame is that of event familiarity. Consistent with an inverse relationship between perceived knowledge and uncertainty, Mishel theorized that patients develop cognitive maps of their experiences. Patients minimize their uncertainty by aligning new events or routine changes with their cognitive map (Mishel, 1988, 2014; Mishel & Braden, 1988); unfamiliarity with surroundings results in an increase in uncertainty (Mishel, 1984). In a complex situation with many cues that the patient must process to understand the event, it is more likely that one or more of those cues will not conform to the patient's cognitive map, resulting in uncertainty.

Minimal research has been published on event familiarity and congruence, the third stimuli frame concept. Patients with HIV and diabetes reported their uncertainty rose when faced with insufficient information about medications and the management of complex treatment regimens that required multiple specifically timed medications (Brashers et al., 2003; Mason, 1985). A lack of information about what diagnostic tests are being performed, and why, also increases uncertainty: Mason (1985) found that one-quarter of patients with diabetes did not know why a laboratory test they were instructed to receive was necessary.

An imbalance between expectations and actual experience (event incongruence) may occur if a treatment is ineffective or when disease progression occurs at a faster or slower pace than the patient anticipates (D. E. Bailey et al., 2010; D. E. Bailey et al., 2014; Mishel, 1988). Differences between expectations and reality may cause the patient to question what they know and what they can anticipate, resulting in additional uncertainty. Patients with gestational diabetes and prediabetes, for example, reported uncertainty about the inevitability of their diagnosis—would it definitely progress, could they prevent it, and what was the difference in their diagnosis and everything they heard previously about diabetes (Middleton et al., 2012)? When reality and experience align, patients' sense of control improves, which is critical to patients with diabetes: three-quarters reported "controlling the disease" was the most difficult thing about living with diabetes, followed by "experiencing the disease" and "living with the disease" (Landis, 1996).

In summary, the UIT stimuli frame construct identifies the categories within which uncertainty may arise. These categories encompass patients' abilities to recognize patterns in their symptoms, be familiar with clinical events in which they are participating, and to align their expectations with reality. The proposed taxonomy should include taxa that support identification of content reflective of uncertainty arising from these stimuli frame constructs.

2.5.2.2 Cognitive capacity. Mishel identifies patients' cognitive capacity as the next construct to influence patients' uncertainty in illness. Cognitive capacity reflects patients' ability to process information (Mishel, 1988), and can be limited physiologically or by anything that may impact patients' ability to pay attention to details or cues in their environment. Cognitive capacity has an indirect impact on patients' uncertainty by affecting their perception of events in the stimuli frame (Mishel, 1988). Physical illness, medications, and pain can all limit patients' cognitive capacity, thereby decreasing their ability to process information and events.

Studies based on the UIT frequently examine factors such as fatigue, illness severity, and depression when exploring the association between cognitive capacity and uncertainty. Fatigue and depression have been found to have a positive association with uncertainty (D. E. Bailey et al., 2010; D. E. Bailey et al., 2009; Clayton, Dudley, & Musters, 2008; Hall, Mishel, & Germino, 2014; Hoth et al., 2015; Lasker et al., 2010; Mast, 1998; Webster, Christman, & Mishel, 1988).

The relationship between uncertainty and illness severity is less clear, possibly a factor of the different ways it was measured. Christman et al. (1988) and Webster et al. (1988) used the Peel Prognostic Index (PPI) to estimate illness severity among patients with recent myocardial infarction. The PPI considers not only the patient's age and sex, but also clinical factors relevant to the condition (e.g., degree of shock and heart failure, cardiac rhythm, and cardiographic changes). Neither study found an association between illness severity and uncertainty. Two studies that used a somewhat more subjective measure of illness severity, however, reported a positive association between illness severity and uncertainty (Chuang, Lin, & Gau, 2010; Mishel, 1984). The final study that explored illness severity and uncertainty used a single unvalidated survey question posed to elicit patient perception of illness severity; it did not identify an association between the two (Mishel, Hostetter, King, & Graham, 1984).

Too much information (i.e., information overload), as might occur in overly complex situations, can also negatively impact a patient's ability to process information because patients either cannot process all content, or they focus on one part of the information received without consideration of the remaining content. Conversely, stronger cognitive capacities improve patients' ability to process information, thereby influencing their ability to identify symptoms, understand events, and recognize cues (Zhang, 2017). It is unlikely that a taxonomy could capture content relative to a patient's cognitive capacity; this may need to be measured through covariates similar to what has been be used in other research (e.g., message reading level or patient's overall health status).

2.5.2.3 Structure providers. The final construct Mishel described as an uncertainty antecedent was structure providers (Mishel, 1988). Mishel identified three structure providers in UIT: education, social support, and credible authority. These structure providers are critical resources designed to improve patients' abilities to understand events in their stimuli frame, those factors that influence a patient's degree of uncertainty, (e.g., symptom pattern, event familiarity, and event congruency; see Appendix B for definitions of terms) (Mishel, 1988). Mishel defined credible authority as an individual with whom the patient trusts or has confidence (Mishel, 1988). Education, social support, and credible authority may either indirectly or directly impact uncertainty. Table 2-5 provides more context for each of the structure provider constructs. An indirect effect occurs when structure providers help patients identify symptom patterns and congruent events, or otherwise become familiar with event. Emotional support, however, is an example of the direct impact a structure provider might have on uncertainty.

Twelve of the sixteen studies that explored the relationship between uncertainty and patients' level of education found an inverse relationship between the two constructs (D. E. Bailey et al., 2010; Christman et al., 1988; Clayton et al., 2008; Kang, Daly, & Kim, 2004; Kazer et al., 2012; Lemaire & Lenz, 1995; Liao, Chen, Chen, & Chen, 2008; Mast, 1998; Mauro, 2008; Mishel & Braden, 1988; Sammarco & Konecny, 2008; Wallace, 2005). Christman's (1988) work, however, noted that the

Table 2-5.

Descriptions of Structure Provider Constructs

Structure Provider Constructs	Impact on Stimuli Frame	Mechanism to Impact Uncertainty
Education	Inverse association between education and uncertainty	Higher levels of education allow patients to recognize symptom patterns and event cues that align with cognitive maps
Social support	Potential for both positive and negative impacts on uncertainty	• May help patient recognize symptom patterns, work through event complexities, anticipate future events, provide financial support, assist with daily tasks with living • If illness is associated with stigma, uncertainty may increase because the patient does not know who can be informed of the illness (Brashers, Goldsmith, & Hsieh, 2002; Brashers, Hsieh, Neidig, & Reynolds, 2006; Mishel, 1999, 2014) • Uncertainty among caregivers and family members may have a negative impact on the patient (Mishel, 1999)
Credible authority	• Potential for both positive and negative impacts on uncertainty • Association may decline over time as patient becomes more familiar with chronic condition (Brashers et al., 2006; Mishel, 2014)	• Direct impact when the patient relies on the clinician to make treatment decisions and interpret symptom patterns for him or her (Mishel, 2014) • Indirect impact when clinician provides information that helps the patient better understand events in the stimuli frame: clinicians can help identify symptom patterns, can support event familiarity by being a consistent resource for information and support, and can develop event congruence by explaining what the patient might expect (Mishel, 1988) • Negative impact if a patient believes that the clinician is providing inaccurate or inconsistent information (Brashers et al., 2006) • Negative impact if clinician does not recognize a patient's request for information and does not provide the information being sought (Brashers et al., 2002).

association was no longer detectable four weeks after discharge among patients with myocardial infarction. Another study that explored the relationship over time noted no association either immediately after making the treatment decision or six weeks after treatment had concluded (Suzuki, 2012). Two studies that reported no association between education and uncertainty recruited from disease-specific national support groups with a high prevalence of educated members, which may have resulted in a more educated study population that limited their ability to measure a statistical difference (Lasker et al., 2010; Lemaire, 2004). Minimal information was available in the final study that found no association among hospitalized patients, beyond that it was measured between the third and fifth days of hospitalization (Mishel, 1984).

In addition to education, Mishel cited social support as a structure provider construct. Research has increasingly focused on supportive communication which, as MacGeorge, Feng, and Burleson (2011) described it, focuses on providing health-relevant information, motivating healthy behaviors, promoting self-esteem and self-care, and reducing emotional distress. Seven percent of patients with breast cancer reported that they sought information about self-care behavior from friends and family (Dodd & Mishel, 1988); a third of patients with diabetes noted that the most helpful factor in living with the condition was support from friends and family (Landis, 1996).

Supportive communication has been parsed into problem-focused and emotion-focused support (Goldsmith & Albrecht, 2011). Problem-focused support includes the provision of information or tangible aid, while emotion-focused support encompasses expressions of support, concern, belonging, esteem, and comforting. Controllable events may be more amenable to both problem-focused (e.g., information provision) and emotion-focused (e.g., reassurance of competence and ability, or expressions of caring) support, while uncontrollable events such as loss or a change in assets may benefit more from emotion-focused support. In the latter scenarios, only problem-focused support that provides tangible aid is beneficial (Cutrona, 1990).

Social support may be operationalized a number of ways: by the size of, and integration with, social networks or as perceived or enacted support (MacGeorge et al., 2011). Among research citing Mishel's work, positive social support was generally measured as the latter and was negatively associated with uncertainty. Social support metrics that were studied included the provision of affirmation and aid (Mishel & Braden, 1987), emotional support (Kang et al., 2004), intimacy and assistance (Diiorio et al., 1991), and length of time as a member of a support group (Lemaire, 2004). Two studies examined social network size and found an inverse association with uncertainty (Sammarco, 2001; Shaha, Cox, Talman, & Kelly, 2008).

There can, however, be negative impacts from social support. One patient with diabetes described the isolation and stigma he felt: "People look at you so funny. People look at you real strange when you use a needle. They don't understand, you know" (Chin, Polonsky, Thomas, & Nerney, 2000, p. 443). As expected from UIT, studies exploring the negative aspects of social support found that patients with these negative influences were more likely to experience uncertainty (Hoth et al., 2015; Lasker et al., 2010; Mishel, 1984; Mishel et al., 1984). The metrics for negative social support included poor family function and perceptions of criticism (Hoth et al., 2015), stigma (Lasker et al., 2010), and separation from family and isolation from others (Mishel, 1984).

The final construct within structure providers is that of credible authority. When researchers explored why a physician's patients with diabetes were not responding to treatment as he expected, they found that the physician's patients' understanding of diabetes differed from his, driven primarily by the physician's use of ambiguous terms that did not resonate with his patients (Mason, 1985). This concept is linked to the indirect influence of credible authority through the patient's stimuli frame and is supported by research conducted by Mishel and Braden (1988) that found an inverse relationship between credible authority and symptom pattern. Middleton et al. (2012) noted that among patients with diabetes, sources of uncertainty associated with the credible authority construct included receipt of ambiguous information and the perception that clinical thresholds (i.e., level of prediabetes or what is "healthy") were vague.

Several randomized controlled trials found that uncertainty was reduced when clinical staff provided educational materials and outreach to patients (Germino et al., 2013; Lemaire & Lenz, 1995; Ritz et al., 2000). These interventions focused on providing clear, and frequently personalized, information to patients. This is consistent with findings from Van Den Borne, Pruyn, and Van Den Heuvel (1987), who reported that patients receiving relevant information from their clinician reported lower uncertainty. Longer patient-clinician relationships (a proxy measure of trust) were associated with explanations that included both a technical and lay-person component to enhance understanding, as well as physician responses that were at a similar level of technicality to the patient's (Waitzkin, 1985).

In summary, the structure providers construct may have direct and indirect impacts on uncertainty. Structure providers, through information provision and social support, may help the patient better understand the factors that are the source of the uncertainty or the structure providers may provide direct support to the patient in better managing the uncertainty. If, however, a structure provider offers ambiguous information or negative support, then uncertainty may increase. The proposed taxonomy must therefore include taxa that classify clinicians' message content; these taxa should differentiate between content with the potential to positively or negatively impact patients' uncertainty levels. This may include, for example, the provision of (or lack thereof) information or positive or negative social support.

2.5.4.2 Summary of UIT antecedents. Mishel's UIT addresses the factors that influence patients' perception and ability to manage uncertainty, called uncertainty antecedents, as well as patients' evaluation of the uncertainty and subsequent coping strategies. The focus for Research Paper 1, however, is on the UIT's uncertainty antecedents, focusing on the stimuli frame, the factors related to patients' illnesses that influence uncertainty, including symptom patterns, event familiarity, and event congruence; patients' cognitive capacity, which influences patients' ability to understand the factors found within the stimuli frame; and patients' structure providers, which include supports that impact how patients process factors within the stimuli frame or influence patients' management of their illness. The proposed taxonomy will include taxa that allow for distinction within secure message content of those uncertainty antecedents.

2.8 Taxonomy Development

This section describes the basis for the proposed taxonomy, including its evolution from Mishel's UIT (1988) and incorporation of previously-published taxa (definitions of this and other terms available in Appendix B). Across the published research that reported a message content classification system (or taxonomy), most used different systems, limiting comparability. In addition, no published literature that reported a secure messaging taxonomy indicated a theoretical basis for the taxonomy. Since theory provides rationale for understanding the world and supports objectivity in research (Jaccard & Jacoby, 2010), it is critical that the concepts captured in any taxonomy are grounded in good theory. The theoretical basis for this taxonomy and research provides the framework for its associations, assumptions, and constraints (Bacharach, 1989). Because this study will not only apply a taxonomy to secure message content, but also ultimately explore associations between assigned taxa and patient outcomes, ensuring there is theory that supports the study's assumptions and conclusions should strengthen the conclusions arising from the research.

The proposed taxonomy will leverage common themes found within secure message taxonomies published to date. An extensive literature review was conducted to identify all published literature that described a classification for secure message content. The literature search identified all articles published through January 30, 2019 that included the phrase "secure messaging," excluding only those not written in English. Figure 2-2 shows the results of the literature search that yielded 194 articles. Twenty-one articles reported a taxonomy for secure messaging content, only one of those attempted to associate message content with healthcare utilization and none explored the association between message content and patient health outcomes. This proposed taxonomy differentiates itself from others in that it is theory-based, which as noted above, provides the rationale for why the associations might exist. Subsequent sub-

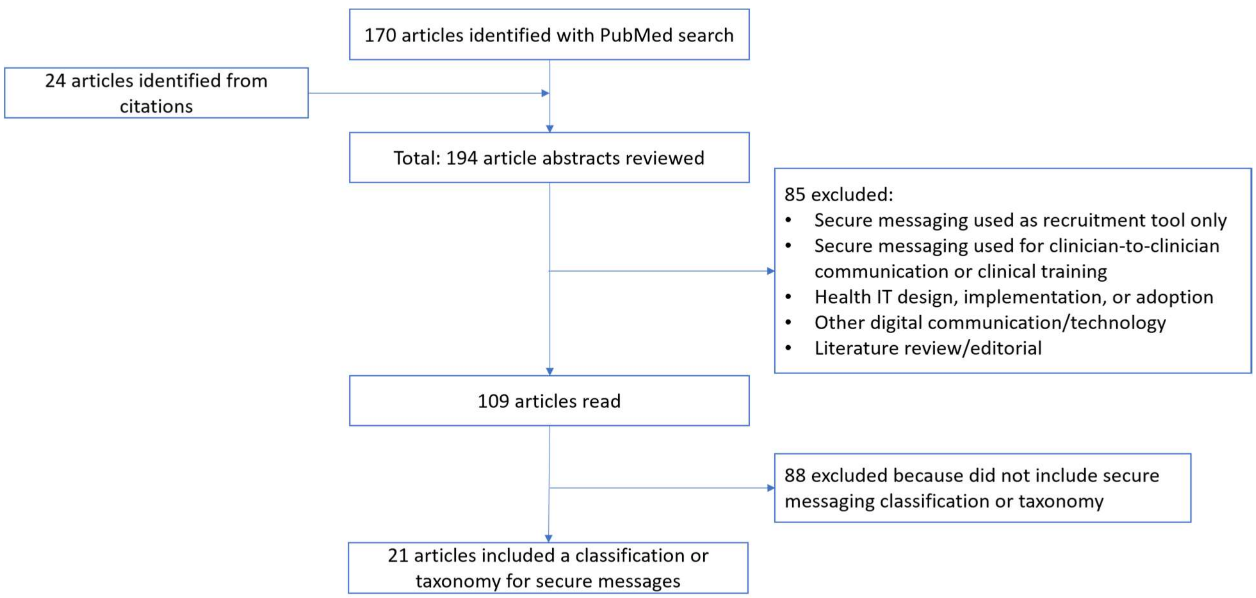

Figure 2-2. Literature Review of Published Secure Messaging Taxonomies

sections of this chapter describe the taxa developed for patient-generated content (Section 2.6.1), clinician-generated content (Section 2.6.2), and taxa categorizing content both patients' and clinicians' use of social communication (Section 2.6.3). A complete list of the taxa and their definitions is available in Appendix D.

2.6.1. Patient-generated content. This section describes the proposed taxa for patient-generated message content. Table 2-6 displays published taxa used to classify patient-generated content (excluding

Table 2-6.

Published Taxa for Patient-Generated Content

Information seeking	Information sharing	Task-oriented	Social Communication	Reference
• RFI about medication/treatment • RFI about symptoms/diseases	--	RFA: Medications/treatments	--	Sittig (2003)
• Medication questions • Test results request • Assistance interpreting test results	Report feeling ill	--	--	Ross et al. (2004)
• Health questions • Messages about medical tests* • Information seeking	Information updates	• Appointment requests • Billing • Messages about medical tests* • Prescription renewal request • Referral requests	Other (thank you, apologies, nonmedical, study-related)	White et al. (2004)
Medical questions	• Medical update • Subspecialty update	Administrative request	--	Anand et al. (2005)
Health-related problem or test result request	--	• Appointment scheduling request • Prescription refill • Referral request • Sick note renewals	--	Bergmo et al. (2005)
• Allergies* • Chronic pain* • Cold/flu* • Cough* • Depressive disorder* • General adult symptom* • General chronic symptom or health condition* • Headaches/migraines* • Hypertension* • Itching* • Lab or test result* • Medical procedure or operation* • Medication* • Other medical question* • Recent office visit* • Sinus pain or pressure*	--	Medication*	--	Liederman et al. (2005)
• Biomedical concern • Medication question • Request test information • Psychosocial concern • Urgent message*	--	Appointment request Prescription refill Referral request	--	C.-T. Lin et al. (2005)
• Simple questions about health • Questions about medications	Updates on clinical condition	--	--	P. C. Tang et al. (2006)

Information seeking	Information sharing	Task-oriented	Social Communication	Reference
• Questions about test results				
• Questions	• Biomedical information* • Lifestyle information*	Administrative instructions	• Emotionally responsive • Compliments • Criticisms • Social talk	Roter et al. (2008)
• Medical tests* • Healthcare question • Urgent issue*	• Information update	• Medical tests* • Referral request	--	Byrne et al. (2009)
• Discuss change in prescription dosing • Discuss laboratory results* • Discuss new condition* • Discuss need for new prescription* • Ongoing medical problem or care plan*	Report change in condition		--	Zhou et al. (2010)
• General medical questions • Medication management*	--		--	Heyworth et al. (2013)

• Symptom (new or recurrent)*
  • New symptom with <24-hour duration (3%)
  • New symptom with >24-hour duration, or recurrent symptom (20%)
• Medical question, additional information, or correction
	Medical question, additional information, or correction*	• Medication renewal, request, or question
		• Test requested, desired, or negotiation-ordered test
		• Medical question, additional information, or correction
		• Referral request
		• Acknowledgement or thanks
		• Request for form completion
			Acknowledgement or thanks	North, Crane, Stroebel, et al. (2013)

• Clinical information needs • Medical needs • Logistical needs*	--	• Medical needs • Logistical needs*	Social needs	Cronin, Fabbri, et al. (2015)
• Other information requests • RFI: Appointment • RFI: Medications or treatments • RFI: Symptoms • RFI: Tests or diagnostic procedures • RFI: Third party payer	--	• Administrative action • RFA: Medications or treatments • RFA: Lab tests, x-rays, or other studies • RFA: Referral to other physicians or non-physicians • RFA: Appointment	--	Mirsky et al. (2016a)
• Solution seeking	--	Administrative requests	Expressions of concern	Alpert et al. (2017)
• Follow-up* • Informational needs • Interventions* • Logistical needs • Prescriptions*	--	• Appointments/scheduling • Prescriptions* • Tests* • Personnel/referrals	Social needs	Robinson et al. (2017)

Information seeking	**Information sharing**	**Task-oriented**	**Social Communication**	**Reference**
• Problems • Tests*		• Management • Medical equipment*		
• Health issue • Medication issue • Test result or issue	• FYI informing • Self-reporting	• Scheduling • Referral • Administrative • Medication renewal/refill • MHV/SM technology-related	• Appreciation • Complaint • Life issue	Shimada et al. (2017)
• Informational communications* • Logistical communications* • Medical communications*	--	Logistical communications*	• Social communications	Sulieman et al. (2017)
• Symptoms information seeking • Test results information seeking* • Opinion seeking • Proactive nature where patient took initiative to ask questions • Requested information regarding treatment of care plans	Health update	• Prescription refill • Test results information seeking*	Gratitude	Hogan et al. (2018)

*Note: There is insufficient information to know definitively to which information exchange taxa this classification belongs; the default was information seeking. FYI=For your information; MHV=MyHealthyVet; RFA=Request for action; RFI=Request for information.

the Yin et al. (2018) for reasons noted in Section 2.4), separated into the proposed Level 1 taxa (i.e., highest level taxa in the taxonomy) as represented in the column headers of Table 2-6 and described in more detail following the table. *Social communication* is a Level 1 taxon used to classify both patient- and clinician-generated content and therefore has its own section (2.6.3).

Mishel (1988) classifies antecedents to patients' uncertainty into three categories: the stimuli frame, patients' cognitive capacity, and structure providers (see Appendix B for definitions). Mishel's stimuli frame includes factors that directly influence the patient's uncertainty experience and include the ability of patients to recognize a symptom pattern, be familiar with clinical events, and align their expectations of results, procedures, and health status with what they are currently experiencing. Structure providers such as a credible clinical authority may help patients by providing information when they experience uncertainty in their illness (Mishel, 1988). Patients may outreach to clinicians seeking information; therefore, the Level 1 taxon that primarily identifies patient uncertainty is *Information* *seeking*. The stimuli frame constructs (i.e., symptom pattern and event familiarity and congruity) will be captured in *Information seeking* sub-taxa and are described in Section 2.6.1.1.

The proposed taxonomy must also incorporate taxa that identify message content not indicative of patient uncertainty. Mishel noted that patients with chronic conditions may adapt to some illness uncertainty (Mishel, 1990). For those with chronic conditions, adapting to an illness might include routine care management, such as scheduling appointments, medication refills, and other administrative functions. These functions primarily focused on action, or task-oriented, requests the patients to their clinical team, and are represented by another Level 1 taxon, *Task-oriented.* There is a possibility that such task-oriented actions are the result of uncertainty: a request for an appointment, for example, could be for either a new condition or a routine follow-up. The Level 1 *Task-oriented* taxon therefore encompasses sub-taxa that will allow for differentiation of those task-oriented activities likely indicate uncertainty. Section 2.6.1.2 describes the sub-taxa that classify content around patients' different *Task-oriented* action requests.

Together, Sections 2.6.1.1 and 2.6.1.2 include the taxa that permit identification of content likely representative of patients' uncertainty in illness (or lack thereof). Appendix D lists all proposed taxa and shows the proposed alignment of each with their representation of uncertainty.

2.6.1.1 Identifying uncertainty antecedents within information seeking content. This section describes how the proposed taxonomy captures the symptom pattern, event familiarity, and event congruity constructs from the UIT stimuli frame within the *Information seeking* Level 1 taxon. Consistent with the UIT, the proposed taxonomy has taxa for symptom-related questions (e.g., new, persistent, or absent symptoms, or a change in symptom severity) to correlate with the symptom pattern construct; questions related to healthcare delivery (e.g., setting, situations, treatments), and rules and routines associated with treatments or procedures to correlate with the event familiarity construct; and questions about expectations or next steps to correlate to the event congruity construct (Mishel, 1988). Half of the published studies included taxa that were so broad in scope that they likely encompassed questions about all three stimuli frame constructs (e.g., health questions, medical questions, health-related problem, informational needs, informational communications) (Anand et al., 2005; Bergmo et al., 2005; Cronin, Fabbri, et al., 2015; Robinson et al., 2017; Roter et al., 2008; Shimada et al., 2017; Sulieman et al., 2017; P. C. Tang et al., 2006; White et al., 2004; Zhou et al., 2010). The proposed taxa, however, are designed to distinguish these constructs through name and definition.

Of the UIT stimuli constructs, the symptom pattern construct appeared most commonly among the published taxonomies (Mishel, 1988). Seven published taxonomies had at least one taxon specifically related to symptoms (Heyworth et al., 2013; Hogan et al., 2018; Liederman et al., 2005; C.-T. Lin et al., 2005; Mirsky et al., 2016a; North, Crane, Stroebel, et al., 2013; Sittig, 2003); only three studies did not include taxa that could be reliably considered to classify content related to patient information-seeking about symptoms (Alpert et al., 2017; Byrne et al., 2009; Ross et al., 2004). Of the seven with a symptom-related taxon, two used taxa that were more specific than a general symptom taxon: Liederman et al. (2005) opted for taxa for a variety of specific conditions and North, Crane, Stroebel, et al. (2013) created separate taxa for new symptoms of varying durations.

For the proposed taxonomy, the taxon that captures the UIT symptom pattern construct will leverage the simplicity seen in the taxonomies by Sittig (2003), Mirsky et al. (2016a), and Hogan et al. (2018). Patient-generated *Information seeking/Symptoms or condition* message content is defined as seeking information about the presence or absence of symptoms, symptom duration, symptom severity (increasing or decreasing), or other questions about the relevance of symptoms specific to a health condition, including questions related to symptoms associated with side effects of medications, treatments, or procedures.

The next two stimuli frame constructs incorporated into the proposed taxonomy are event familiarity and event congruity. These constructs speak to the degree to which the patient is familiar with the healthcare setting, situation, or treatment and whether the event conforms to the patient's expectations (Mishel, 1988). Sulieman et al. (2017), Robinson et al. (2017), and Cronin, Fabbri, et al. (2015) report a "logistical needs" taxon to classify such message content from patients. Other researchers published taxa that could be interpreted as a patient requesting information about clinical events or requesting an action from the clinician. An example of this is the "test result or issue" taxon, which could be interpreted either as a request for a test result or a question about the test process (Byrne et al., 2009; Mirsky et al., 2016a; Ross et al., 2004; Shimada et al., 2017). To allow for differentiation between requests for action (e.g., request for test results) and requests for logistical information about a clinical event (e.g., what is needed to prepare for the test), the proposed taxonomy includes an *Information seeking/Logistics* taxon defined as questions about medication or other treatment management (e.g., change in prescription, medication dosage), clinical processes, healthcare settings, or a patient's care plan; this taxon includes questions regarding why the test is being performed or the medication is necessary, how to prepare for the test or procedure upcoming diagnostic procedures; how to interpret laboratory results; and what routine is needed for the medication or treatment.

Table 2-7 lists the *Information seeking* sub-taxa and their definitions. Both taxa classify content reflective of patient uncertainty.

Table 2-7.

Taxa that Classify Information Seeking Patient-Generated Content

Level 2 Taxon	Definition
Logistics	Questions about medication or other treatment management (e.g., change in prescription, medication dosage), clinical processes, how to interpret laboratory results, healthcare settings, or a patient's care plan; questions regarding why the test is being performed or the medication is necessary; how to prepare for the test or procedure upcoming diagnostic procedures, or what routine is needed for the medication
Symptoms or condition	Questions to clinicians about the presence or absence of symptoms, symptom duration, symptom severity (increasing or decreasing), or other questions about the relevance of symptoms specific to a health condition, including questions related to symptoms associated with side effects of medications, treatments, or procedures

2.6.1.2 Task-oriented taxa to characterize patients' uncertainty. Unlike *Information seeking* taxa, the *Task-oriented* taxa are intended to differentiate between content that reflects patient uncertainty and content that reflects when a patient may have achieved adaption (i.e., managed uncertainty). Lee and Zuercher (2017) noted that many task-oriented secure messaging actions replaced functionality previously conducted by phone (e.g., scheduling appointments and refill and referral requests). This is reflected in the fact that the majority of previously published taxonomies include requests for both information and action (Alpert et al., 2017; Anand et al., 2005; Bergmo et al., 2005; Byrne et al., 2009; Cronin, Davis, et al., 2015; Hogan et al., 2018; Liederman et al., 2005; C.-T. Lin et al., 2005; Mirsky et al., 2016a; North, Crane, Stroebel, et al., 2013; Robinson et al., 2017; Roter et al., 2008; Shimada et al., 2017; Sittig, 2003; Sulieman et al., 2017; White et al., 2004). Thus, the *Task-oriented* taxon is defined as requests for tasks to be completed (e.g., action on the part of the clinician or clinical staff, such as an appointment or referral request) and corresponding responses.

Task-oriented requests indicative of routine care management are less likely to reflect patient uncertainty. Published literature identified several taxa for routine self-management activities, including medication refills and renewals, referrals, and scheduling. Of those, only the taxon for medication refills can definitively be interpreted as routine self-management; therefore, the proposed taxonomy includes a *Task-oriented/Medication refills and renewals request* taxon.

According to the UIT, new conditions and changes in condition are likely associated with changes in the patient's stimuli frame and are therefore likely associated with increased uncertainty (Mishel, 1988). Requests for a change in medication or a new medication might be an indication of a change in condition with corresponding uncertainty. A taxon that captures that content separately is therefore necessary (*Task oriented/New or change medication request).* Similarly, requests by a patient for a referral to another provider likely indicate a change in condition or healthcare experience, or a new condition, and must be separately identified in the taxonomy (*Task-oriented/Referral requests*).

Depending on the context, scheduling could be reflective of routine self-management, a new condition, or a change in condition. Therefore, three *Task-oriented* sub-taxa will address the different scheduling needs: *Scheduling request/New condition or symptom*; *Scheduling request/Follow-up*; and *Scheduling request/Preventive care or physical exam*. The latter two sub-taxa are likely reflective of routine self-management and are therefore unlikely to be associated with uncertainty, but an appointment request for a new condition or symptom indicates a change in the patient's stimuli frame and likely corresponding increases in uncertainty. Finally, the proposed taxonomy includes classifications for appointment maintenance activities: *Scheduling request/Reschedule* and *Scheduling request/Cancellation*. These are not expected to be associated with patient uncertainty.

At least two taxonomies included taxa associated with patients' requests for laboratory testing or other diagnostic procedures (Mirsky et al., 2016a; North, Crane, Chaudhry, et al., 2013). The taxon to capture this content is *Scheduling request/Laboratory test or diagnostic procedure*, defined as a patient requesting the clinician to put in an order for a laboratory test or diagnostic procedure (e.g., x-ray, ultrasound). This type of request may be indicative of a change in the patient's condition or reflective of routine testing; without additional context it will be difficult to know if uncertainty is represented within this taxon.

Published taxonomies also classified other administrative actions not captured in the above-mentioned taxa. A sub-taxon, *Task-oriented/Other administrative,* will therefore capture activities inclusive of requests for sick notes, contact information, medical records, patient portal access, or information about billing or insurance. Also within this category are technology-related questions related to interfacing with the patient portal or other patient-facing technology. Content captured in the *Task-oriented/Other administrative* taxon is not anticipated to reflect patient uncertainty.

In summary, the *Task-oriented* taxa listed in Table 2-8 classify patient-generated content represent taxa that classify both routine care management functions and patient uncertainty (the full list of taxa and their definitions is included in Appendix D). These taxa have been created to differentiate between those two states as much as possible.

2.6.1.3 Classifying patient information sharing content. There will be times when patients share information with their clinicians that is not indicative of uncertainty; this section describes taxa that classify that content. For example, patients share information about their symptoms when clinicians ask questions about patients' conditions. Mishel noted that trust is an important component of the relationship between patients and their structure providers, including their credible clinical authority (Mishel, 1988; Mishel & Braden, 1988); and Street, Makoul, et al. (2009) note that communication between patient and

Table 2-8.

Taxa to Classify Task-Oriented Patient-Generated Content

Level 2 Taxon	Level 3 Taxon	Definition
Medication refills and renewals requests	--	Request for medication refill or renewal
New or change medication request	--	Request for a new medication or switch to a different medication
Other administrative	--	Requests for sick notes, contact information, medical records, patient portal access, or information about billing or insurance; technology-related questions related to interfacing with the patient portal or other patient-facing technology
Referral requests	--	Request for referral to other healthcare facility or clinician
Scheduling request	Cancellation	Request that scheduled appointment be cancelled
Scheduling request	Follow-up	Request for an appointment relative to an existing health condition
Scheduling request	Laboratory test or diagnostic procedure	Request for a laboratory test or diagnostic procedure (e.g., x-ray, ultrasound) order
Scheduling request	New condition or symptom	Patient request for an appointment relative to a newly identified health condition or new symptom for existing condition; new patient appointment; or clinician requests patient make appointment
Scheduling request	Preventive care or physical exam	Request for a preventive care or routine physical exam
Scheduling request	Reschedule	Request for appointment to be changed to another date or time

clinician must support a trusted exchange of information to be effective. Patients' sharing of information with their clinician may be indicative of such trust.

There are contexts in which a clinician requests additional information from the patient in order to appropriately respond to the patient's request for action or information (e.g., a patient requests a medication refill and the clinician follows up with a question to determine if the patient's condition has changed); therefore, a separate Level 1 taxon for *Information sharing* permits classification of content in which the patient responds to a clinical request for information or is otherwise sharing information with the clinician in ways not associated with *Information seeking* content. The *Information sharing/Response to clinician's message* taxon is defined as the patient reporting symptoms or condition status in response to a clinical question or otherwise responding to clinician's comment in preceding message. The *Information sharing* taxa will not be applied when the message includes *Information seeking* content.

Ten published taxonomies included an *Information sharing* category for patient-generated messages (Anand et al., 2005; Byrne et al., 2009; Hogan et al., 2018; North, Crane, Chaudhry, et al., 2013; Ross et al., 2004; Roter et al., 2008; Shimada et al., 2017; P. C. Tang et al., 2006; White et al., 2004; Zhou et al., 2010). These taxonomies included taxa for self-reporting, medical and subspecialty updates, and health status updates; therefore, in addition to the *Information sharing/Response to clinician's message* taxon, the proposed taxonomy includes two additional *Information sharing* sub-taxa: *Self-reporting* and *Clinical update.* These sub-taxa are defined first by the fact that the patient shares information with the clinician that may not require immediate action or a response. The *Information sharing/Self-reporting* sub-taxon is further defined to include messages where the patient reports self-measured biomedical results (e.g., home monitoring of blood glucose or blood pressure) not in response to a clinical question. This is differentiated from the *Information sharing/Clinical update* sub-taxon for patient-generated messages, wherein patients report results of clinical tests, procedures, or outcomes of visits with a different clinician or healthcare facility.

Table 2-9 lists the three taxa associated with the *Information sharing* Level 1 taxon (a full list of taxa is included in Appendix D). The *Information sharing* sub-taxa allow for differentiation between potentially unsolicited information (*Self-reporting* and *Clinical update*) and *Information sharing* in response to a clinician's question (*Response to clinician's message*). It is unlikely that these sub-taxa alone could classify message content reflective of patient uncertainty.

2.6.1.4 Summary. In summary, not all patient-generated message content will reflect patient uncertainty. The taxa listed in the preceding sub-sections are designed to distinguish between content that may indicate the patient is uncertain in their illness and content that is less likely to be indicative of uncertainty. Appendix D lists these taxa and their theorized associations with uncertainty.

2.6.2. Clinician-generated content. In contrast to Section 2.6.1 that described proposed taxa for application to patient-generated content, this section proposes taxa for classifying clinician-generated

Table 2-9.

Taxa to Classify Patient-Generated Content Representing Information Sharing

Level 2 Taxon	Definition
Clinical update	Patient sharing information with clinician that does not require immediate action; includes reporting results of clinical tests, procedures, or outcomes of visits with a different clinician or healthcare facility
Response to clinician's message	Patient reporting symptoms/condition status in response to a clinical question, providing an update to clinician, or otherwise responding to clinician's comment in preceding message; does not include information seeking content,
Self-reporting	Patient sharing information with clinician that does not require immediate action; includes messages where patient is reporting self-measured biomedical results not in response to a clinical question

content. According to Mishel (1988), uncertainty is impacted by credible authorities (see Appendix B for definitions) in both direct and indirect ways. Credible clinical authorities directly impact patients' uncertainty when they make treatment decisions and interpret symptoms patterns for patients (Mishel, 2014); by providing information about the context of a situation or symptom, the credible clinical authority helps a patient make sense of a situation that is causing uncertainty, thereby indirectly impacting the patient's uncertainty. Brashers et al. (2002) noted that uncertainty can be increased if a clinician does not recognize a patient's request for information or does not provide the information requested. It is therefore important to understand whether a clinical response aligns with a patient's *Information seeking* request. A single taxon that captures clinical responses is unlikely to allow for those distinctions.

Table 2-10 lists the taxa assigned to clinician-generated messages for published studies. Only Roter et al. (2008) and Mirsky et al. (2016a) included taxa that differentiated between the types of information-sharing provided by clinicians; Roter (2008) identified "biomedical information," "lifestyle information," and "administrative instructions" as taxa for information sharing while Mirsky used "information/clarification" and "medical guidance" taxa. In contrast, the Anand et al. (2005) and Hogan et al. (2018) taxonomies used a single taxon that encompassed all types of information sharing by the clinician (medical guidance and information provision, respectively).

If defined appropriately, the "medical guidance" taxon reported by Mirsky et al. (2016a) and Anand et al. (2005) is appropriate for capturing the direct impact clinicians might have on patient

Table 2-10.

Prior Published Taxonomies of Clinician Secure Messages

Taxa Assigned to Clinician-Generated Messages		Reference
• Medical guidance	• Subspecialty reference	Anand et al. (2005)
• Phone call	• Administrative paperwork	
• Prescription	• Appointment	
• Biomedical information	• Emotionally responsive	Roter et al. (2008)
• Lifestyle information	• Compliments	
• Questions	• Criticisms	
• Administrative instructions	• Social talk	
• Prescription	• Phone call	Mirsky et al. (2016a)
• Appointment	• Specialist consult	
• Information/clarification	• Unknown	
• Medical guidance	• Dosage change	
• Administrative paperwork	• Medical examination	
• No patient-centered language	• Supportive talk	Alpert et al. (2017)
• Partnership-building		
• Complexity of medical decision-making: minimal, low, moderate, high		Robinson et al. (2017)
• Information provision	• Information seeking	Hogan et al. (2018)
• Giving care instructions or action steps	• Ask about symptoms	
• Orientation to procedures, treatments, or preventive behaviors	• Previous treatment plans	

uncertainty (e.g., making treatment decisions, helping patients interpret their symptoms). The proposed *Information sharing/Medical guidance* taxon is therefore designed to capture content that could directly impact patients' uncertainty and is defined as clinicians providing treatment decisions, giving care instructions, or instructing the patient on the best next steps in his or her care plan, providing information on symptoms or the patient's health condition, and interpreting laboratory or diagnostic procedure results. This definition incorporates Hogan et al.'s (2018) "giving care instructions or action steps" taxon, and will capture clinical responses aimed at directly impacting patients' uncertainty or supporting the patient's assessment of uncertainty related to the symptom pattern construct.

Credible clinical authorities also indirectly impact patients' uncertainty by providing them with information so that patients can familiarize themselves with upcoming clinical events (Mishel, 1988). The *Information sharing/Orientation to procedures, treatments, or preventive behaviors* leverages Hogan et al.'s (2018) taxon of the same name and captures clinical responses aimed at indirectly impacting uncertainty arising from the event familiarity and congruence constructs. Its definition includes clinical responses that explain what a patient might expect during a treatment or diagnostic procedure, or in a new healthcare setting or situation.

The *Information sharing/Medical guidance* and *Information sharing/Orientation to procedures, treatments, or preventive behaviors* taxa classify content in which a clinician shares information that may manage patient uncertainty. If the clinician is unable or unwilling to provide a response via secure messaging (e.g., defers to another clinician or a later date), then there is no information sharing. This proposed taxon—*Information sharing/Deferred*—is defined as clinician responses that refer the patient to another clinician for a response or postpone an answer pending additional clinical information (e.g., wait for laboratory test results). Finally, a clinician may decide, based on the information shared by the patient that the patient must be seen in-person by a clinician and recommend that the patient schedule an appointment. This type of response is captured by *Task oriented/Recommendation to schedule appointment*. Table 2-11 lists these taxa and their associated definitions; a complete list of taxa and their definitions is provided in Appendix D.

Table 2-11.

Clinician-Generated Information Sharing and Task-Oriented Taxa

Level 1 Taxa	**Level 2 Taxa**	**Definition**
Information sharing	Deferred	Clinical responses that refer the patient to another clinician for a response, postpone an answer pending additional clinical information (e.g., wait for laboratory test results)
Information sharing	Medical guidance	Clinician provides treatment decisions, gives care instructions, informs the patient on the best next steps in his or her care plan, interprets diagnostic procedure or laboratory results, or provides information on symptoms or the patient's health condition
Information sharing	Orientation to procedures, treatments, or preventive behaviors	Clinical responses that explain what a patient might expect during a treatment or diagnostic procedure, or in a new healthcare setting or situation
Task-oriented	Recommendation to schedule an appointment	Clinician suggests that patient schedule an appointment

Communication between patient and clinician does not solely focus on areas of uncertainty and there are instances when information sharing is not an appropriate response. For example, the TORP (Appendix Table E- 1) outlines a concise set of taxa that classify clinician responses to patient requests for action (*Task-oriented* requests). The TORP describes clinician responses in terms of the degree to which: (1) a response was provided; and (2) how an action was fulfilled (e.g., completely, partially, or denied) (Kravitz et al., 1999). In contrast to *Information sharing* and *Action responses,* Hogan et al. (2018) and Roter et al. (2008) included taxa indicative of clinicians' requests for more information from the patient with their "Ask about symptoms" and "Questions" taxa, respectively. Mirsky et al. (2016a) also included a taxon

that might classify clinician-generated information seeking content ("Information/clarification"). In lists the taxa that the proposed taxonomy will leverage from the TORP, presenting them as sub-taxa of the *Action responses* Level 1 taxon. It should be noted that the *Acknowledge* taxon may be used in response to patients' *Information seeking* content as well, when a clinician acknowledges receipt of the message but neither defers nor attempts to answer the patient's question.

Table 2-12.

Task-Oriented Responses Sub-Taxa

Action Responses Sub-Taxa	**Definition**
Acknowledge	The response includes a recognition that the request for action or information is made, but no indication is provided about whether the request will be fulfilled
Denies	The response indicates that the request will not be fulfilled
Fulfills request	The response includes documentation that the request action was completed
Partially fulfills request	The response indicates that there are additional steps that are necessary to fulfill the request, or that only part of the request can or has been completed

In contrast to *Information sharing* and *Action responses,* Hogan et al. (2018) and Roter et al. (2008) included taxa indicative of clinicians' requests for more information from the patient with their "Ask about symptoms" and "Questions" taxa, respectively. Mirsky et al. (2016a) also included a taxon that might classify clinician-generated information seeking content ("Information/clarification"). In recognition that clinicians may seek additional information or context in order to answer patients' questions, clinician-generated *Information seeking* message content is defined as a clinician's request for additional information or clarity in response to a patient's message.

In summary, the taxa designed for clinician-generated content allow for assessments of whether patients' requests for action were fulfilled or their requests for information were addressed. supports development of interpersonal relationships (Rabby & Walther, 2003; Rains, Brunner, Akers, Pavlich, & Goktas, 2017; Walther, 1992a, 1992b). Both SIP theory and the hyperpersonal model highlight the strong impact verbal cues play in trust-building and relational development in mediated lists the proposed taxa for classifying clinician-generated content. This contrasts with the taxa designed for patient-generated message content presented in the preceding section, which were focused on identifying potential points of uncertainty.

Table 2-13.

Proposed Taxa to Classify Clinician-Generated Content

Level 1 Taxa	Level 2 Taxa	Definition
Action responses	Acknowledge	The response includes a recognition that the request for action or information is made, but no indication is provided about whether the request will be fulfilled
Action responses	Denies	The response indicates that the request will not be fulfilled
Action responses	Fulfills request	The response includes documentation that the request action was completed
Action responses	Partially fulfills request	The response indicates that there are additional steps that are necessary to fulfill the request, or that only part of the request can or has been completed
Information seeking	--	Clinicians' requests for information or clarity around patients' condition or symptoms, or symptom severity or duration
Information sharing	Deferred	Clinical responses that refer the patient to another clinician for a response, postpone an answer pending additional clinical information (e.g., wait for laboratory test results)
Information sharing	Medical guidance	Clinician provides treatment decisions, gives care instructions, informs the patient on the best next steps in his or her care plan, interprets diagnostic procedure or laboratory results, or provides information on symptoms or the patient's health condition
Information sharing	Orientation to procedures, treatments, or preventive behaviors	Clinical responses that explain what a patient might expect during a treatment or diagnostic procedure, or in a new healthcare setting or situation
Task-oriented	Recommendation to schedule an appointment	Clinician suggests that patient schedule an appointment

2.6.3. Social communication taxa. The final Level 1 taxon within the proposed taxonomy focuses on social communication between the patient and clinician. Social support is a structure provider in the UIT (see Appendix B for definitions), meaning it can influence the patient's degree of uncertainty (Mishel, 1988). Consistent with patient-centered communication, there is significant clinical value in patients' expressions of emotions and appropriate clinical responses because those expressions can enhance partnership-building and trust (Epstein et al., 2005; Epstein & Street, 2007). Additionally, Social Information Processing (SIP) theory highlights that social exchange through mediated communication supports development of interpersonal relationships (Rabby & Walther, 2003; Rains, Brunner, Akers, Pavlich, & Goktas, 2017; Walther, 1992a, 1992b). Both SIP theory and the hyperpersonal model highlight the strong impact verbal cues play in trust-building and relational development in mediated communication (Walther, 1996, 2006; Walther & D'Addario, 2001; Walther, Loh, & Granka, 2005;

Walther & Parks, 2002). The proposed taxonomy will therefore accommodate the identification of *Social communication* that supports interpersonal relationship development not otherwise accommodated in the taxa identified to this point.

Eight published taxonomies included taxa associated with *Social communication*, such as appreciation, complaints, and life issues (Alpert et al., 2017; Cronin, Fabbri, et al., 2015; Hogan et al., 2018; North, Crane, Chaudhry, et al., 2013; Robinson et al., 2017; Roter et al., 2008; Shimada et al., 2017; Sulieman et al., 2017); only two of those included taxa that classified clinicians' social communication (Alpert et al., 2017; Roter et al., 2008). The proposed taxonomy will use the same *Social communication* sub-taxa to classify both patient- and clinician-generated content. *Appreciation and praise* will be one sub-taxon within *Social communication*, defined as content that expresses gratitude or offer acknowledgement or appreciation of a service provided, change in health status, or another act. In contrast to *Social communication*/*Appreciation and praise*, complaints indicate frustration and potentially a loss of trust between patient and clinician, so differentiation of this type of communication is critical. The sub-taxon to identify this content will be labeled *Social communication*/*Complaints* and includes expressions of frustration or displeasure.

Shimada et al. (2017) defined the "life issues" taxon as "contextual issues that are not strictly biomedical and are about the patient's life context" (p.944). Street, Makoul, et al. (2009) note that social issues such as access to transportation or social supports can influence access to care. Thus, communication in which aspects of the patient's life not specifically related to health may be important to recognize. This will be facilitated by a sub-taxon labeled *Social communication*/*Life issues*.

Table 2-14 lists the proposed *Social communication* taxa, which apply to both patient- and clinician-generated content. The exchange of social communication through mediated communication is expected based on the SIP and hyperpersonal models (Walther, 1996; Walther & Burgoon, 1992). Because Mishel noted the importance of trust-building communication between patient and clinician (Mishel, 1988), we might expect that *Social communication/Appreciation and praise* and *Social communication/Life issues* may be associated with improved trust while *Social communication/*

Table 2-14.

Proposed Taxa to Classify Social Communication Content

Social Communication Taxa	**Definition**
Appreciation and praise	Content that expresses gratitude or offers acknowledgement or appreciation of a service provided, health status, or another act
Complaints	Expressions of frustration or displeasure
Life issues	Communication about aspects of the patients' life not specifically related to health

Complaints would indicate the opposite. According to the UIT, the latter would result in an increase in uncertainty while the two former taxa should result in decreased uncertainty (Mishel, 1988).

2.6.4. Summary. This proposed taxonomy is grounded in prior research and is structured to identify potential areas of patients' uncertainty in their illnesses, based on selected UIT constructs. Appendix D lists all taxa and the alignment with uncertainty as described in the sections above. Where there was consistency across published classification systems, those themes were leveraged, as appropriate, within this proposed taxonomy. None of the published research, however, described a theoretical basis for their classification systems. It is hoped that by providing a theoretical grounding behind this study's taxonomy, it will better detect differences necessary to associate content with health outcomes and healthcare utilization.

2.9 Study Population

Figure 2-3 displays at a high-level how the sampling of the study population of patients, clinicians, and secure messages will occur. The study will leverage a random sample of VCU Health patients with selected chronic conditions; all secure messages included in threads initiated by those patients between January 1 and December 31, 2017; and a census of the clinicians who communicated with those patients via those secure messaging threads. Subsequent sections of 2.7 describe the proposed patient, message, and clinician selection process and sample size derivation.

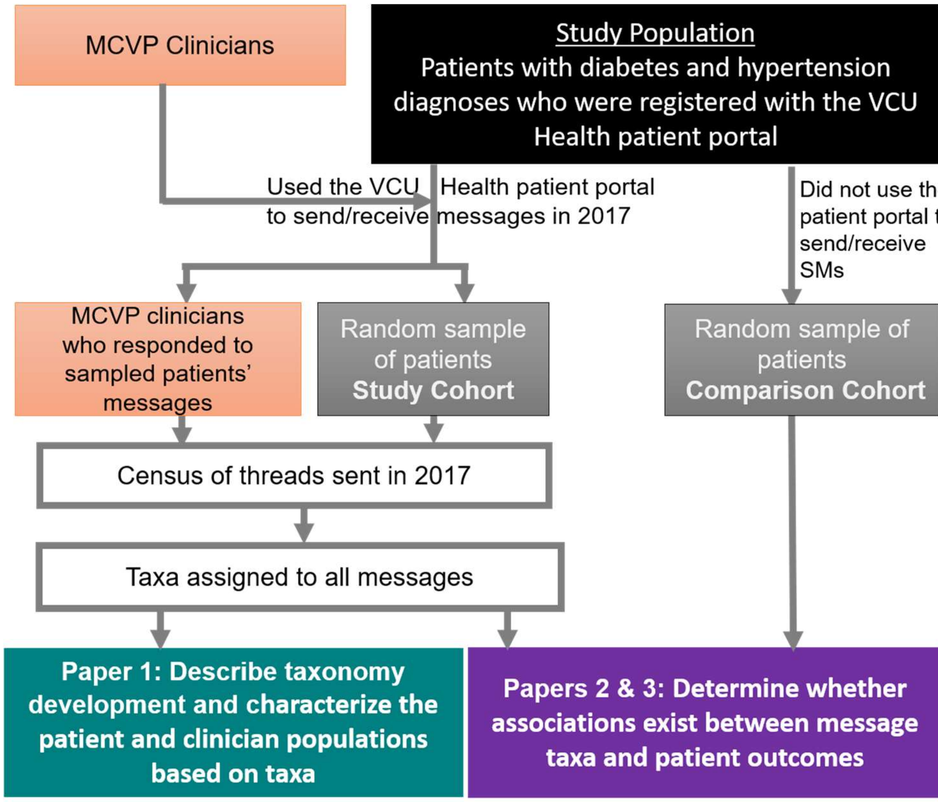

Figure 2-3. Study Population and Papers Overview

2.7.1 Patient study population. The study population includes a random sample of VCU Health system adult patients (18 years of age or older by January 1, 2017) with a diagnosis of diabetes, hypertension, or both conditions. Diagnoses were determined based on ICD-10 codes. To be included in the sample, patients needed at least two outpatient visits or a single inpatient visit between January 1 and December 31, 2016 with a diagnosis code for the health condition. Selected diagnosis codes included those for type 2 diabetes (ICD-10 codes beginning with E11-) and hypertension (ICD-10 codes beginning with I10-, I11-, I12-, or I13-). The study sample is further limited to patients who had at least one visit to a VCU Health facility in each 2017 and 2018, to ensure the availability of pre- and post-measurement data required for Research Paper 3 (see Chapter 5).

Due to the chronic nature of their condition, patients must develop self-management coping strategies and a robust understanding of their condition that may be gleaned through information-seeking behaviors (Mishel, 1990, 1999). These are key factors in the theoretical basis for this research as well as the taxonomy. Individuals with diabetes and hypertension were selected because they are likely to experience uncertainty as their health status changes. In addition, these are common chronic conditions in the United States and are among the top ten leading causes of death (National Center for Health Statistics, 2017). If the effectiveness of the taxonomy can be demonstrated in these two conditions, it may be applicable to other conditions.

To control for the potential confounder of digital technology access, the study will only include patients registered with the VCU Health patient portal. It is reasonable to assume that patients who registered for the portal at least have access to internet and the technical savvy to establish an account.

2.7.2 Secure message sample. The study will only include message threads by the sampled patients, and only encompasses those messages and threads that were saved to the clinical chart. A message is saved when a member of the clinical team selects “Save to Chart.” A message thread encompasses all messages in a secure message conversation (i.e., the initiating message and all subsequent replies). Patient-initiated message threads are those messages in which the patient sent, or generated, the first message in the thread. Clinician-initiated threads will be excluded; however, the clinician-generated responses to patient-initiated threads are included. The rationale for the inclusion of only patient-initiated threads is twofold: other research demonstrated that the majority of secure messages were patient-initiated (Harris et al., 2009), and a digital conversation initiated by a patient is likely to be a better indicator of uncertainty than a clinician-initiated thread.

All threads initiated and concluded in 2017 (January 1 through December 31, inclusive) by the randomly selected patients, and all messages (i.e., all patient- and clinician-generated messages) within each thread will be coded and included in subsequent analyses. Threads in which the initiating message is sent in 2017 but for which responses are exchanged in 2018 will be excluded from the study.

2.7.3 Clinician study population. The clinician study population includes MCVP clinicians who responded to sampled patient-initiated message threads. All clinician types who interacted with patients via secure messaging will be included in the clinician study population, as prior literature indicates that message response is frequently a team-based activity that includes medical assistants, nurses, physician assistants, advanced practice nurses, pharmacists, and physicians of all specialties (Garrido et al., 2014; Heyworth et al., 2013; Hoonakker et al., 2017; Wooldridge et al., 2016). It is possible that communication practices differ by clinician type (e.g., nurse, physician assistant, physician) and clinical specialty (e.g., primary care, obstetrics, surgical). Inclusion of all clinician types and specialties permits analysis on those factors.

2.7.4 Sample size. The unit of analysis all study analyses is the patient. Sample size estimates are therefore based on the number of patients needed to achieve adequate power to detect differences in the population. Table 2-15 presents the total patients with diabetes, hypertension, or both conditions by portal registration status and estimated number of patient-initiated threads. Given these numbers, there is an adequate number of patients to support most analyses; the rate-limiting factor in determining sample size will be the length of time it takes to manually review each message.

Table 2-15.

Counts of Unique VCU Health Patients and SM Threads by Health Condition, 2017[a]

	Diabetes only	**Hypertension only**	**Both diabetes and hypertension**
No. patients with at least 1 visit to VCU Health each year 2016-2018 who were registered with the patient portal	683	3,546	2,503
Percentage[b] of patients who initiated a message thread	46	42	41
No. patient-initiated SM threads	1787	7732	6104

[a] Based on analysis of preliminary VCU Health secure message data, likely underrepresents percentage
[b] Percentage of patients registered with the VCU Health patient portal.

Assuming a desired power of 80% and 95% confidence (alpha=0.05), power calculations were run in SAS v9 for each outcome (details in Appendix F). The outcomes of interest will be measured as continuous variables (more details on outcome variables are provided Chapters 4 and 5). Table 2-16 lists the selected study outcomes and estimated mean differences and standard deviations identified from literature; Appendix F displays the graphs for each of these power calculations. For 80 percent power, the ability to detect a statistical difference between samples requires between 36 and 140 patients given published standard deviation, estimated mean difference, and outcomes. Of the outcomes studied across the three papers, the office visits outcome requires the largest sample.

Table 2-16.

Power Calculation Inputs and Estimated Sample Sizes by Outcome

Outcome construct	Condition/ Service	Measured outcome	Estimated mean difference	Standard deviation	Minimum sample for 80% power (alpha=0.05)	References
Healthcare utilization (Paper 2)	Office visits	Number of office visits	1	2.09	140	North, Crane, Chaudhry, et al. (2013)
	Medication adherence	MPR	0.1	0.19	116	L. T. Tang, Quan, and Rabi (2017)ang
Patient health outcome (Paper 3)	Diabetes	A1C (%)	1.0	1.39; 1.94	64-122	P. C. Tang et al. (2013)
	Hypertension	SBP	8	11.4; 14.4	66-104	
		DBP	8	8.3; 9.4	36-46	

A1C=glycated hemoglobin; DBP=Diastolic blood pressure; MPR=Medication possession ratio; SBP=Systolic blood pressure

A pilot study resulted in coding of secure message threads initiated by 73 VCU Health patients with either hypertension, diabetes, or both conditions between January 1 and December 31, 2017. This goal of the pilot study was to gain understanding of the prevalence of message taxa. Some message types (scheduling or prescription refill requests) can be identified through the automatically-generated message subject line which permits prevalence of those message types to be determined through automated methods. The pilot study population therefore excluded patients who wrote only those message types; instead, study participants were randomly selected from those patients who initiated at least one thread that was not a scheduling or prescription refill request. Table 2-17 displays the percentage of patients for whom at least one message was coded with each taxon and shows the estimated number of patients needed to meet each outcome's sample size requirement. The two taxa that require the largest number of patients to detect a one-unit change in office visits are *Preventive care or physical exam* and *Self-reporting*.

Due to the desire to evaluate the efficacy of the taxonomy on patients with two different chronic conditions while minimizing the number of messages to be coded, the final sampled set of patients will leverage patients with both diabetes and hypertension. These patients can be included in analyses for either condition by including a covariate that indicates whether the patient has both conditions or only the

Table 2-17.

Estimated Number of Patients by Taxa Required to Achieve the Necessary Sample Size for Each Outcome

Taxa	Percent of pilot study patients with at least one message [a]	Estimated patients needed for the OV outcome [b]	Estimated patients with diabetes [c] needed for medication adherence outcome [d]	Estimated patient with diabetes needed for A1C outcome [d]	Estimated patients with HTN needed for SBP outcome [d]	Estimated patients with HTN needed for DBP outcome [d]
Patient Task-Oriented Requests						
Medication refills and renewals requests	54.8	255	212	223	190	84
New or change medication request	26.0	538	446	469	400	172
Other administrative	57.5	243	202	212	181	80
Referral request	17.8	787	652	685	584	258
Scheduling request	--	--	--	--	--	--
Cancellation	26.7	524	434	457	390	172
Follow-up	22.7	617	511	537	458	203
Laboratory test or diagnostic procedure	25.3	553	458	482	411	182
New condition or symptom	26.7	524	446	457	400	172
Preventive care or physical exam	6.7	2090	1731	1821	1552	687
Reschedule	40.0	350	290	305	260	115
Patient Information Seeking						
Logistical information	64.4	217	180	189	161	71
Symptoms/Condition	41.1	341	282	297	253	112
Patient Information Sharing						
Clinical update	34.2	409	339	357	304	135
Response to clinician's message	57.5	243	202	212	181	80
Self-reporting	16.4	854	707	744	634	280
Clinician Responses						
Task-oriented/ Recommendation to schedule an appointment	32.9	426	353	371	316	140
Action responses	--	--	--	--	--	--
Acknowledgement	34.2	409	339	357	304	135
Denies	27.4	511	423	445	380	168
Fulfills request	76.7	183	151	159	136	60
Partially fulfills request	63.0	222	184	194	165	73
Information seeking	35.6	393	326	343	292	129
Information sharing	--	--	--	--	--	--
Defer	35.6	393	326	343	292	129
Medical guidance	63.0	222	184	194	165	73
Orientation to procedures, treatments, or preventive behaviors	43.8	320	265	279	237	105
Social Communication						
Appreciation and praise	37.0	378	314	330	281	124

Taxa	Percent of pilot study patients with at least one message [a]	Estimated patients needed for the OV outcome [b]	Estimated patients with diabetes [c] needed for medication adherence outcome [d]	Estimated patient with diabetes needed for A1C outcome [d]	Estimated patients with HTN needed for SBP outcome [d]	Estimated patients with HTN needed for DBP outcome [d]
Complaints	23.3	601	498	524	446	197
Life issues	27.4	511	423	445	380	168

[a] The pilot study sampled from patients who wrote at least one non-*Task-oriented* message; these results may therefore underestimate the proportion of *Task-oriented* taxa (and clinical *Action responses* content) that may occur in a sample of patients who wrote all message types. [b] The office and emergency department outcomes are not condition-specific (see Chapter 4 for specifics); the analyses therefore use the full sample of patients. [c] A separate analysis will be run for patients with hypertension; similar numbers are estimated to be required of the patients with hypertension. [d] Condition-specific outcome; analyses will use two-thirds of the patient population (patients with only the selected condition plus patients with both conditions). A1C=glycemic level; DBP=diastolic blood pressure; HTN=hypertension; OV=office visits; SBP=systolic blood pressure

condition of interest. To achieve a sample size that permits detection of a one-unit change in most outcomes of interest, a minimum sample size of at least 854 patients is necessary (permits detection of one-unit change in office visits for all taxa except *Preventive care or physical exam*). To make this evenly divisible by three (i.e., one-third of the sample for each patients with only diabetes, patients with only hypertension, and patients with both conditions), the final sample will therefore include at least 285 patients with diabetes, 285 with hypertension, and 285 with both hypertension and diabetes, for a minimum total of 855 patients who sent messages in 2017. This sampling strategy permits use of 570 patients for condition-specific analyses (combining 285 patients with only the selected condition and 285 patients with both conditions); these condition-specific analyses will use a control variable to differentiate patients with both conditions. With this sample size for condition-specific analyses, statistically detectable changes will not be available for *Preventive care or physical exam* (all condition-specific outcomes), *Self-reporting* (all condition-specific outcomes excluding diastolic blood pressure (DBP)), *Referral request* (all condition-specific outcomes excluding DBP).

Patients registered with the VCU Health patient portal who did not send a message in 2017 will be similarly sampled for a total comparison cohort of equal size and health condition distribution.

Because the pilot study excluded patients who sent only scheduling and refill request messages, the population is not representative of those patients. It also means that the taxa distribution in the pilot study likely underrepresents scheduling and refill requests. To account for this discrepancy, this study's population size will be increased by the approximate proportion of patients in the base population who sent only a scheduling or prescription refill request (25 percent), as identified based on message subject lines. The final study population should therefore include 357 patients each with diabetes only, hypertension only, and both diabetes and hypertension, selected from both the VCU Health patients registered with the patient portal who initiated messages and those who did not. Table 2-18 displays the maximum estimated time to review messages associated with 1071 patients.

Table 2-18.

Maximum Estimated Number of, and Time to Code, Messages for Selected Patient Sample Size

Health condition	**Average threads per patient** [a]	**Est. max num. messages for 357 patients** [b]
Diabetes only	5.1	4,916
Hypertension only	5.5	5,301
Both diabetes and hypertension	4.8	4,627
Maximum possible number of messages for review:		14,844
Maximum possible number of words to review (assuming maximum of 139 words/message[c])		2,063,324
Maximum possible number of hours to complete coding (assuming editing reading rate of 180 words/minute[d]):		191

[a] Based on preliminary analysis of VCU Health secure message data; [b] Based on preliminary analysis of VCU Health secure message data that indicates a mean of 2.7 messages/thread. [c] Alpert et al. (2017); Mirsky et al. (2016b); Sittig (2003); [d] Trauzettel-Klosinski and Dietz (2012); Ziefle (1998)

2.7.4.1 Detecting statistical differences by patient demographics. Chapters 4 and 5 describe analytic methodologies whose goals include detection of differences in patient outcomes while controlling for differences in patient demographics. The ability to detect statistical differences in patient outcomes by patients' sex, race, or age across individual taxa will be limited using the proposed sample sizes. Although oversampling is a solution, it would require significant increases in the numbers of patients included in the study (see Appendix Tables F-2, F-3, and F-4). This study will therefore not oversample.

2.7.4.2. Final sampling strategy. The study population will draw from patients registered with the VCU Health patient portal who have diabetes, hypertension, or both conditions. Figure 2-4 displays the sampling strategy. The first stratum separates patients by health condition. Only 683 patients with diabetes only met the inclusion criteria so all these patients will be included in the final study sample. Patients with hypertension only and with both conditions will be further stratified by whether they initiated at least one message thread between January 1 and December 31, 2017. The SAS procedure surveyselect will extract a simple random sample of 357 patients from each of those four sampling frames.

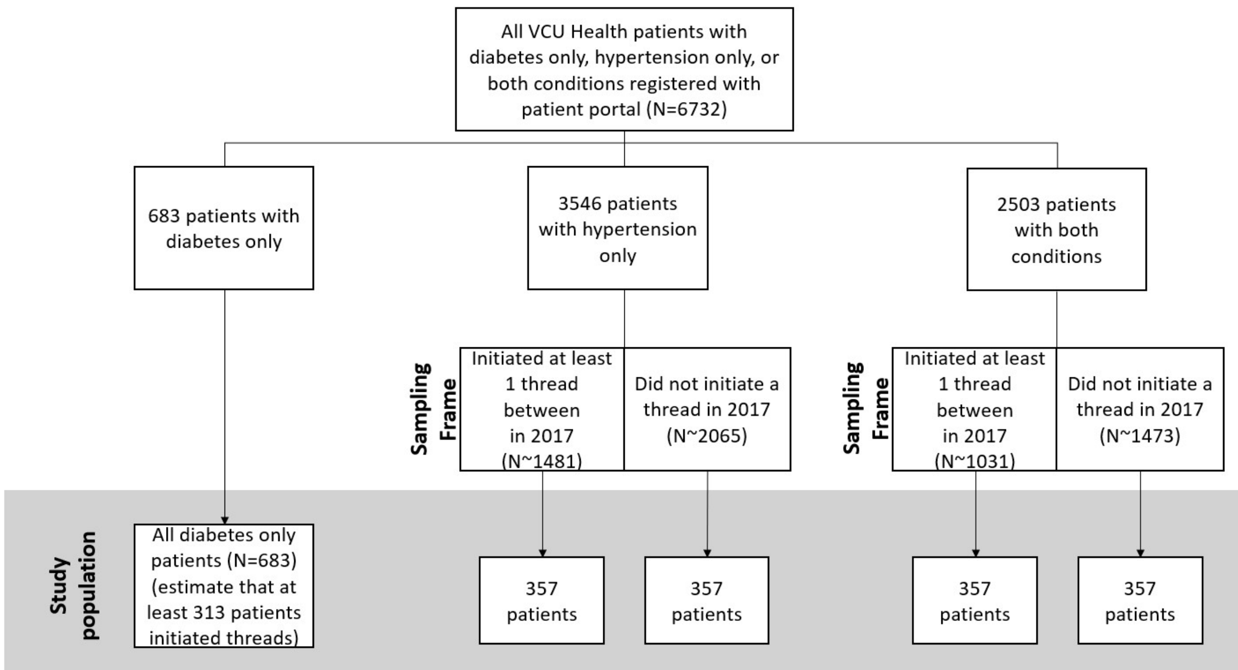

Figure 2-4. Sampling Strategy

2.7.5 Ethical considerations. This study is a retrospective observational cohort study that was approved by the VCU Institutional Review Board under expedited review (HM20013425). The research leverages data that were previously collected for other purposes and risks to the patient and clinician will therefore be low. The risk to the patients and clinicians included in this study is primarily around a breach of privacy. To mitigate this risk, all data are stored on a password-protected computer maintained in a locked room. Only aggregated results will be reported in publications to further ensure confidentiality. All data are maintained in a secure environment and deidentified, to the extent possible, by the researchers following the chart reviews. Chart reviews are necessary to abstract the secure message and medication data. Information abstracted from patients' charts will include what is minimally necessary to achieve the study aims: message content, the condition for which the medication is being used for treatment (i.e., diabetes or hypertension), and the calculated medication possession ratio. Abstracted data will be input into REDCap to ensure data are secure and confidentiality is maintained. Information collected regarding clinicians' responses will similarly be maintained in a confidential and secure manner and will not be reported out on an individual level.

2.10 Methods for Research Paper 1

The methods for Research Paper 1 include content and descriptive analyses. Content analysis—a systematic review of text that converts the narrative into codes that can be quantified and from which inferences can be made (Krippendorff, 2019)—is critical to measuring the levels of uncertainty within patient-generated messages and classifying clinicians' responses to those messages. As noted above, previous research reported differences in secure message use by patient and clinician characteristics, although the findings were inconsistent across studies and those studies were based on message volume and thread intensity rather than message content. Some of these differences might be explained by exploring which patients and clinicians communicate using which types of message content. Content analysis codes the message content so that the content types can be quantified and included in analyses to detect differences by patient and clinician characteristics. The next sub-sections propose the processes by which the data extraction, content analysis, and descriptive analyses will occur.

2.8.1 Data extraction and content analysis. Messages will be extracted from the EHR manually and imported into NVivo for coding, grouped by patient and thread, so that the coding can be performed on each message but viewed within the context of the full thread. The context unit will therefore be the message thread. Coding units will be no longer than a single message but may be shorter depending on the content in the message (e.g., if multiple taxa are applied to the message). All messages will be independently read and coded by two coders, Dawn Heisey-Grove and Dr. Jonathan DeShazo. Messages will be stored in a NVivo master file; coders will assign taxa to each message in their own copy of the master file. Extracts from the two files will be compared during the coding process to ensure inter-rater reliability is strong. Coders will be encouraged to make notes using the NVivo memo function as they code for referral later as needed. Weekly meetings will be used to discuss coding discrepancies and open issues based on any memos in NVivo.

The coders will use consensus to resolve any coding discrepancies and discuss whether modifications are necessary to the taxonomy. Message recoding will occur when taxa definitions are changed during the conflict resolution discussions. Once coding is complete, one coder (DHG) will extract a new random sample of threads of the full sample (10 percent) and re-code the messages. These codes will be compared to the final codes assigned by the two coders to estimate retest reliability using a Pearson's correlation (Polit & Beck, 2017).

2.8.3 Descriptive analyses. Research Paper 1 explores whether taxa use varies by patient or clinician characteristics. To answer this question, descriptive analyses will test two hypotheses around whether the taxa vary by (1) patient characteristics or (2) clinician characteristics (see Appendix C). Table 2-19 lists the patient and clinician characteristics included in the analyses. Chi-Square tests will measure unadjusted statistical differences within each characteristic for each taxon. Those characteristics found to be statistically different will be included in a logistic regression that uses the taxon as the dependent variable and characteristics as the independent variables. More detail on the analyses for each hypothesis is provided in Table 2-19.

2.8.3.1 Hypothesis 1: Differences in taxa by patient characteristics. To assess the first hypothesis (whether taxa vary by patient characteristics, see Appendix C for details), the analyses will be based on whether the patient sent (or received) at least one message with content coded for each taxon. Both patient- and clinician-associated taxa will be included in these analyses; the latter are included to understand if there are differences in the content (as determined by the assigned message taxa) sent by clinicians based on patients' characteristics.

The unit of analysis is the patient. Sampled patients who initiated at least one message during 2017 constitute the cohort included in the Chi-Square analyses. Dichotomous values (i.e., Yes or No) will be created for each taxon to determine whether the patient sent content coded for that taxon during the study period. Comparisons for Chi-Square analyses include the bivariate patient characteristics listed in

Table 2-19 above. For characteristics with more than two values, multiple comparisons will be performed, and the p-values corrected using a Bonferroni adjustment.

2.8.3.2 Hypothesis 2: Differences in taxa by clinician characteristics. The second hypothesis focuses on the clinician characteristics associated with taxa. The unit of analysis will be the clinician; the cohort will only include clinicians who received at least one patient-initiated thread from the sampled patients. Similar to analyses for the first hypothesis, taxa assigned to both patient- and clinician-generated content will be included in the analyses; analyses on patient-generated taxa associations with clinician characteristics demonstrates whether patients send different message content, as indicated by taxa, based on clinician characteristics.

As with analyses for the first hypothesis, these analyses are based on a bivariate value of whether the clinician sent (or received) at least one message with the assigned taxon. Table 2-19 lists the clinician characteristics to be used in these analyses. If sample sizes are insufficient to conduct analyses by clinician specialty, specialties will be grouped into primary care (general practice, family medicine, internal medicine, geriatrics, and gynecology) and specialist. If sample size is insufficient by clinician type, groupings will include physician, advanced practice practitioners (advanced practice nurses and physician assistants), clinical support staff (e.g., registered nurses, medical assistants), and other clinician types (American Academy of Pediatrics, 2019; Bishop, 2012). As with hypothesis 1 analyses, Bonferroni corrections will be applied when multiple comparisons are conducted for characteristics with more than two values.

2.11 Limitations of Research Paper 1

The goal of the research conducted in support of Research Paper 1 is to apply a theory-based taxonomy and assess any differences in patient and clinician characteristics associated each taxon. The taxonomy is designed to identify patient-generated message content indicative of uncertainty and classify clinician responses in a way that allows for a general assessment of whether the clinical response addressed the patient’s uncertainty or task-oriented request. There is, however, no way to definitively know if a patient was experiencing uncertainty without direct assessment through a survey tool like

Table 2-19.

Patient and Clinician Characteristics Included in Analyses

Variable Name	Variable Type	Definition	Value Set
Patient Characteristics			
Age	Continuous	Calculated field (age on January 1, 2017)	Number
Sex	Categorical	As defined in VCU Health EHR	Male Female
Race	Categorical	As defined in VCU Health EHR	White Black/African American Other
Rural home location	Categorical	Based on Core-Based Statistical Areas	Rural Micropolitan Area Metropolitan Area
Number of clinicians with whom SMs are exchanged	Continuous	Calculated field: Number of clinicians with whom patient exchanged at least 1 message in 2017	Number
Payer type	Categorical	As defined in VCU Health EHR	TBD
Number of comorbidities	Continuous	For 2017, number of chronic condition diagnoses reported in VCU Health I	Number
Baseline A1C	Continuous	Most recent A1C percent value collected between June-December 2016	Number
Baseline SBP	Continuous	Most recent SBP value collected between June-December 2016	Number
Baseline DBP	Continuous	Most recent DBP value collected between June-December 2016	Number
Clinician Characteristics			
Clinician type	Categorical	Clinician type as available from MCV data	TBD, although preferred: Physician, Medical Assistant, Physician Assistant, Registered Nurse, Nurse Practitioner, Pharmacist, Occupational therapist, Physical therapist, Dietician, Podiatrist
Clinical specialty	Categorical	Clinician type as available from MCV data	TBD, such as: Primary care, Surgical, Cardiology, Endocrinology, Ophthalmology, Nephrology, Podiatry
Practice location	Categorical	Clinic/practice location	TBD (may be individual practice identifiers or urban/rural location)
Annual message volume	Continuous	Calculated/summation: Number of messages clinician exchanged with all patients (not just the randomly selected patients) in each 2016 and 2017	Number

A1C=glycated hemoglobin; DBP=diastolic blood pressure; EHR=electronic health record; MCV=Medical College of Virginia; SBP=systolic blood pressure; TBD=to be determined; VCU=Virginia Commonwealth University

Mishel's Uncertainty in Illness Scale (Mishel, 1981). Similarly, it is impossible without directly communicating with the patient, to know if the clinical response addressed the patient's inquiry in a way that the patient found acceptable. The taxonomy can only identify content that was likely to measure these constructs and conduct analyses accordingly. Krippendorff (2019) notes that such abductive inferences are at the heart of all content analyses. The use of a theory-based taxonomy supports each code's (or taxon's) construct validity. As advised by Krippendorff (2019), future validation of the taxonomy would occur if other researchers applied the taxonomy to different study populations' messages.

Another limitation occurs with how the study population was selected. Prior research noted that internet access mediates secure messaging use: differences in secure message use by age, household income, and race were no longer apparent after adjustment for internet use (Graetz et al., 2016). Because the secondary data sources available for this study do not capture internet access or use, the study population is limited to only those VCU Health patients registered with the online patient portal. As it is unlikely that a patient would or could register for a patient portal in the absence of internet access, the study population will be limited to individuals with likely internet access and use, thereby controlling for an unmeasurable confounder. This therefore limits the study's generalizability to patients with access to the internet who have the technical proficiency to register with the patient portal. Given that the IOM (2001) advocates for use of communication modalities based on patients' preferences, this limitation is appropriate in that it limits the scope of the analysis to those patients who opt to use this form of communication with their clinicians.

The characteristics listed in Table 2-19 represent the ideal analysis. Based on a preliminary review of available data, there is insufficient sample to analyze based on patient ethnicity and primary language. There is no published research to date that addresses variation in secure message use based on ethnicity, so it is unclear what impact, if any, excluding this covariate might have on the analysis. Based on the research conducted by Schickedanz et al. (2013), patients whose primary language is not English are less likely to use secure messaging, so this population may not be relevant for this study because it focuses on those patients whose preference is communication with their clinicians via electronic modalities.

The proposed taxonomy is designed to be generalizable to all health conditions. The sample population only includes patients with diabetes and hypertension so generalizability to messages sent by patients with other chronic conditions cannot be assessed. Additionally, it is possible that the message content sent by patients who only have acute conditions will differ; however, that cannot be known through these analyses since the two conditions evaluated through this research are chronic.

Only one year of secure message exchange between patients and clinicians is included in these analyses. If, however, the patient and clinician exchanged messages prior to 2017, there may already exist a relationship and understanding about how they use secure messaging to communicate. Data are available regarding the number of messages the clinician sent the prior year (2016), which will provide an indicator of the clinicians' message use overall and may be a proxy for comfort level with this type of communication.

3. Theoretical Basis for Research Papers 2 and 3

The second and third research papers explore the association between taxa assigned to secure messages and patients' health outcomes and utilization of healthcare services. The theoretical basis for these papers provides the rationale for why secure message content should be associated with patient outcomes and healthcare utilization. Although grounded in Mishel's UIT (1988) like Research Paper 1, Research Papers 2 and 3 also rely on theories that explain how interpersonal communication—a component of patient-centered care—occurs in technology mediated communication. Section 3.1 covers the UIT constructs that address when patients might outreach to their clinicians (Mishel, 1988). Section 3.2 describes, based on the Street, Makoul, et al. (2009) framework, how patient-clinician communication can be linked to patient outcomes. The final set of theories, described in Section 3.3, highlight why a technology-mediated communication modality like secure messaging should promote interpersonal communication needed to support patient-centered care.

Following descriptions of the theories, this chapter demonstrates how the theoretical constructs can be applied to frame the issue of secure messaging research and demonstrates why patient outcomes should be linked to secure message content. Section 3.4 describes that linkage and lists propositions that are the basis for this research. Chapters 4 and 5 list the associated hypotheses upon which the research for those papers are based.

3.1 Uncertainty Appraisal and Coping

Chapter 2 described uncertainty antecedents (see Appendix B for definitions)—those factors that influence the degree of uncertainty experienced by the patient—from Mishel's UIT (1988). This section reviews the UIT constructs relative to the actions of the patient once uncertainty is recognized. The goal of this review is to provide some context on when a patient might outreach to a clinician for support. Two UIT constructs are explored in this section: patients' appraisal of uncertainty and coping strategies based upon that appraisal.

3.1.1 Uncertainty appraisal. The appraisal phase occurs once the patient identifies the uncertainty (Figure 3-1). Patients will evaluate the uncertainty to determine whether it is a danger or an opportunity. Perception of events as dangerous was associated with depression, increased anxiety and pessimism, and poorer outlooks of the future (Mishel, 1988, 2014). Several studies reported a positive association between uncertainty and danger appraisals (Kazer et al., 2012; Wonghongkul, Moore, Musil, Schneider, & Deimling, 2000). In the appraisal process, patients assess the uncertainty based on their understanding of the information available to them (*inference;* refer to Appendix B for a list of definitions), or on their beliefs about the event that may not grounded in fact (*illusion*) (Mishel, 1988).

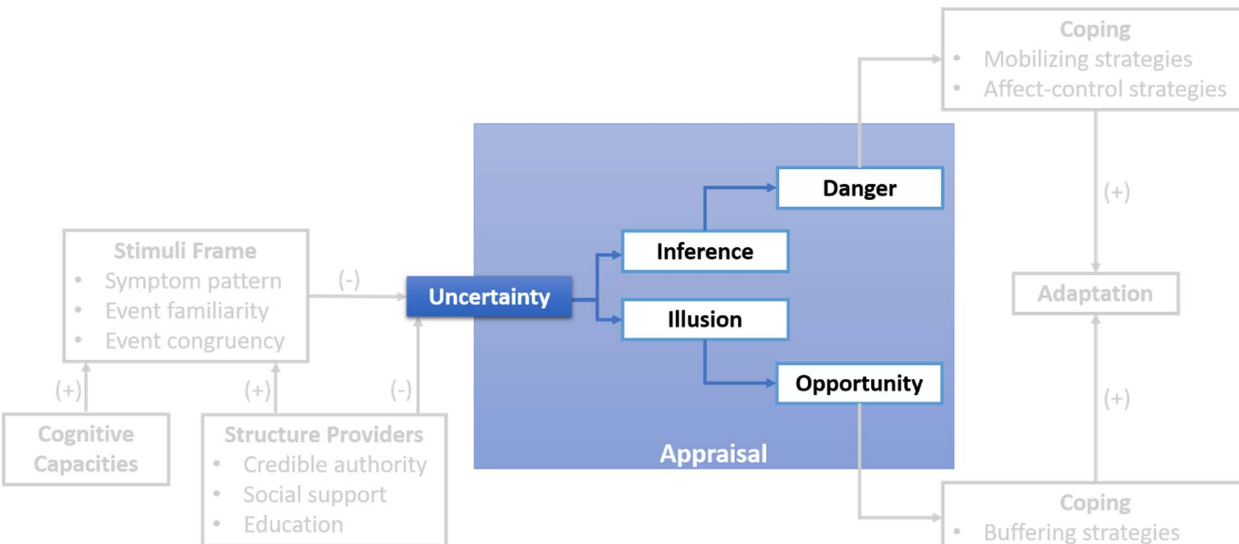

Figure 3-1. Uncertainty Appraisal in Mishel's Uncertainty in Illness Model

Note: From "Uncertainty in Illness," by M.H. Mishel, 1988, *Journal of Nursing Scholarship, 20,* p. 226. Reprinted with permission from John Wiley and Sons, license number 4543220998516.

Patients use inference to assess events based on their sense of self and their belief in their own resourcefulness and skills mastery (Mishel, 1988; Mishel, Padilla, Grant, & Sorenson, 1991). Mishel defines mastery as "beliefs about the ability to behave in a way that can mitigate the adverseness of events" (Mishel et al., 1991, p. 237). During illness, an event that is ambiguous, complex, or unpredictable will result in a reduction in the patient's sense of mastery (Mishel, 1988; Mishel et al., 1991; Mishel & Sorenson, 1991). Patients who experienced a reduced sense of mastery were more likely to evaluate an uncertainty as a danger (Mishel et al., 1991), whereas patients who reported a greater sense of mastery over their symptoms and the course of their illness reported less uncertainty (Mishel, 1999).

Mishel (1988) noted a second appraisal mechanism, illusion. Illusion can have significant benefits by promoting hope among patients with chronic or terminal illness; for example, Mishel notes that for some, an indeterminate prognosis could be perceived as an opportunity for hope because it does not provide a definitive timeline (Mishel, 1988). Patients' illusions may not, however, have much basis in fact. As a result, one of the coping mechanisms associated with illusion is the avoidance of new information that may otherwise destroy the patient's view of the event as an opportunity.

The outcome of the appraisal (either illusion or inference) results in the patient developing appropriate coping strategies depending on whether uncertainty is assessed as a danger or opportunity (Figure 3-2). Mishel states that the outcome of such coping strategies is adaptation to a state in which patients' uncertainty is managed and frequently lowered through either avoidance or an increase in self-mastery. These constructs—coping strategies for danger and opportunity, and adaption—are described in more detail below. Although Mishel identifies only a few coping mechanisms in her model, research has since expanded the scope to include adaptive coping associated with ambiguity (Diiorio et al., 1991) and problem-solving coping associated with opportunity appraisals (Mishel & Sorenson, 1991).

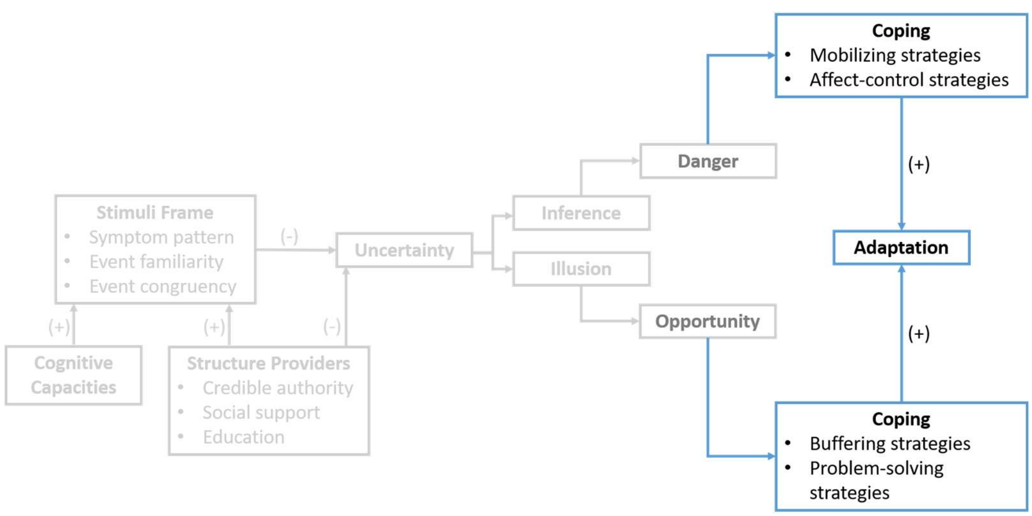

Figure 3-2. Coping and Adaptation in Mishel's Uncertainty in Illness Model
Note: From "Uncertainty in Illness," by M.H. Mishel, 1988, *Journal of Nursing Scholarship, 20,* p. 226. Reprinted with permission from John Wiley and Sons, license number 4543220998516.

3.1.2 Coping strategies. When an event is perceived as dangerous, the patient focuses coping strategies that reduce uncertainty, thereby reducing danger. Mishel notes that the patient may opt for either affect-control or mobilization strategies (Mishel, 1988). Affect-control strategies focus on managing emotional responses but not all of these strategies reduce uncertainty. Mishel et al. (1991), Mishel and Sorenson (1991), and Wineman et al. (1994) found that emotion-based coping strategies were positively associated with uncertainty. Hall et al. (2014), however, provided a more nuanced view by differentiating positive and negative affect; by doing so, they found that uncertainty was positively associated with negative affect strategies but was negatively associated with positive affect strategies. A patient who employs affect-control strategies may disengage from the environment or family and friends, seek support in their faith, or seek information from patients with similar health status who are doing well (Mishel, 1999). Mobilization strategies involve direct action where the patient may become more vigilant and self-aware and may actively seek information to improve his or her mastery (Mishel, 1988). As a manifestation of vigilance and self-awareness, patients may restructure their lives to better manage unpredictable symptoms (Mishel, 1999). Alternatively, patients may seek information from a variety of sources, including structure providers (i.e., credible authority, education, and social support). One study noted that perceived danger uncertainties were associated with increased willingness to communicate with physicians (Brashers & Brabow, 1996). If, however, structure providers cannot consistently provide adequate information in a culturally sensitive way, patients' uncertainty may increase (Brashers et al., 2002; Brashers et al., 2006).

In contrast to coping strategies used when an uncertain event is evaluated as a danger, appraisal of uncertainty as opportunity may result in a strategy in which uncertainty is maintained. In this way, patients retain their positive view of the event. Clinicians support patients who employ these "buffering" coping strategies by ensuring the information they provide is administered with sensitivity to the patients' desires. This may include showing deference to cultural norms in information control and decision-making, and by communicating in a way that does not disrupt that optimistic view (Brashers et al., 2002).

Effective coping should lead to adaptation, where the patient has learned to manage their uncertainty to their satisfaction (Mishel, 1990). Most studies do not measure adaptation, but rather the indirect results of that construct. There are numerous ways to do this, including improved patient health outcomes, improved mental health, and reduced stress (Mishel, 1988, 1999). A common measurement was quality of life, which had an inverse relationship with uncertainty (Hoth et al., 2013; Lasker et al., 2010; Niv et al., 2017; Padilla, Mishel, & Grant, 1992; Parker et al., 2013; Sammarco, 2001; Sammarco & Konecny, 2008).

3.1.3 UIT summary. To date, most studies based on the UIT measure the antecedent constructs (e.g., stimuli frame, cognitive capacity, structure providers) and the patient's degree of uncertainty. Research Paper 1 is similarly focused in that its goal is to create taxa that likely identify patients' uncertainty based on Mishel's antecedent constructs.

A patient who experiences ambiguity, lack of clarity, or unpredictability during their illness may experience uncertainty (Mishel, 1988). If that uncertainty is perceived as a danger—which occurs frequently when a patient's mastery is perceived as insufficient in the situation—the patient may employ coping strategies that include information seeking or social support from their structure providers, such as the clinicians with whom they have some measure of trust. Patients who identify an opportunity, however, may employ buffering coping mechanisms to maintain that uncertainty and will likely not adopt coping mechanisms that might supply information to shake their optimism. It is the first set of coping strategies—information or social support seeking—that would likely manifest in patients' use of secure messaging. It is unlikely that patients who adopt buffering coping mechanisms would seek information that might dissuade them from their current state of optimism.

When adaptation is measured, it is frequently captured as quality of life. A direct link between uncertainty, coping strategies, and health outcomes was not clearly described, which is why other theories are leveraged for this study.

3.2 Framework for Clinician-Patient Communication and Improved Health Outcomes

In contrast to the UIT (Mishel, 1988), Epstein and Street (2007) more clearly delineated the linkage between patient uncertainty and health outcomes in a National Cancer Institute (NCI) monograph that described a framework for patient-centered communication. This framework included pathways by which patient-centered communication should lead to changes in health outcomes. To provide context around why mediated communication such as SM should be associated with changes in patient outcomes, this section describes the direct and indirect pathways Epstein and Street (2007) identified as leading to changes in patient outcomes.

Epstein and his colleagues provided definitions for a number of terms circulating to support patient-centered research (Epstein et al., 2005): patient-centeredness refers to a set of core values around which patient care is focused, while patient-centered care applies those core values to the provision of healthcare; patient-centered communication is one of a number of tools by which those core values might be applied to healthcare provision. The core values include considering patients' preferences and needs when providing care, enhancing the clinician-patient partnership, and including patients in the decision-making process when they desire inclusion.

The pathways described in the NCI monograph were formalized in an article published by Street, Makoul, et al. (2009) that highlighted the communication functions that could lead either directly or indirectly to changes in health outcomes. Figure 3-3 reproduces the framework published in that article. More detail is provided in subsequent sub-sections on the communication functions, indirect and direct pathways, and pathway moderators.

3.2.1 Communication functions. Listed in Figure 3-3, the communication functions outlined in the Street, Makoul, et al. (2009) framework include actions that clinicians can perform to foster patient-centered care. The goal of these communication functions is to encourage patients' active participation in the clinical visit and engage patients in such a way that they understand critical aspects of their health and have the confidence needed to provide self-care. Active engagement from the patient involves expressions of concern or other feelings and assertive communication, such as offering opinions, asking questions,

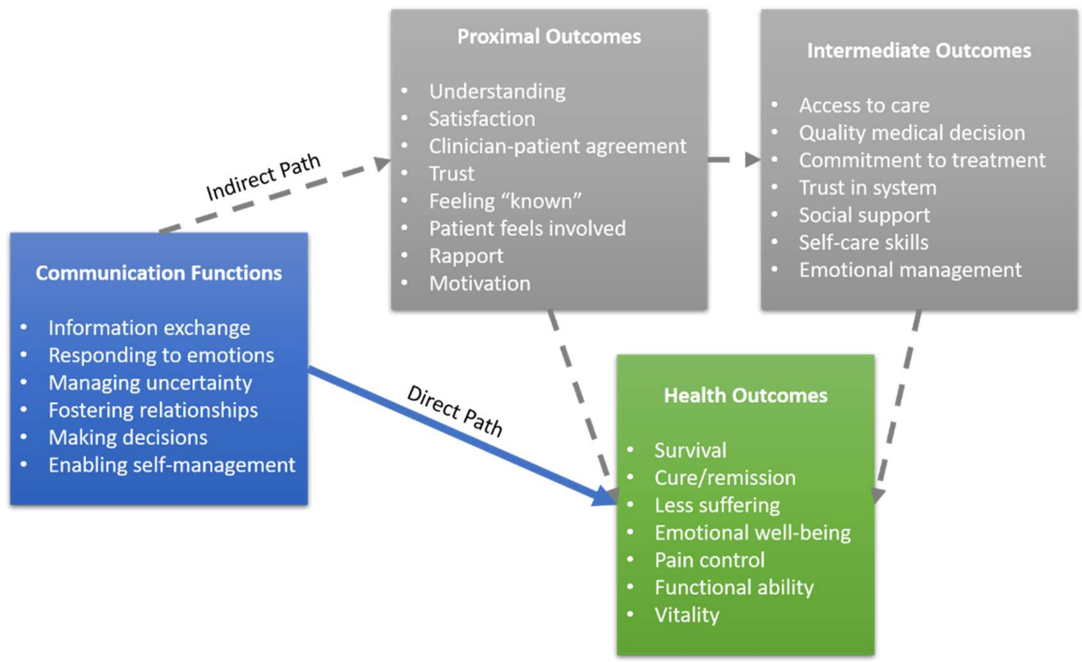

Figure 3-3. Direct and Indirect Pathways from Communication to Health Outcomes
(Street, Makoul, et al., 2009)

introducing topics, and interrupting (Epstein & Street, 2007).

Clinicians' verbal patient-centered behaviors that foster patients' active engagement include (1) demonstrating verbal attentiveness by avoiding interruptions; (2) providing information using language that the patient understands (and validating that the patient understands); (3) partnership-building by encouraging patient involvement and collaborative and participatory decision-making, and by asking about the patient as a person (e.g., questions about family, social issues); and (4) supportive or empathetic talk as demonstrated through offers of reassurance, support, and encouragement. These verbal behaviors may be further supported by nonverbal behaviors that indicate attentiveness, such as maintaining eye contact, leaning in, and nodding (Epstein & Street, 2007).

There are a number of methods to measure patient-centered communication behaviors. The two most common are (1) direct observation of the patient-clinician interaction with coding of activities by an independent observer such as the Roter Interactive Analysis System (RIAS) (Roter & Larson, 2002); and (2) participant (i.e., patient and clinician) reports following the visit (Epstein et al., 2005). The RIAS is a widely used systematic analysis of audio or video recordings of patient and clinician communication that focuses on socio-emotional and task-oriented components of the clinician-patient interaction and allows for coding of content from multiple speakers during a visit (Roter & Larson, 2002). Less common measurements of patient-centered communication behaviors include direct observation of a clinician's interaction with a standard patient, patient viewing and scoring of a video-recorded consultation, and semi-structured interviews.

All methods used to measure patient-centered communication behavior have operational challenges. An external observer may quantify the patient-clinician interaction based on an objective view of the conversation, but the observer cannot provide context of how those behaviors are interpreted. On the opposite end of the spectrum, participant reporting after the encounter may be subject to recall bias and frequently reflects a judgement of the behaviors rather than quantification of which behaviors took place (Aschengrau & Seage III, 2003; Epstein et al., 2005).

A recent review identified more than 1300 scale items to measure components of patient-centered communication (Street & Mazor, 2017); this may be another source of conflicting findings on the degree to which patient-centered communication is occurring and its impact on patients' health (Epstein et al., 2005). Further, there may be little correspondence in measurements depending on who is doing the scoring and how the measure is operationalized (e.g., subjective or quantifying the frequency of a behavior). For example, Gordon and Street (2016) compared physician, patient, and observer scores for (1) physician's information sharing; (2) patient active participation; and (3) the degree of participatory decision-making. Scores from patients, observers, and physicians correlated when measuring physicians' information-sharing behaviors. The other two measures, however, demonstrated discordance. With respect to the degree to which patients actively participated during their discussions with clinicians, physicians' ratings were not correlated with either the patients' self-reports or the observers' objective quantification. Further, patients' self-reports did not correlate with observers' quantified measures, although there was an association between patients' self-reports and observers' subjective evaluation of the exchange. The final measure—participatory decision-making—showed a lack of correlation between all three groups, although the observers' subjective and quantitative evaluations were correlated.

Therefore, depending on who is doing the measurement and what is being measured, there may be significant variability in findings.

The communication functions described by Street, Makoul, et al. (2009) are similar to the characteristics of Mishel's structure providers (e.g., credible clinical authorities) who influence patients' uncertainty; in fact, one of the communication functions from the Street, Makoul, et al. (2009) framework is managing uncertainty. Indeed, Mishel (1988) noted that credible authorities could directly and indirectly impact patients' uncertainty. Similarly, the communication functions in the Street, Makoul, et al. (2009) framework have both direct and indirect impacts on patient outcomes. If these communication functions (e.g., information exchange, responding to emotion, fostering relationships, enabling self-management, and making decisions)—called out explicitly by Street, Makoul, et al. (2009) and less directly by Mishel (1988)—can be measured in secure message content, then associations with patient outcomes should be detectable following the direct and indirect pathways described in the Street, Makoul, et al. (2009) model.

3.2.2 Pathways to influence patient outcomes. This section describes those direct and indirect pathways through which patient-clinician communication might influence patient outcomes. Street, Makoul, et al. (2009) noted few direct paths between communication and health outcomes; patient-centered communication more commonly supports indirect changes to patient outcomes.

Street, Makoul, et al. (2009) cited two examples whereby patient-centered communication might directly influence patients' outcomes: therapeutic talk where the clinician validates the patient's concerns and empathetic communication, both verbal and nonverbal, that reduce the physical impact of stress or pain. Del Piccolo et al. (2015) found that patients' anxiety increased when clinicians did not respond in a patient-centered way to patients' expressions of concern or reference to stressful events in their lives. In another analysis where breast cancer survivors watched a video of a clinical exchange, survivors expressed less anxiety after observing an exchange during which the clinician demonstrated enhanced compassion (Fogarty, Curbow, Wingard, McDonnell, & Somerfield, 1999). Clinicians' expressions of emotion may have a direct link to patients' outcomes: Ong, Visser, Lammes, and de Haes (2000) found that physicians' displays of anxiety were negatively associated with patients' self-reported quality of life. Finally, patient-centered communication may have a direct association with appropriate healthcare utilization: patients who perceived that their clinicians addressed their psychological needs and listened to their concerns were more likely to adhere to colonoscopy screening recommendations (Underhill & Kiviniemi, 2012). The proposed taxonomy's *Social communication* sub-taxa may capture some of these types of communication.

More commonly, however, patient-centered communication supports changes in health outcomes indirectly. The most immediate outputs of patient-centered communication (listed as "proximal outcomes" in Figure 3-3) are improvements in patients' understanding of information relevant to their condition, and concordance between patient and physician in terms of prioritization of concerns and treatment options (Epstein & Street, 2007; Street, Makoul, et al., 2009). Intermediate outputs include patients' satisfaction with care, trust in their clinician, confidence in their ability for self-care, and commitment to adhere to treatment recommendations. Proximal outputs may lead directly to health outcomes or to the intermediate outputs that may then lead to changes in health outcomes. Each of these outputs is discussed in more detail in the following sub-sections.

3.2.2.1 Proximal outcomes. Proximal outcomes are the most immediate results of patient-centered communication (Epstein & Street, 2007). Patient satisfaction was the most commonly studied among the proximal outcomes described in the framework (see Figure 3-3), typically measured as patient self-reports obtained at various timepoints following the clinical visit. One study explored the association between nonverbal patient-centered communication behaviors and patient satisfaction and found that direct gaze was positively associated with patient satisfaction (Farber et al., 2015). Physicians' social behaviors were also positively associated with patient satisfaction (Ong et al., 2000); these may be measured through the proposed taxonomy's *Social communication* sub-taxa.

Patients' perceptions that their clinicians understood their culture and background and could empathize with their circumstances, were associated with the partnership-building construct of patient-centered communication. Some of this may be linked to a feeling that the clinician was personally similar to the patient and assessing this by comparing patient and clinician demographic characteristics (e.g., sex, age, race) could be beneficial. Patients' perceptions of similarity with their clinicians was positively associated with satisfaction (Street, O'Malley, Cooper, & Haidet, 2008). As expressed during a semi-structured interview with a patient describing how he felt clinician communication could improve:

> "I think the background of the race of people, different races of people, study their background, their culture, their diet, what they're pretty used to eating, like we're used to eating certain things...I would think that doctors who are non-Black should learn about the Black cultures because I think he would be more in-tune to our problems...." (Hansen, Hodgson, & Gitlin, 2016, p. 1067)

In general, partnership-building talk was strongly associated with proximal outcomes for patients' satisfaction with their care, trust in their clinician, and intent to adhere to treatment recommendations (Street et al., 2008). The latter represents an indirect pathway from a proximal to intermediate outcome. Other proximal-to-intermediate outcome pathways include improved disclosure and active patient participation. For example, cancer patients' perceptions that their clinicians saw them as a person was associated with greater disclosure on the use of complementary health approaches (Sohl et al., 2015). Active patient participation was also more common if the clinician engaged in partnership-building communication (Street, Gordon, Michael, Krupat, & Kravitz, 2005). Although the proximal outcomes are not measurable in this proposed study, taxa are included that may allow for measurement of some of these behaviors.

3.2.2.2 Intermediate outcomes. Intermediate outcomes of patient-centered communication functions include improving patients' access to care and services, their knowledge of their condition, and their ability to manage their emotions; enhancing trust between patient and clinician; and empowering patients to participate in medical decision-making and their own self-care. Through these intermediate outputs, patients gain resources to facilitate improvements in their outcomes.

Street, Makoul, et al. (2009) noted that access to care includes not just referring patients to necessary tests or treatment, but also providing information about how to get those services, providing appropriate clinical referrals and coordination between healthcare teams, and advocating for the patient to receive necessary services. Several studies noted that when clinicians did not communicate about a follow-up plan, patients assumed (sometimes incorrectly) that no follow-up was necessary (Slatore et al., 2013; Sullivan, Golden, Ganzini, Hansen, & Slatore, 2015). A clear description of next steps from the clinician is therefore necessary to ensure that the patient receives appropriate treatment and follow-up. This concept relates to the proposed taxon, *Information sharing/Orientation to procedures, treatments, or preventive behaviors*.

Improvements in patients' knowledge and understanding of their condition increases their confidence and ability to manage that condition and make informed decisions about their care (Epstein & Street, 2007; Street, Makoul, et al., 2009). In a patient-centered communication approach, information sharing by the clinician does not stop at providing the patient with information; rather, clinicians should work with patients to ensure that they understand, retain, and can recall the information provided to them. To accomplish this, the clinician should be aware of the patient's expectations, knowledge, and beliefs. Frequently, however, there is discrepancy between the patient's and clinician's understanding (Arora, Weaver, Clayman, Oakley-Girvan, & Potosky, 2009; Street & Haidet, 2011; Street, Richardson, Cox, & Suarez-Almazor, 2009; Zulman, Kerr, Hofer, Heisler, & Zikmund-Fisher, 2010). Avoiding this discrepancy involves the use of plain language and repetition, asking the patient to restate what was heard in his or her own words, and encouraging active participation by the patient (e.g., asking questions, affective communication) (Epstein & Street, 2007). In spite of these challenges, studies presented positive associations between information sharing and patient satisfaction (Ong et al., 2000; Street, Makoul, et al., 2009; Street et al., 2008).

Promoting patients' trust in their clinicians and the healthcare system should reduce patients' anxiety because patients can recognize a supportive resource (Epstein & Street, 2007; Street, Makoul, et al., 2009). Arora et al. (2009) described an indirect pathway from clinicians' patient-centered communication behavior to improved trust to reduced uncertainty, but an intervention that trained clinicians to increase patients' active engagement found no association with clinician behavior and patient trust (Epstein et al., 2017). Indirectly, improved trust improves patients' satisfaction with their care

(Epstein & Street, 2007). The direct path between trust and health outcomes is less well-studied; however, a study by Lafata et al. (2013) found a negative association between patients' glycemic levels and their trust in their clinicians.

When clinicians help patients manage emotions, patients can better manage their uncertainty, anxiety, and stress, leading to better, more informed decision-making and treatment adherence (Epstein & Street, 2007; Street, Makoul, et al., 2009). In patient-centered communication, supportive talk occurs when the clinician acknowledges concerns and provides information and emotional support that allows the patient a better sense of control and self-confidence. Breast cancer survivors who watched a video of a clinician demonstrating compassionate care to a patient were more likely to believe the clinician cared about the patient than those watching a video in which the clinician did not demonstrate those behaviors (Fogarty et al., 1999). Perceptions of clinicians' competency improved when the clinicians demonstrated empathic behaviors (Kraft-Todd et al., 2017). Patients who received emotional support from their clinicians reported that support to be critical to their decision-making process (Riffin, Pillemer, Reid, & Löckenhoff, 2016). Clinicians' supportive talk was also associated with improvements in patients' active participation (Street et al., 2005) and adherence to treatment recommendations (Underhill & Kiviniemi, 2012).

Shared decision-making is an integral part of patient-centered care. To accomplish this, clinicians must engage patients to make decisions based on scientific evidence while taking into account patients' needs and values; here again, clinicians should present information in a way that patients understand (Epstein & Street, 2007). Shared decision-making improves patients' adherence to treatment and reduces medical errors (Street, Makoul, et al., 2009). Unfortunately, more than half of cancer patients reported that their clinicians engaged in sub-optimal decision-making communication (Arora et al., 2009). Several studies noted, however, that the degree to which patients desired shared decision-making varied greatly (Dehlendorf, Levy, Kelley, Grumbach, & Steinauer, 2013; Riffin et al., 2016).

More than other intermediate outcomes, communication that improved patients' decision-making was directly associated with improvements in health outcomes. Patients with diabetes who participated in collaborative goal-setting with their clinicians had lower glycemic levels at the end of the study (Lafata et al., 2013). In a separate study, patients with diabetes who also had hypertension experienced improvements in hypertension control when they reported that their clinicians supported participatory decision-making (Naik, Kallen, Walder, & Street, 2008).

Changes in patient empowerment and agency is the final intermediate outcome. This refers to patients' ability to confidently navigate the healthcare system, manage their own care, and actively participate in decisions about their treatment and care (Epstein & Street, 2007; Street, Makoul, et al., 2009). Clinicians help patients achieve these characteristics by encouraging them to be active participants and to express their feelings during visits. Cancer patients' mental health, for example, was positively associated with their self-efficacy scores (Arora et al., 2009). Topics for discussion between patient and clinician should include how to manage the condition, what strategies to take in the event of uncertainty, identification of resources (both instrumental and informational), and motivational support.

Among patients with glaucoma, eight-month self-efficacy scores were lower among patients whose clinicians did not encourage patients to ask questions and who did not provide as much education about glaucoma (Carpenter et al., 2016). Patients' proactive communication and control were also associated with better hypertension control among patients with diabetes (Naik et al., 2008), and in a randomized pilot trial, patients with diabetes who were trained on collaborative goal-setting and how to talk with clinicians had higher self-efficacy scores three and twelve months following the intervention (Naik et al., 2011).

In summary, the Street, Makoul, et al. (2009) framework identifies direct and indirect pathways in which patient-clinician communication can influence patient outcomes. Proximal and intermediate outcomes, ranging from improved patient satisfaction, increased trust in the clinician, and improved access to care and self-care skills, have been associated with improved health outcomes. This study's proposed taxa identify message content indicative of some of the framework's communication functions, as well as some of the self-care and access to care components identified in the intermediate outcomes.

This permits analyses of these communication functions within secure messages and their association with patient outcomes as identified through the Street, Makoul, et al. (2009) framework.

3.2.3 Moderators. The NCI monograph described a number of factors that impacted the association of patient-centered communication on the outcomes described above (Epstein & Street, 2007). These moderators were arranged in terms of mutability (i.e., can they be changed) and which factors might not be within the patient's or clinician's control (i.e., intrinsic). Table 3-1 presents the factors from the monograph and their assigned categories.

Table 3-1.

Factors that Moderate the Relationship Between Patient-Centered Communication and Health Outcomes

Intrinsic Stable	• Age	• Income
	• Education	• Personality
	• Family Structure	• Primary language
	• Gender	• Race
Intrinsic Mutable	• Clinician attitudes	• Perceived risk
	• Emotional disorder	• Self-awareness
	• Health literacy	• Self-efficacy
	• Illness representations	• Social distance
Extrinsic Stable	• Cultural values	
	• Regulatory factors	
	• Type of cancer	
Extrinsic Mutable	• Access to care	• Social support network
	• Family functioning	• Stage of cancer
	• Media coverage	

Note: As reported from Epstein and Street (2007)

Most studies that included moderators explored only the impact of the intrinsic stable factors. The factors most frequently studied were age, education, race, and sex. Table 3-2 summarizes these findings. In general, studies that explored the impact of age on patient-centered communication were mixed; however, the majority found a positive association between age and the pathway components of patient-centered communication. Most studies that examined the relationship between education and patient-centered communication noted a positive association between higher education and improved communication by both the patient and clinician. Findings on race were mixed, with some studies finding no association and others noting differences.

Table 3-2.

Relationship of Intrinsic Stable Factors with Patient-Centered Communication

Intrinsic Stable Factor	**Negative or No Associations**	**Positive Associations**
Age	• Patients' and clinicians' age negatively associated with patients' expressions of emotions (Del Piccolo et al., 2015) • Patients' age negatively associated with coded behavior of clinicians' information giving to patients (Street, 1991)	• Patients' age and trust in clinician (Lafata et al., 2013) • Patients' perception of feeling similar to clinician and age (Street et al., 2008) • Patients' opinion-giving behavior and age (Street, 1991)
Education	• No association between patients' education and clinicians' procedural and treatment information giving (Street, 1991)	• Patients with at least a high school education reported better clinician communication (Song et al., 2014) • Clinicians' information giving on diagnostic health and patients' education (Street, 1991) • Patient's opinion-giving behavior and education (Street, 1991) • Patients' affective behavior and education (Street, 1991) • Patients active communication and education (Street et al., 2005; Street et al., 2008) • Patients' self-reported competence in managing care and education (Lafata et al., 2013)
Race	• No differences in patient-clinician communication by race (Lafata et al., 2013; Song et al., 2014) • No differences in collaborative goal-setting by race (Lafata et al., 2013)	• Non-Hispanic whites were more likely to disclose information to clinicians (Sohl et al., 2015) • Patients in racially concordant clinician-patient pairs reported more perceived personal similarities with their clinicians than those in racially discordant pairs (Street et al., 2008) • Patients' race and concordance with clinicians regarding health priorities (Street & Haidet, 2011)
Sex/Gender	• No differences in patient-clinician communication by patient gender (Lafata et al., 2013) • Patient-clinician concordance by sex was not associated with patients' perceptions of personal similarity (Street et al., 2008)	• Male patients were more likely to disclose information to clinicians (Sohl et al., 2015) • Male patients were more likely to express opinions (Street, 1991) • Female patients were more likely to display affective behaviors (Street et al., 2005)

3.2.4 Summary. Patient-centered communication involves information-giving, partnership-building, and supportive talk by clinicians, with the goal of encouraging patients to express concerns and actively participate in the clinical visit (Epstein & Street, 2007). Some of these constructs have corollaries in the proposed taxonomy (e.g., *Information sharing/Medical guidance; Information sharing/ Orientation to procedures, treatments, or preventive behaviors;* and *Social communication/Praise and appreciation*). There is variability in how both patients and clinicians interpret the behaviors of the other (Gordon & Street, 2016). Patient-centered communication primarily impacts health outcomes indirectly by improving patient satisfaction, understanding, trust in their clinician, self-care skills, and emotional management (Street, Makoul, et al., 2009). Here again, the proposed taxonomy may capture some of these constructs. Patient-generated content coded as *Social communication/Praise and appreciation* may indicate patient satisfaction and patient self-care may be detected through some of the patient-generated taxa (e.g., *Task-oriented/ Medication refills and renewals requests; Information sharing/Self-reporting*).

Methods to measure patient-centered communication and the pathway's intermediate outcomes varied (Epstein & Street, 2007; Street, Makoul, et al., 2009; Street & Mazor, 2017). Moderators, including patient and clinician characteristics, may play a significant role on the effects of patient-centered communication (Del Piccolo et al., 2015; Lafata et al., 2013; Sohl et al., 2015; Street, 1991; Street et al., 2005; Street & Haidet, 2011; Street et al., 2008), and the proposed covariates will include some of these factors.

3.3 Technology-Mediated Communication in Support of Relational Communication

Research based on Mishel's UIT (1988) and the patient-centered communication framework developed by Street, Makoul, et al. (2009) focused on face-to-face interactions between patient and clinician. The most simplistic way of viewing communication, however, is as a transactional exchange of messages between a sender and receiver (Thurlow, Lengel, & Tomic, 2004). In computer-mediated communication (CMC), those messages are exchanged using some technological service; the term "computer" has become more loosely defined over time to include any computing technology (e.g., email, video, instant message, social media). This section highlights two CMC theories—Social Information Processing theory (Walther, 1992a) and the hyperpersonal model (Walther, 1996)—that describe how communication can mimic face-to-face communication when mediated by technology.

Early CMC theories did not promote the concept that CMC could provide opportunities for relational communication; rather the belief was that CMC could only be task-oriented because of the lack of nonverbal cues in the medium (e.g., vocalizations; body orientation, relaxation, and language; gaze; facial expression and orientation) (Wright & Averbeck, 2012). SIP theory changed this conception by exploring how time and unique verbal-only cues could support communication that fostered interpersonal relationships (Walther, 1992a; Wright & Averbeck, 2012). The hyperpersonal model incorporated components of SIP theory to describe how channel-specific elements of mediated communication, paired with how senders craft messages and receivers interpret those messages, could influence the sender-receiver relationship (Walther, 2011). These theories provide validation that patient-centered communication, which requires information exchange, responses to emotion, relationship fostering, and other support, can be provided through technology-mediated communication.

3.3.1 Social Information Processing theory. In SIP theory, Walther argues that people are inherently motivated to communicate in support of interpersonal relationship management and that regardless of the medium, they will find a way to make that relational communication happen (Walther, 1992a). There are, therefore, two fundamental components necessary to support relational communication: time and information processing, or the encoding and decoding of communication cues. Table 3-3 briefly describes these two constructs; further detail on each is provided below the table. Given enough time, dyads using technology-mediated communication modes are motivated to exchange relational messages will create and use text-based (or modality-specific) cues to support that exchange. SIP theory is typically used to highlight and explain similarities and differences between text-based communication and face-to-face communication (Walther, 2011).

3.3.1.1 Chronemics in SIP theory. Chronemics is the study of the how time plays a role in communication. Walther argued that chronemics—the first construct in SIP theory—is a critical component in effective relational communication when using a communication medium that does not provide many opportunities for vocal and kinesic cues to be exchanged (Walther, 1992a). This is because it takes additional time to craft, read, and interpret written messages. Additionally, it may take more

Table 3-3.

Main Concepts of Social Information Processing Theory

Concept	Description
Chronemics	It takes more time to create a written message, and more messages are required to transmit the same number of cues in a lean medium like email
Message encoding and decoding	In mediated communication using a lean medium, verbal content and linguistic, stylistic, or time-based cues replace nonverbal cues

messages in CMC to communicate the same number of cues as might be communicated through face-to-face communication because face-to-face communication has numerous nonverbal cues that may be leveraged (Walther, 2011). More time is therefore necessary during CMC to leverage the cues needed to communicate intent, decode those written cues, and process the message. In support of this concept, Walther published a meta-analysis of 35 studies that explored whether there was a difference in relational communication if the time granted for mediated communication was constrained (Walther, 1992b). Among the studies included, 11 did not constrain the amount of time that CMC participants had available for communication; Walther found that those studies reported lower levels of task-oriented communication when compared to studies in which CMC participants' communication time was restricted to the same amount of time as the face-to-face participants.

Walther (1995) explored the evolution of different aspects of relational communication over time and found that expressions of immediacy, action, and commonality between communication partners was higher among student CMC dyads than their face-to-face counterparts when developing a consensus statement for one of three scenarios (strategies to hire faculty, requirements for students to own computers, and the appropriateness of using writing-assistance software for class papers). Walther also noted that among his participants, those within the face-to-face group were more task-oriented than the mediated participants who were more socially-oriented. In this study, while CMC participants had unlimited 24/7 access to email for the five-week study period, the face-to-face participants met three times for up to two hours each; such constraints on time for the face-to-face participants may explain their greater task-orientation. Walter identified no statistical differences in formality over time between the two communication modalities.

Aside from Walther's meta-analysis, much of the research conducted around CMC involves one of two strategies: observations of study participants conducting a predefined task or activity, or respondents evaluating characteristics of defined scenarios. An exception to this was a survey sent to members of cancer-related listservs to evaluate their experiences using the listserv (Turner, Grube, & Meyers, 2001). The respondents in that study reported that the depth of their relationship with the listserv increased as the amount of time they spent reading messages increased.

Other studies compared how mediated and face-to-face communication evolved over time, in support of the premise that although relational development might be slower, CMC should yield similar results as face-to-face communication. Participants' initial impressions was a common focus of these studies. Walther (1993) found that students assigned to a face-to-face communication group developed initial impressions of their partners and those impressions did not change significantly over a five-week period; mediated communicators, however, had less well-developed initial impressions of their partners at the first measurement and those impressions evolved over time. Similarly, Tidwell and Walther (2002) found that the willingness to attribute characteristics to a communication partner changed significantly over time among their CMC group and increased at a greater rate than the face-to-face group, such that at the final measurement, the two group's values had converged. Tidwell argues "these findings suggest that while [face-to-face] interactants had some initial advantage in attributional confidence, perhaps due to their ability to see their partners and make attributions based on physical appearance, this advantage disappeared as the conversation evolved" among CMC participants (Tidwell & Walther, 2002, p. 335).

Another study explored whether individuals' initial impressions of an interviewee's intelligence changed over time based on the communication media (Walther, Deandrea, & Tong, 2010). Individuals' impressions did not change when they interviewed the target using phone (i.e., vocal cues); however, as the number of messages exchanged via email increased, impressions did change. Part of this may be because interviewees in this study generated significantly more answers in response to the interview questions when communicating using CMC compared with phone communication, and CMC interviewees had fewer false starts and filled pauses.

A meta-analysis conducted by Ruppel et al. (2017) explored the relationships between self-disclosure breadth (i.e., number of topics discussed) and depth (i.e., level of intimacy disclosed), communication medium (e.g., face-to-face vs CMC, both video- and text-based), and interaction time. Small but non-statistical differences in disclosures between face-to-face and CMC were identified with longer interaction times. The authors noted that the latter finding may be attributed to the small number of studies included in the analysis; however, these findings do not support the time premise of SIP theory. Similarly, in a study of college students who were getting acquainted using CMC and face-to-face communication, Tidwell and Walther (2002) found no difference in the proportion of self-disclosures between the communication media. They did note that most of the interactions between face-to-face participants involved primarily biographic questions and disclosures and that the prevalence of such peripheral questions was higher in face-to-face communication than CMC. In addition, CMC senders asked a higher proportion of questions about receivers' attitudes, values, and beliefs than was observed during the face-to-face interactions.

In summary, time is an influential component in CMC. Given sufficient time, CMC supports interpersonal relationships similar to what is accomplished through face-to-face communication, and the level of relational communication found in mediated and face-to-face communication is similar. In situations where time is constrained, communication becomes more task-oriented. In the context of secure messaging between clinicians and patients where a relationship already exists and there are no time constraints to the online communication, there is no reason to believe that relational communication—in the form of patient-centered communication and patient-activated response—is not possible.

3.3.1.2 Encoding and decoding mediated messages. The second construct in SIP involves the construction (encoding) and interpretation (decoding) of the mediated messages. Walther noted that with mediated communication, message senders have the opportunity to carefully craft messages that can convey literal intent and can also leverage mediated communication cues to replace nonverbal cues typically used in face-to-face communication (Walther, 1992a). Message receivers, in turn, may have more time to read and interpret those messages; interpretation of mediated communication cues may be open to interpretation, however, similar to nonverbal cues.

Traditionally, nonverbal cues might include linguistic, stylistic, or time-based cues; or verbal content itself (Walther, 2006). In a qualitative study of members of an online dating service, Ellison and colleagues noted the "importance of small cues" (Ellison, Heino, & Gibbs, 2006, p. 424) as their respondents developed impressions of potential dating partners. Misspellings, for example, might represent a lack of education or laziness; sending messages late at night demonstrated the individual's preference for late-night activities; and messages that were overly long might be interpreted unfavorably. Given time, people adapted to written messages as a way of communicating and incorporate new ways to convey content information might previously have been expressed through nonverbal cues (Thurlow et al., 2004).

Brown, Fuller, and Thatcher (2016) evaluated how some of those "small cues"—the use of uppercase and lowercase letters; spelling, grammar, and typing errors; and emoticons—impacted assessments of email senders' social, functional, political, and methodological competence. Participants were randomly assigned to read a set of emails with the same narrative content that had one feature modified (i.e., letter case, errors, or emoticons). The participants then evaluated the sender's competence after each email. Senders who employed a neutral style of writing that essentially lacked any cues (i.e., standard case, no errors or emoticons) were rated lower in social competence than senders who included emoticons. Senders using a neutral writing style scored higher in political competence compared with senders who wrote in all lowercase letters. Neutral writing was also scored higher in functional competence over messages with emoticons, all uppercase, or all lowercase letters. An unexpected finding was that senders who included emoticons in their messages were scored as more methodologically competent than those who wrote in a neutral style.

Similar to the Tidwell and Walther (2002) and Walther et al. (2010) studies where impressions evolved over time, Brown et al. (2016) found that changing cues over time resulted in changed perceptions. Evaluations of senders' social, functional, and political competence improved with a switch in writing style from including emoticons, errors, or all lowercase to neutral. No change was reported under those conditions for methodological competence. Evaluations of methodological competence, as well as functional and political competence, improved following a switch from all uppercase letters to a neutral writing style. Social and methodological competency evaluations decreased when the writing style switched from including emoticons to a more neutral style.

The use of emoticons as cues in email communication may not be as straightforward as it seems, however. Emoticons can reinforce the narrative portion of a message, as in the case of a negative message with a negative emotion like a frowning face (Walther & D'Addario, 2001). Readers of messages that included a positive message followed by a negative emoticon, however, rated those messages as unhappy as a negative message with a negative emoticon. A similar effect was not observed when a negative message was paired with a positive emoticon: in that situation, the reader interpreted the message as ambiguous. This indicates that not all cues will be interpreted as the sender might expect.

A variety of socioemotional cues are utilized in verbal-only mediated communication. During face-to-face communications immediacy—a marker of intimacy and related to action, involvement, and inclusion between partners—was associated with pleasantness, pauses in speech, smiling, body relaxation, and directness of gaze (Walther, 1995). Fewer cues are available to CMC communicators to express immediacy; Walther's work found that these included explicit positive statements of affection, topic changes, indirect disagreement, and praise. Similarly, mediated communication of affection (or lack thereof) may be expressed using explicit positive statements of affection or topic changes, compared with face-to-face cues that include smiling, facial orientation, head movement, gaze, vocal pleasantness and timbre. As expected through SIP theory, although the overall amount of socioemotional communication was similar in this study between CMC and face-to-face communication, the variance accounted for through verbal-only communication differed significantly between the two forms of communication. Most of the variance in mediated communication of immediacy and affection was accounted for by verbal cues while the face-to-face communication variance accounted for by these cues was minimal.

3.3.1.3 Summary. A number of mediated communication cues have been identified that replace nonverbal cues that cannot be used in CMC. By using these cues, senders and receivers can achieve levels of relational communication possible through face-to-face communication. Through mediated communication, impressions and relationships evolve over time as happens with face-to-face communication. Mediated communication includes cues that facilitate interpersonal communication; however, the cues used in CMC are different from those used in face-to-face communication. Although the proposed taxonomy is not designed to capture these cues, SIP theory (Walther, 1992a) notes these cues are likely present to support interpersonal communication; therefore, patient-centered communication should be supported by secure messaging.

3.3.2 The hyperpersonal model. In contrast to the SIP theory that focused on time and the construction and interpretation of the messages themselves, the hyperpersonal model identifies how CMC might occur through impersonal, interpersonal, or hyperpersonal communication (Walther, 1996). Impersonal, or task-oriented, CMC might occur when artificially induced by limited timeframes (referencing SIP theory) or when there is no need for an interpersonal communication goal. Interpersonal CMC, as with face-to-face communication, will occur given enough time and motivation. According to Walther, hyperpersonal communication occurs when CMC users—in part due to the absence of nonverbal cues and the anonymity of the media—create and manage relationships in a more positive (or negative) way than might occur through face-to-face communication (Walther, 1996). The latter construct will not be addressed in this paper since Walther noted in later work that hyperpersonal communication may not be possible when relationships include both online and offline communication (Walther, 2011); given that the patient-clinician relationship is typically initiated through face-to-face communication, hyperpersonal communication is not relevant for this study.

Walther describes four components of CMC that support interpersonal and hyperpersonal communication.

Table 3-4.

Hyperpersonal Model Constructs

Component	Description
Channel	• Users of mediated communication will take advantage of the features of the communication medium • Characteristics of text-based communication that might be leveraged are: anonymity of the communication and the time and cognitive resources afforded by the medium to thoughtfully compose and interpret messages (Walther, 1996; Walther, van der Heide, Ramirez, Burgoon, & Pena, 2015)
Sender	• CMC facilitates selective self-presentation • Senders may craft messages that presents them in a desirable light if they so choose (Walther, 1996; Walther et al., 2015)
Receiver	• Recipients may make assumptions about the sender based on the sender's group characteristics (Walther & Parks, 2002) • Recipients may make overly positive or negative attributions of the sender in absence of cues that might normally result in a contrary opinion
Feedback	Describes a loop wherein the sender's selective self-presentation and the recipient's overly generalized interpretations of the sender may lead to idealized perceptions that result in behavioral changes on both sides to meet those expectations (Walther et al., 2011)

3.3.2.1 Mediated channel factors that influence relational communication. The first construct in the hyperpersonal model focuses on the effect the communication medium itself has on the relational aspects of the communication exchange. The asynchronous nature of most text-based CMC benefits communicators in several ways. The hyperpersonal model leverages the chronemics construct from SIP by noting that time allows message senders time to edit and thoughtfully compose their messages. Walther (1996) noted having almost unlimited time to "plan, contemplate, and edit one's comments more mindfully and deliberatively than one can in more spontaneous, simultaneous talk" (p. 26). This may lead lists those constructs with a brief description. Additional details are provided below the table.

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Walther (2007) also found that the time spent composing messages was not driven primarily by typing speed, but rather editing and word count. Editing was positively and more strongly associated than word count with self-reported mindfulness during message composition. Study participants also selectively edited depending on the desirability of the targeted recipient: male college students edited their messages most when writing to female college students, compared to messages to high school students or other male college students. Conversely, female college students edited the most when composing messages to female college professors, followed by when they wrote to male college students. Differences by sex in the absolute number of edits were also observed: female students made, on average, 71.5 edits for high-status targets like a college professor, compared with 49.5 edits among male students. In these scenarios, the student spent more time editing when the recipient was more desirable or respected (i.e., male student or college professor). It is therefore possible that within a patient-clinician relationship using secure messaging for communication, there may be unequal levels of mindfulness and editing between the patient and clinician depending on the recipient's level of desirability.

The second component of text-based mediated communication that supports relational communication is the ability to devote more cognitive resources to the message construction and interpretation. A study of patients of online therapists reported that one of the features they appreciated best about online communication with their therapist was the ability to re-read messages and devote more mental resources to understanding the messages received from their therapist (Cook & Doyle, 2002). They also noted more comfort in expressing themselves via writing; part of this may be due to a "sense of freedom they felt to express themselves online without embarrassment or fear of judgment from therapists. Many expressed the stress they typically feel in a face-to-face therapy situation and indicated that, for the first time, they were able to be completely honest and open with a therapist" (Cook & Doyle, 2002, p. 101). Walther noted that with CMC there is no longer a need to simultaneously process multiple cue types and sources as must occur in face-to-face communication, although this has not been well studied (Walther, 2011; Walther, Slovacek, & Tidwell, 2001)

Consistent with the theory that email affords its users flexibility and ability to devote more resources to message composition and interpretation, survey respondents scored email highest on accessibility, personalization, and persistence (Fox & McEwan, 2017). Moderate scores were assigned to email for editability, conversational control, privacy, and anonymity. Face-to-face communication, however, scored highest on the ability to convey and understand expressions of emotion (i.e., bandwidth) and social presence, two attributes for which email scored lowest.

A survey of participants in online support groups found that the strongest characteristics promoting use of such support groups were anonymity, interaction management (i.e., ability to plan and write a good message), and 24/7 access (Walther & Boyd, 2002). In another study, students were asked to evaluate each communication medium (email, face-to-face, phone, and instant messaging) for its comfort, availability, security, feedback immediacy, media cues, and sociability across four scenarios (Palvia, Pinjani, Cannoy, & Jacks, 2011). Email was the predominant choice over other communication media for all situations with high uncertainty and high equivocality, where word choice was critical and double meanings were possible. Regardless of uncertainty level, email was also the preferred choice in low equivocality situations. Face-to-face communication was preferred in highly social conditions, when confidentiality was a concern, and when information integrity had to be maintained.

Conversely, another study asked students which medium they would use to communicate to a close friend about tickets to a basketball game, a pay raise, diagnosis of a sexually-transmitted disease, and participation in a car crash but study participants did not select email as the most appropriate medium for any scenario (Oeldorf-Hirsch & Nowak, 2018). Email was, however, selected as the most convenient measure most of the time.

In summary, an electronic communication modality like email allows users more control over messaging. The hyperpersonal model highlights features specific to CMC modalities—the ability to edit according to one's own schedule and the convenience of being able to respond 24/7—that are the exact features both clinicians and patients highlighted as reasons they liked SM as a form of communication (Haun et al., 2017; Haun et al., 2015; Nazi, 2013; Rief et al., 2017; Wade-Vuturo et al., 2013).

The absence of nonverbal cues that are common in face-to-face communication, and the use of other mechanisms within the electronic modality to convey emotion or intent (e.g., emoticons), may result in unintended interpretations of the message content. As noted previously, this study will not explore the use of non-narrative cues within secure messaging; however, the findings reported in this section provide support to the concept that mediated communication such as email supports patient-centered communication that reduces patient uncertainty and improves outcomes.

3.3.2.2 Careful message coding and selective self-presentation. The second construct in the hyperpersonal model addresses how the sender might leverage time and the ability to carefully construct the message to selectively present himself or herself more (or less) desirably, or deliver a message with more (or less) ambiguity (Walther, 1996). With CMC, the sender has more control over the nonverbal cues included in the message; additionally, the sender can devote all cognitive resources to crafting the message whereas during face-to-face communication there is a need to simultaneously attend to the communication partner’s nonverbal cues. Reduced cues (i.e., no nonverbal cues) may permit reallocation of the senders’ cognitive resources to message construction. This may mean that the sender is able to better construct messages that achieve their intended message goal (Walther, 2006).

Senders tend to vary the language they use to communicate messages depending on the intended recipient. For example, language complexity varies depending on the recipient: when writing to a renowned professor, college students increased the complexity of their language but they decreased the complexity of their message when writing to classmates or high-school students (Walther, 2007). Language use also varies between CMC and face-to-face conversations. Mediated conversation included more prepositions, causation words, and past-tense language than vocal conversations (Walther et al., 2010). Email messages intended to disclose romantic interest used more positive language than voicemail messages for the same topic; however, for more task-oriented activities, voicemail messages used more positive language (Wells & Dennis, 2016). When communicating with a high-school student, senders used more personalized language than when sending messages to a more high-status target like a college professor.

Consistent with the concept of selective self-presentation, members of an online dating service reported presenting their idealized self or a desired future state (e.g., reporting weighing less than they actually did) in their personal profile to facilitate finding a dating partner more aligned with their interests (Ellison et al., 2006). One participant described a situation in which a sender reported being a scuba diver when the sender did not have the experience the participant would have anticipated for such a claim. In discussing the situation, the participant stated "they may not have tried to lie; they just have perceived themselves differently because they write about the person they want to be" (Ellison et al., 2006, p. 426).

In summary, senders may take time and use more editing to carefully craft a message to a more desirable target and the converse may also be true. This study will not assess these factors but message length and time to respond may be elements that could be used to assess these issues.

3.3.2.3 Reliance on cues to develop perceptions of sender. The third construct of the hyperpersonal model relates to the message recipient, or receiver. The receiver construct states that in the absence of nonverbal cues, receivers may develop an overreliance on the cues available to them within the message and develop inflated perceptions of the sender as a result (Walther, 1996).

The receiver construct is derived in part from the Social Identity/Deindividuation (SIDE) theory, which states that due to the anonymity offered by some CMC media, communicators must infer things about each other based on their membership in an online social community (Walther, 1996). SIDE theory predicts that greater attraction will occur between individuals within common communities and interactions occur based on the social norms of that community (Rabby & Walther, 2003). SIDE theory, therefore, predicts interactions based on social experience and less on individual interpersonal relationships. The hyperpersonal model deviates from SIDE theory by focusing on relationship building based on cues within the mediated communication rather than group membership.

To support the receiver construct in the hyperpersonal model, Walther referenced a study conducted by Snyder and Tanke (1977), in which men were shown photos of attractive and unattractive women and asked to describe those women's characteristics based solely on the photo. Men evaluated attractive women as sociable, humorous, and poised, while unattractive women were rated as socially inept, awkward, and serious. Walther modified the Snyder and Tanke study to evaluate the receiver component of the hyperpersonal model (Walther et al., 2001). The study introduced members' photos to international student work teams; some teams had prior interactions (long-term) and others were new to each other (short-term). There was no visual interaction until or unless a photo was introduced. Teams with a longer history of working together who were never shown a photo reported higher ratings for social attractiveness, intimacy, and affection than either the long-term teams who were shown photos or the short-term teams with and without photos. In addition, there was a negative impact on team members' interactions following the introduction of photos. From these findings, it appears that team members developed an idealized impression of their colleagues and that the introduction of a photo that provided visual cues about individuals' physical appearance may have changed those idealized impressions.

There are other examples of over-attribution within mediated communication. In a study in which students were provided cues about an interviewee's intelligence prior to a phone or mediated interview, students conducting the CMC interview rated their interviewee's intelligence as higher than those who conducted the interview on the phone (Walther et al., 2010). Another study compared messages with the same content but containing different cues relating to the sender's gender (i.e., male vs female), messages perceived as being sent by a female were evaluated as being more professional than those sent by males (Marlow, Lacerenza, & Iwig, 2018).

The sender's gender had other impacts on the receiver's perception of their messages. Traditionally, high person-centered communication (i.e., patient's perception that the clinician considered the patient's preferences and needs and included the patient in the decision-making process when the patient desired inclusion) is associated with women while low person-centered communication is associated with men (High & Solomon, 2014; Spottswood, Walther, Holmstrom, & Ellison, 2013). When study participants reviewed email messages from a sender with a gender-neutral name, they were more likely to assume that messages with high person-centered content were sent from a woman and that men sent messages evaluated as low person-centered (Spottswood et al., 2013). Any type of person-centered support received from a man was evaluated as more sensitive if received via CMC compared to face-to-face interactions (High & Solomon, 2014). When the support received was counter to the expected norms (e.g., if messages sent from a sender with a male-gendered name had high person-centered content), the CMC evaluation for sensitivity and appropriateness was rated lower than similar support received in person.

In summary, the receiver construct highlights how messages might be interpreted by the message recipient in the absence of the typical nonverbal face-to-face cues. Much of this construct assumes that the sender and receiver have not met in person and therefore may not apply to the patient-clinician relationship.

3.3.2.4 Over-attribution within a feedback loop. The feedback construct is the least supported and researched of all constructs in the hyperpersonal model. Walther (1996) describes a feedback loop whereby the effects of the senders' selective self-presentation, and the receivers' over-attribution of the senders' characteristics, are intensified through behavioral confirmation. The partners in the exchange react to the expectations conveyed in the messages they receive. Here again, Walther's premise was based in the work published by Snyder and Tanke (1977) in which men who thought they were speaking on the phone with attractive women exhibited more positive affects (i.e., the men were more sociable, sexually warm and permissive, outgoing, and humorous). In fact, each man was randomly assigned to a woman; the photo he was shown was not of the woman with whom he spoke. Independent judges, given access only to each woman's side of the conversation and who were blinded to whether the man though the woman was attractive or unattractive, evaluated women in the attractive target group similarly to the men's initial evaluation of those women before the conversation began. Essentially, the woman's (receiver's) behavior in response to man's (sender's) message was to change her behavior to conform to the expectations delivered in the sender's message. The hyperpersonal model anticipates that text-only CMC would yield similar results.

One study evaluated the impact of mediated written feedback on college students' behavior. In it, students were asked to self-present as either introverted or extroverted in a public blog or private online journal that would be evaluated later; the students were to convey that behavior (i.e., introvert or extrovert) by relating examples from their lives rather than making something up (Walther et al., 2011). Some students then received feedback on their writing that validated the behavior they were instructed to provide, others received no feedback. The study found that receipt of reinforcing feedback amplified the conveyed behavior (e.g., individuals who presented as extroverted tested more highly extroverted after the writing exercise).

3.3.2.5. Summary. Both the SIP theory and the hyperpersonal model focus on the increased control senders have over their text-based messages, because of increased time to construct the message, the cognitive resources available to mindfully create the message, and the selection of content and cues that may be included in the message. As a result, asynchronous text-based CMC offers senders greater flexibility and control over the communication. For patients' communication with their clinicians, SM gives patients the opportunity to frame their message and edit as necessary based on their schedule, which may be desirable for sensitive health topics. For those individuals wishing to communicate solely on impersonal, task-oriented activities, this form of communication may offer convenience and access without many of the socioemotional factors necessary in face-to-face and phone exchanges. This may correspond to the proposed task-oriented taxa (e.g., medication refills, appointment scheduling). In addition, reinforcing feedback received through CMC had an amplification effect: receivers of feedback that reinforced their behavior were more likely to convey that behavior again. Considering the proposed taxonomy, patients who receive praise from clinicians (i.e., messages coded with *Social communication/Praise and appreciation*) for improvements in health status may experience some of the amplification effect theorized through the hyperpersonal model.

The hyperpersonal model constructs of receiver and feedback are less supported that the first two constructs (channel and sender). Walther (2011) noted that the effect of each may vary if partners communicate both online and offline, as happens between patients and clinicians. Further, with the advent of social media and the extensive information available about many on the internet, creating idealized representations of a sender may no longer be necessary or desired.

3.4 From Theory to Propositions

Figure 3-4 provides a high-level model of how secure messaging use might resolve uncertainty and lead to changes in patients' outcomes, based on the UIT (Mishel, 1988), Walther's CMC theories (1992a, 1996), and the Street, Makoul, et al. (2009) framework. Further detail is provided below

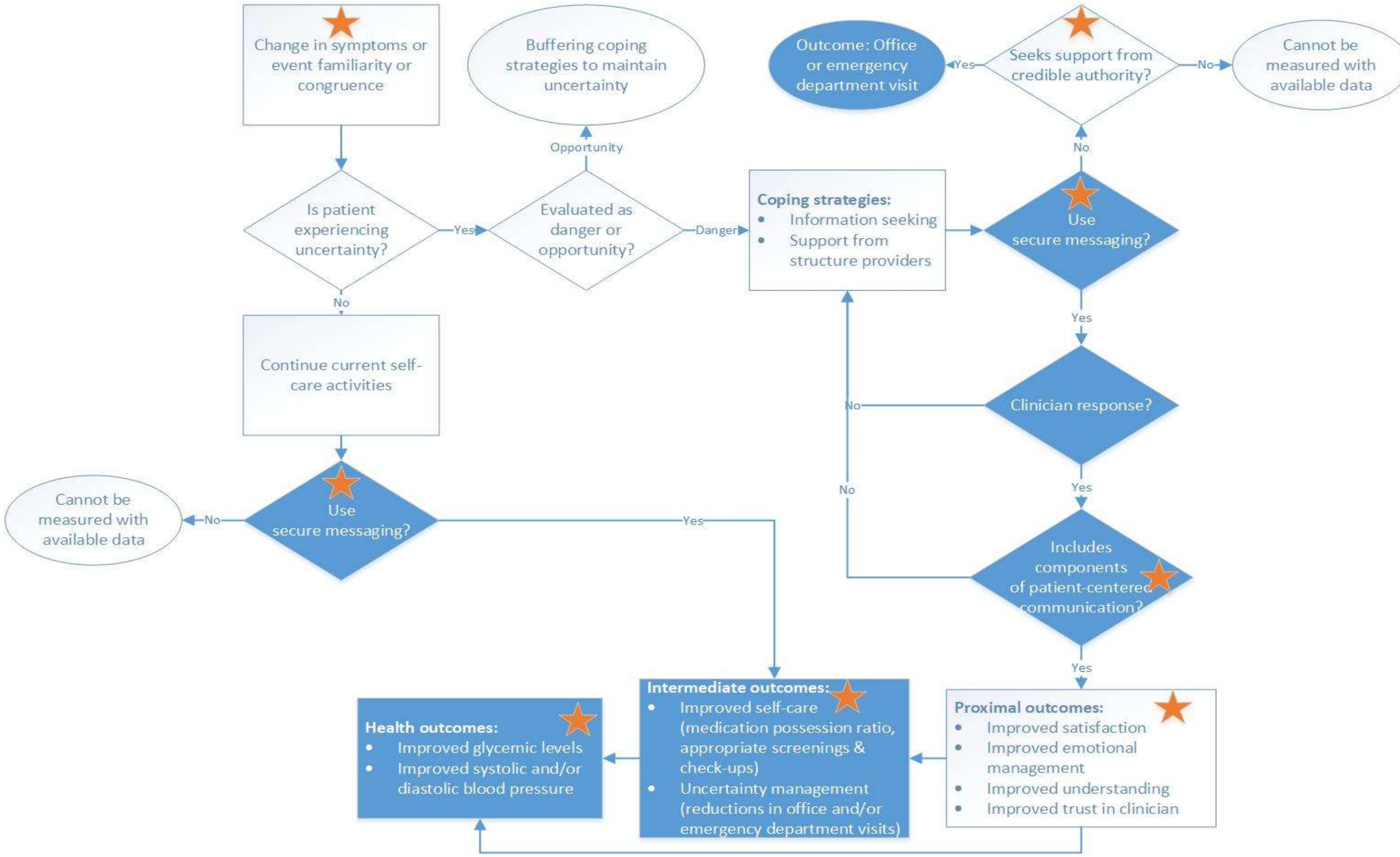

Figure 3-4. Theory Application to Secure Messaging

Notes: (1) Blue-shaded shapes are potentially measurable with current research; unshaded shapes are not measurable. (2) Orange stars represent points where impact from moderators may be observed. Possible moderators include age and sex of the patient and/or clinician; patient's education, trust in clinician, and current health status. (3) Components of patient-centered communication that could be measured through the secure messaging taxonomy include information sharing, responding to emotions, managing uncertainty, and making decisions.

the figure about the evolution of the propositions that frame the proposed model. Appendix C summarizes each research paper's goals, objectives, propositions, research questions, and hypotheses.

In brief, a patient who experiences uncertainty because of a change in the stimuli frame (i.e., symptom pattern, or event familiarity or congruence; refer to Appendix B for a complete list of definitions) may seek support from his or her supportive resources (i.e., structure providers) to manage the uncertainty; in this case, the structure provider would be a credible clinical authority. Patients with access to secure messaging (i.e., registered with the patient portal) may opt to use it to communicate with their clinicians. If patients receive responses from their clinical team and those responses provide adequate content to mitigate patients' uncertainty, then those patients may use that information to increase their self-mastery and thereby manage their uncertainty. An appropriate clinical response may also garner improved trust in the clinician and satisfaction with the healthcare system, which strengthens partnership-building and patient engagement. Patients may benefit from improved understanding of their condition and better self-care skills based on clinical responses, which may lead to improvements in patients' health outcomes and appropriate reduction in clinic and emergency department visits.

According to the UIT, a patient who experiences ambiguity, lack of clarity, or unpredictability during their illness may experience uncertainty (Mishel, 1988). Patients who identify the uncertainty as opportunity will employ buffering coping mechanisms to maintain that uncertainty. If, however, that uncertainty is perceived as a danger—which occurs frequently when a patient's mastery, or agency, is perceived as insufficient for the situation—the patient may employ coping strategies that include information seeking or emotional management from their structure providers (see Appendix B for definitions). Those structure providers may include clinicians with whom the patients have some measure of trust. Patients not experiencing uncertainty are unlikely to reach out to their clinicians for information.

Information-seeking and sharing should be available in formats with which patients are most comfortable (Brashers et al., 2002; Institute of Medicine, 2000). Email is the modality of choice when concerns are non-urgent, when convenience is a top priority, and for matters of high uncertainty (Oeldorf-Hirsch & Nowak, 2018; Palvia et al., 2011). This is supported by research by Nazi (2013) and Haun et al.

(2017) in which patients cited convenience as a primary benefit of secure messaging. As noted by SIP (Walther, 1992a), mediated communication such as email allows individuals to mindfully craft messages that present themselves in the best light. Therefore, within the context of secure messaging, patients who are comfortable with email as a communication modality will use secure messaging as a communication tool with their clinicians when convenience is valued, and the issue is not urgent.

As noted by Walther (1996), there will be circumstances where task-oriented (i.e., action requests and responses) messaging is appropriate and desired. Survey responses indicated that email was the preferred communication modality for simple, straightforward situations with little equivocality (Palvia et al., 2011); respondents preferred email because of its accessibility, personalization, and permanence (Fox & McEwan, 2017). As a result, patients with chronic illnesses who prefer to use email to communicate will likely employ task-oriented secure messaging functions to manage their care because it allows them to accomplish such tasks at their convenience. Task-oriented message functionality that might support mastery of a chronic illness and the healthcare environment include self-monitoring reports (e.g., sending blood pressure or blood sugar), ensuring regular office visits (e.g., appointment scheduling), and medication management (e.g., prescription refills), all of which have been shown to improve patient outcomes when performed outside of secure messaging (Greenwood, Gee, Fatkin, & Peeples, 2017; McManus, Mant, Haque, & et al., 2014). Within task-oriented messages, there is a need to distinguish between activity types since task-oriented messages that are more administrative (e.g., sick note renewal) and lack ties to patient outcomes in the literature may not have a similar association with outcomes. Propositions 1 and 2 identify which areas need specific taxa to identify patients' task-oriented content types that will, and will not, be associated with patient outcomes.

> P1: Patient messages that include content related to self-care (e.g., *Medication refills and renewals requests, Scheduling*) will be associated with improved patient outcomes.

Task-oriented requests are not the only communication that patients may employ through secure messaging. SIP theory identified three manifestations of technology-mediated communication (Walther, 1992a). The first two manifestations (impersonal and interpersonal) appear in many secure messaging classification systems to date. As noted by Walther (1996), impersonal task-oriented messages will only occur when artificially induced by constraints of the medium or when there is no need for interpersonal communication goals. Because humans are inherently motivated to develop relational communication, most messages exchanged between patients and clinicians should support interpersonal, or relational, communication.

Consistent with SIP theory (Walther, 1992a), verbal communication strategies that exist for face-to-face communication should persist within the mediated communication medium if sufficient time is permitted for the communication. Because a secure message thread is accepted to be most like a clinical visit, it should therefore be expected that secure messages could support patient-centered communication. Clinician responses may serve to maintain, increase, or reduce the patient's level of uncertainty (Brashers et al., 2002; Mishel, 1988). Information-sharing from clinicians that is conveyed in plain language—using terms that the patient can recognize and understand—improves patients' understanding (Street, Makoul, et al., 2009), and has positive associations with patient satisfaction (Ong et al., 2000; Street, Makoul, et al., 2009; Street et al., 2008). Such clinician-generated information sharing messages should facilitate uncertainty management by allowing the patient to recognize a pattern in their symptoms, better anticipate the future, or otherwise achieve clarity (Mishel, 1988). If adequate response is received, patients may not require an in-office visit, an outcome measured as an appropriate reduction in healthcare services use. In addition, patients who receive appropriate information may regain their sense of mastery or agency. Following the indirect path between patient-centered communication and health outcomes, a strong sense of mastery yields improved self-care and ultimately, improved patient health outcomes (Hibbard & Greene, 2013; Laurance et al., 2014; McManus et al., 2014). Keeping the appropriateness of the clinical response in mind, an additional proposition can be derived:

> P2: Patients whose clinicians respond with information sharing message content will have improved outcomes.

In contrast, interactions that do not support the patient raise uncertainty within the patient (Mishel, 1999; Street, Makoul, et al., 2009). Credible authority relates to the degree of confidence and trust that patients have in their clinical team. Consistent with patient-centered communication principles, the top five behaviors associated with gaining patient trust included providing comfort, demonstrating competency, encouraging and answering questions, and providing explanations of processes, procedures, and appropriate referrals (Thom, 2001). Patients who trust their clinicians may be more open to sharing information with the clinicians (Epstein & Street, 2007). Patient-centered communication improves trust and therefore encourages information exchange; a clinician may accomplish this is through offers of reassurance, support, and encouragement to the patient (Epstein & Street, 2007). The Street, Makoul, et al. (2009) framework indicated that trust between patient and clinician can lead to an indirect pathway to improved outcomes, therefore:

> P3: Patients who shared information with their clinicians using secure messaging will have improved health outcomes and reduced healthcare utilization.

> P4: Patients whose clinicians sent messages of praise or appreciation will have reduced healthcare utilization and improved health outcomes.

Trust may be eroded, however, if the patient is dissatisfied with his or her care (Brashers et al., 2002; Brashers et al., 2006). Patients whose messages indicate dissatisfaction with their care will therefore likely have poorer outcomes.

Each of these trust-building functions could be communicated through mediated communication (Alpert et al., 2017). Consequently, if clinicians' responses to patient-generated information-seeking messages do not include information that reduces patient uncertainty (e.g., provides a task-oriented response such as "make an appointment" or a response is not provided), or their responses provide information in such a way that exceeds the patient's cognitive capacity or health literacy level, then the benefits of the communication noted in the preceding propositions will not manifest and the patient will need to seek other ways to manage their uncertainty. If the patient still desires support from the clinician, this may manifest as a new healthcare visit. Alternatively, the patient may seek support elsewhere, perhaps from their social network, family, or other information sources. If those alternate sources do not provide accurate or adequate information, the patient's health may suffer, which leads to the next proposition:

P5: Patients whose clinicians do not respond or otherwise defer information sharing will poorer outcomes.

Both the UIT (Mishel, 1988) and the patient-centered communication pathway (Street, Makoul, et al., 2009) highlighted the importance of conveying information in a way that the patient understands. In the same way that clinicians must consider their approach to patient-centered communication during face-to-face patient encounters, the language and verbal cues in secure messages are important to ensure that patients understand the information being shared. An advantage of secure messaging and other mediated communication is that clinicians can take their time in crafting their messages appropriately, which clinicians cited as an advantage in prior studies (Nazi, 2013; Wade-Vuturo et al., 2013)

In the absence of following up with patients to assess their understanding of the information shared, proxies must be identified. A study that examined the reading level of secure messages found that most clinician-generated messages were written on a reading level that was interpretable by the patient; however, 29 percent of secure message threads included a clinical response that was more than three Flesch-Kincaid Grade Levels (FKGLs) above the patient's (Mirsky et al., 2016b). Such a significant gap in reading level for those messages may result in challenges in patients' understanding of the content. It will therefore be important to compare the FKGLs of clinicians' responses to those of patients' messages as a proxy measure of cognitive capacity. It is expected that clinician responses to patients' secure messages that are not written at a comparable reading level will not reduce the patient's uncertainty.

The theories leveraged for this research highlighted the importance of moderators on the associations between the constructs (Mishel, 1988, 1990; Street, Makoul, et al., 2009). As discussed in this chapter and the preceding one, patients' evaluations of uncertainty and coping strategies may vary by demographic characteristics and health status (Street, Makoul, et al., 2009); communication strategies vary by patient and clinician characteristics such as age, sex, race, primary language, and individuals' use of mediated communication may vary by the characteristics of either the sender or receiver and their comfort level with the communication medium (Byron, 2008; Gilligan et al., 2017; Morrow, 2016; Trauzettel-Klosinski & Dietz, 2012; Walther, 2007). It will therefore be important for the proposed study to assess the impact of patient and clinician characteristics on the use of secure messaging, message content, and outcome measurements, which leads to the following propositions:

> P6: Secure messaging content will vary by patient demographic characteristics and health status.
>
> P7: Secure messaging content will vary by clinicians' demographic characteristics and the number of secure messages they send.

4. Research Paper 2: Secure Messaging and Healthcare Utilization

4.1 Introduction

The goal of Research Paper 2 is to demonstrate associations between secure message taxa and patients' healthcare utilization, operationalized as the number of office and emergency department visits and medication adherence rate. To date, no published research has explored whether message content classified using a theory-based taxonomy was associated with changes in patients' utilization of healthcare services. Studies exploring the associations between healthcare utilization and secure messaging use typically quantified the number of messages rather than exploring the association between utilization and message content. The one study that explored the association between message content and medication adherence used machine learning to identify relevant word clusters rather than a theory-based taxonomy assigned to message content; as a result, the findings were specific to the condition studied (breast cancer) (Yin et al., 2018). Both SIP theory and the hyperpersonal model demonstrate that relational communication is supported through mediated communication, so it is possible that patient-clinician communication that builds trust and informs the patient should yield benefits similar to face-to-face interactions. Consistent with the Street, Makoul, et al. (2009) framework, therefore, patient-centered communication offered through SM should be associated with improved outcomes.

For this paper, the healthcare utilization outcome will be measured through office and emergency department visits, as well as patients' medication adherence rates. This paper addresses the question: Which patient-generated and clinician-generated message taxa are associated with reduced office and/or emergency department visits, or improved medication adherence? Table 4-1 lists the hypotheses for this Research Paper. Because secure messaging is an avenue for communication between patients and clinicians, Section 4.2 describes the relevance of patient-clinician communication on patient satisfaction and health outcomes. Section 4.3 then reviews published findings on secure messaging and patients' utilization of healthcare services. The final sub-sections discuss the proposed research methodology and study limitations; the methodology builds on the work described for the first Research Paper (Chapter 2).

Table 4-1.

Research Questions and Hypotheses for Research Paper 2

Hypotheses
2-1a. Patients who sent messages assigned *Task-oriented* content not associated with uncertainty (e.g., *Medication refills and renewals requests*), will have fewer office and emergency department visits, and higher MPRs, compared to patients who sent messages not coded as *Task-oriented* that were not associated with uncertainty.
2-1b. Patients who sent messages assigned *Task-oriented* content not associated with uncertainty (e.g., *Medication refills and renewals requests*), will have fewer office and emergency department visits, and higher MPRs, compared to patients who did not use the patient portal to initiate a message thread.
2-2a. Patients who received messages assigned clinician *Information sharing* taxa (excluding *Defer)* will have fewer office and emergency department visits, and higher MPRs, compared to patients who did not receive messages assigned *Information sharing* taxa.
2-2b. Patients who received messages assigned clinician *Information sharing* taxa (excluding *Defer)* will have fewer office and emergency department visits, and higher MPRs, compared to patients who did not use the patient portal to initiate a message thread.
2-3a. Patients who sent messages assigned *Information sharing* taxa will have fewer office and emergency department visits, and higher MPRs, compared to patients who sent messages coded with other taxa.
2-3b. Patients who sent messages assigned *Information sharing* taxa will have fewer office and emergency department visits, and higher MPRs, compared to patients who did not use the patient portal to initiate a message thread.
2-4a. Patients who received messages assigned the clinician *Praise or appreciation* taxon will have fewer office and emergency department visits, and higher MPRs, compared to patients received non-*Praise or appreciation* messages from clinicians
2-4b. Patients who received messages assigned the clinician *Praise or appreciation* taxon will have fewer office and emergency department visits, and higher MPRs, compared to patients who did not use the patient portal to initiate a message thread.
2-5a. Patients who did not received a response to their initiated thread will have more office and emergency department visits, and lower MPRs, compared to patients who received a response to the thread they initiated.
2-5b. There will be no difference in office visits, emergency department visits, or MPR between patients who did not received a response to their initiated thread and patients who did not use the patient portal to initiate a message in 2017.
2-6a. Patients who received messages assigned clinician *Defer* or *Deny* taxa will have more office and emergency department visits, and lower MPRs, compared to patients who received messages assigned the clinician *Information sharing* or *Fulfill* taxa.
2-6b. There will be no difference in office visits, emergency department visits, or MPR between patients who received messages assigned clinician *Defer* or *Deny* taxa and patients who did not use the patient portal to initiate a message in 2017.

4.2 Patient-Clinician Communication

This section describes the limitations and benefits of technology-mediated communication, such as secure messaging, between patients and clinicians. The 2001 Institute of Medicine (IOM) report highlighted the importance of patient-centered care to overall healthcare effectiveness, quality, and safety (Institute of Medicine, 2001). Since the 2001 IOM report, additional focus has been placed on ensuring that communication is patient-centered—that is, it should support evidence-based shared decision making while considering the patient's needs and wants (Institute of Medicine, 2001). There are many factors that contribute to effective patient-centered communication, including patient and clinician characteristics, the relationship between those individuals, and how healthcare is delivered (Epstein et al., 2005). The latter includes access to care, wait times, visit length and frequency, and mode of communication (e.g., verbal, electronic). Changing one component of the communication exchange, such as making electronic communication options available, does not ensure that the communication is patient-centered (Epstein & Street, 2011; Levinson, Lesser, & Epstein, 2010); however, a critical feature in managing patients' uncertainty around their illnesses includes the availability of trusted authorities (e.g., clinicians) (Mishel, 1988). Use of electronic communication mechanisms improve patients' access to their trusted clinical authorities between office visits. Access to those trusted sources who may provide educational resources as well helps patients adapt to their health status, may lead to better self-management and improved health outcomes (Mishel, 1988; Street, Makoul, et al., 2009).

Patient-clinician communication goals should garner trust, encourage shared decision making, and support information-seeking and information-sharing behaviors between both patient and clinician (Ong, de Haes, Hoos, & Lammes, 1995). Consensus guidelines for clinicians advise that information should be communicated in "simple and direct terms," using plain language and pictographs or visual aids for patients with low health literacy or numeracy (Gilligan et al., 2017). Patients' characteristics, such as age and sex, may impact how and what is understood of the information being shared. For example, medication adherence requires that patients understand the appropriate quantity of which medications to take when. Among older patients with diabetes who may need to manage four or five medications a day, the complexity of adherence may present a significant challenge (Morrow, 2016).

Communication modality may also impact patients' comprehension and retention of the shared information. One study examined whether visits with a primary care physician needed to occur with the primary care physician, and if so, whether they needed to happen in-person. Almost 20 percent of in-office visits that required a primary care physician were determined to be suitable for another modality

(Pelak, Pettit, Terwiesch, Gutierrez, & Marcus, 2015). In contemplating a shift to a different form of communication such as secure messaging, however, consideration must be given to the limitations of that communication modality. Although empathy with the patient is a commonly-identified component of patient-centered communication, emotions are frequently difficult to express and commonly misinterpreted in email communication (Byron, 2008). In addition, written forms of communication may present challenges for individuals with low health literacy. Processing capacity and the ability to express and perceive emotion may decline with age (Byron, 2008; Morrow, 2016). There may also be differences in reading speed and accuracy when information is presented on a computer rather than on paper (Trauzettel-Klosinski & Dietz, 2012).

The IOM identified value in the use of alternate communication modalities, such as phone and email, between clinical visits as a way to provide opportunities for patients to follow-up with their clinician regarding information that was forgotten or missed during the clinical visit (Institute of Medicine, 2001). A significant amount of information—between 40-80 percent (da Assunção et al., 2013; Kessels, 2003; Tarn & Flocke, 2011)—is forgotten almost immediately by patients. When given opportunities to seek information in between clinic visits, many patients may take advantage. A study conducted to evaluate the impact of between-visit encounters among patients with diabetes found than more than three-quarters of the patients had a between-visit encounter: 63 percent had a phone encounter and 41 percent used secure messaging (Lyles et al., 2012). Patients with between-visit encounters had better glycemic control but worse cholesterol control. In addition, many studies that evaluated secure message content identified information seeking behaviors (i.e., questions about condition or medications) as commonly-occurring message types.

In summary, while technology-mediated communication may offer convenience and flexibility to both patients and clinicians, there may be limitations in its utility for certain patients with low health literacy, complex health conditions, or limited cognitive capacity.

4.3 Secure Messaging and Patients' Utilization of Healthcare Services

This section provides a general description of how healthcare utilization is measured within the populations of interest and reviews published literature that explored the association between secure messaging and healthcare utilization. Research Paper 2 focuses on patients with either hypertension, diabetes, or both conditions.

Treatment of diabetes and hypertension include both lifestyle management and pharmacologic treatments. Recommendations for lifestyle changes include weight management, dietary changes, physical activity, and smoking cessation (American Diabetes Association, 2018b; Garber et al., 2018; Qaseem et al., 2017; Whelton et al., 2018). Pharmacologic treatment varies depending on the individual, severity of disease, and comorbidities. Each condition has an escalating scale of treatments available and the more severe the disease the more medications the patient is likely to require for optimal disease management. In addition, guidelines for patients with diabetes recommend clinical evaluation every three months that includes screening for hypertension, high cholesterol, and a foot examination. Recommendations for both conditions include additional home measurement and health status tracking (American Diabetes Association, 2018b).

The Agency for Healthcare Research and Quality (AHRQ) described a number of metrics appropriate to measure healthcare utilization; some are population-based and others may be used to measure individual use (Agency for Healthcare Research and Quality, Accessed 2018). At an outpatient individual level, metrics to assess healthcare utilization include physician office and hospital outpatient visits, emergency department visits, receipt of a prescription medication in a calendar year, receipt of a hospital inpatient discharge, and a dental visit in a calendar year.

Table 4-2 lists published studies that examined the association between patient healthcare utilization and SM. There are two types of healthcare utilization included in the table: (1) selected measures as identified by AHRQ (i.e., number of office visits, urgent care and emergency visits, and phone calls or consultations) and (2) whether the recommended screenings and testing was completed. The latter are identified in Table 4-2 with a caret. When differences were observed in utilization rates,

Table 4-2.

Association Between SM and Patients' Healthcare Utilization Reported in SM Literature

Outcome (DV)	Increase in Utilization	Decrease in Utilization	No Association
Office visit (OV)	• Increase in total OVs, primary care visits, and specialty care visits* (Harris et al., 2009) • Increase in OV in those with follow-up periods <1 year (North, Crane, Chaudhry, et al., 2013) • 1.25% increase in annual OVs with every 10% increase in SM threads (Liss et al., 2014)	• Average 1 fewer OV per patient per year (Bergmo et al., 2005) • Annual OV rates decreased by 0.23 – 0.25 visits per member (6.7% decrease compared to non-SM users) (Zhou, Garrido, Chin, Wiesenthal, & Liang, 2007)	• No statistical difference in OVs after adjustment for "first message visit surge" (North, Crane, Chaudhry, et al., 2013) • No association in OV frequency between SM-users and non-SM users (Meng et al., 2015)
Emergency visits	Increase in emergency visits* (Harris et al., 2009)	Decrease in urgent care visits among facilities that adopted SM early (Shimada et al., 2013)	• No change in urgent care visits among facilities that adopted SM later (Shimada et al., 2013) • No association between SM-users and non-SM users for emergency or after-hour visits (Meng et al., 2015)
Glycemic screening and testing^	• SM associated with 11 percentage point improvement in HEDIS measure performance for A1C screening (Zhou et al., 2010) • Increase adherence to biannual testing among patients with diabetes associated with increased frequency of SM use*; no difference seen if SM measurement taken in year preceding outcome date or the quarter preceding it (Harris, Koepsell, Haneuse, Martin, & Ralston, 2013) • Increased SM frequency associated with greater likelihood of meeting A1C screening target* (Chung et al., 2017)	N/A	N/A
Low-density lipoprotein (LDL) screening^	SM use associated with improved performance on HEDIS measure for LDL screening (Zhou et al., 2010)	N/A	N/A
Nephrology monitoring among patients with diabetes^	• SM use associated with improved performance on HEDIS measure for nephropathy screening (Zhou et al., 2010) • Increased SM frequency associated with greater likelihood of meeting nephrology monitoring target* (Chung et al., 2017)	N/A	N/A
Phone consultation	Increase from 279 scheduled phone visits to 281 (per 1000 members) (Meng et al., 2015)	• 13.7% fewer phone calls among SM users (Zhou et al., 2010) • 0.2 fewer patient-initiated phone calls annually (Meng et al., 2015)	No change in number of phone calls among either intervention or control groups (Bergmo et al., 2005)
Retinopathy screening among patients	• SM use associated with improved performance on HEDIS measure for retinopathy screening (Zhou et al., 2010) • Increased SM frequency associated with greater likelihood of meeting eye exam	N/A	N/A

with diabetes^	screening target* (Chung et al., 2017)	

Notes: *Statistical evidence of dose-response effect. ^Utilization measured in terms of adherence to guidelines. A1C=glycated hemoglobin; HEDIS=Healthcare Effectiveness Data and Information Set; LDL=Low-density lipoprotein; OV=Office visit; SM=Secure messaging

they tended to be small. All studies that examined whether guideline-recommended screening and testing occurred identified an association between guideline adherence and use of secure messaging (Chung et al., 2017; Harris et al., 2013; Zhou et al., 2010).

Several publications noted an increase in both messages and healthcare utilization around the first use of SM. Meng et al. (2015) observed a 143 percent increase in utilization of clinical services, excluding phone calls, in the month following first use of SM. Zhou et al. (2007) noted a similar spike in utilization, but observed that it both preceded and followed portal registration. Meng et al. (2015) and North, Crane, Chaudhry, et al. (2013) reported that the surge dissipated within four to six months. Published studies addressed the utilization surge in different ways: Zhou et al. (2007) excluded the two-month period on either side of the portal registration date while North, Crane, Chaudhry, et al. (2013) opted to exclude the 30-day period following the date the first SM was sent.

In summary, there are a number of ways that healthcare utilization may be measured and findings to date are mixed about the effect of secure messaging on those measured outcomes.

4.4 Methods for Research Paper 2

Research Paper 2 builds on the methodology described in Chapter 2. The coded sample of messages created through that work will be analyzed in a series of regression analyses. The sample population (VCU Health adult patients with hypertension, diabetes, or both conditions) and the message sample (all message threads initiated by selected patients that were initiated and completed within calendar year 2017) are the same as described in Chapter 2. Table 4-3 lists the hypotheses for Research Paper 2, with the associated analytic cohort and independent and dependent variables. Following the table are sections describing how the dependent and independent variables are measured, what analytic methods are proposed for this paper, and the estimated adequacy of the study sample.

Table 4-3.

Research Paper 2 Hypotheses and Associated Analytic Components

Hypothesis	Analytic Cohort	Independent Variables	Dependent Variables
2-1a. Patients who sent messages assigned *Task-oriented* content not associated with uncertainty (e.g., *Medication refills and renewals requests*), will have fewer office and emergency department visits, and higher MPRs, compared to patients who <u>sent messages not coded as *Task-oriented* that were not associated with uncertainty.</u>	All patients who initiated at least one message thread in 2017	Taxon counts: 1. Medication refills and renewals requests 2. Other administrative 3. Cancellation 4. Follow-up 5. Preventive care or physical exam 6. Reschedule 7. Grouping of these 6 taxa	1. Office visits 2. Emergency department visits 3. Diabetes medication MPR 4. Hypertension medication MPR
2-1b. Patients who sent messages assigned *Task-oriented* content not associated with uncertainty (e.g., *Medication refills and renewals requests*), will have fewer office and emergency department visits, and higher MPRs, compared to patients <u>who did not use the patient portal to initiate a message thread</u>.	Patients who sent *Task-oriented* content not associated with uncertainty AND patients who did not use the patient portal to initiate a message thread in 2017	Taxon counts: 1. Medication refills and renewals requests 2. Other administrative 3. Cancellation 4. Follow-up 5. Preventive care or physical exam 6. Reschedule 7. Grouping of these 6 taxa	1. Office visits 2. Emergency department visits 3. Diabetes medication MPR 4. Hypertension medication MPR
2-2a. Patients who <u>received</u> messages assigned clinician *Information sharing* taxa (excluding *Defer)* will have fewer office and emergency department visits, and higher MPRs, <u>compared to patients who did not receive messages assigned *Information sharing* taxa</u>.	All patients who initiated at least one message thread during 2017	Taxon counts: 1. Medical guidance 2. Orientation to procedures, treatments, or preventive behaviors 3. Grouping of these 2 *Information sharing* taxa	1. Office visits 2. Emergency department visits 3. Diabetes medication MPR 4. Hypertension medication MPR
2-2b. Patients who <u>received</u> messages assigned clinician *Information sharing* taxa (excluding *Defer)* will have fewer office and emergency department visits, and higher MPRs, compared to patients <u>who did not use the patient portal to initiate a message thread</u>.	Patients who sent messages coded with *Information sharing* taxa AND patients who did not use the patient portal to initiate a message thread in 2017	Taxon counts: 1. Medical guidance 2. Orientation to procedures, treatments, or preventive behaviors 3. Grouping of these 2 Information sharing taxa	1. Office visits 2. Emergency department visits 3. Diabetes medication MPR 4. Hypertension medication MPR
2-3a. Patients who <u>sent</u> messages assigned *Information sharing* taxa will have fewer office and emergency department visits, and higher MPRs, <u>compared to patients who sent messages coded with other taxa</u>.	All patients who initiated at least one message thread during 2017	Taxon counts: 1. Clinical update 2. Response to clinician's message 3. Self-reporting 4. Grouping of these 3 *Information sharing* taxa	1. Office visits 2. Emergency department visits 3. Diabetes medication MPR 4. Hypertension medication MPR

Hypothesis	Analytic Cohort	Independent Variables	Dependent Variables
2-3b. Patients who sent messages assigned *Information sharing* taxa will have fewer office and emergency department visits, and higher MPRs, compared to patients who did not use the patient portal to initiate a message thread.	Patients who sent messages coded with *Information sharing* taxa AND patients who did not use the patient portal to initiate a message thread in 2017	Taxon counts: 1. Clinical update 2. Response to clinician's message 3. Self-reporting 4. Grouping of these 3 *Information sharing* taxa	1. Office visits 2. Emergency department visits 3. Diabetes medication MPR 4. Hypertension medication MPR
2-4a. Patients who received messages assigned the clinician *Praise or appreciation* taxon will have fewer office and emergency department visits, and higher MPRs, compared to patients received non-*Praise or appreciation* messages from clinicians	All patients who initiated at least one message thread during 2017	Praise or appreciation taxon counts (clinician-generated)	1. Office visits 2. Emergency department visits 3. Diabetes medication MPR 4. Hypertension medication MPR
2-4b. Patients who received messages assigned the clinician *Praise or appreciation* taxon will have fewer office and emergency department visits, and higher MPRs, compared to patients who did not use the patient portal to initiate a message thread.	Patients who sent Information sharing AND patients who did not use the patient portal to initiate a thread in 2017	Praise or appreciation taxon counts (clinician-generated)	1. Office visits 2. Emergency department visits 3. Diabetes medication MPR 4. Hypertension medication MPR
2-5a. Patients who did not received a response to their initiated thread will have more office and emergency department visits, and lower MPRs, compared to patients who received a response to the thread they initiated.	All patients who initiated at least one message thread during 2017	Non-response count	1. Office visits 2. Emergency department visits 3. Diabetes medication MPR 4. Hypertension medication MPR
2-5b. There will be no difference in office visits, emergency department visits, or MPR between patients who did not received a response to their initiated thread and patients who did not use the patient portal to initiate a message in 2017.	Patients who did not receive a response to their initiated thread AND patients who did not use the patient portal to initiate a thread in 2017	No response/No messaging	1. Office visits 2. Emergency department visits 3. Diabetes medication MPR 4. Hypertension medication MPR
2-6a. Patients who received messages assigned clinician *Defer* or *Deny* taxa will have more office and emergency department visits, and lower MPRs, compared to patients who received messages assigned the clinician *Information sharing* or *Fulfill* taxa.	All patients who received messages coded as *Defer* or *Deny* AND all patients who received messages coded as *Information sharing* or *Fulfill*	Taxon counts: 1. Defer 2. Deny 3. Grouping of these 2 taxa	1. Office visits 2. Emergency department visits 3. Diabetes medication MPR 4. Hypertension medication MPR
2-6b. There will be no difference in office visits, emergency department visits, or MPR between patients who received messages assigned clinician *Defer* or *Deny* taxa and	Patients who received messages assigned clinician *Defer* or *Deny* taxa AND patients	Taxon counts: 1. Defer 2. Deny 3. Grouping of these 2 taxa	1. Office visits 2. Emergency department visits 3. Diabetes medication MPR

Hypothesis	Analytic Cohort	Independent Variables	Dependent Variables
patients who did not use the patient portal to initiate a message in 2017.	who did not use the patient portal to initiate a thread in 2017		4. Hypertension medication MPR

MPR=Medication possession ratio

4.4.1 Measures. Research Paper 2 explores the association between message taxa and healthcare utilization among patients with hypertension and diabetes. The proposed outcomes selected to assess patients' rates of healthcare utilization are: (1) number of office visits; (2) number of emergency department visits; and (3) rate of medication adherence. These measurements are based only on patients' visits to VCU Health and will only include medications prescribed by VCU Health clinicians. As a result, there may be some gaps if patients opt to receive care outside the VCU Health delivery network.

4.4.1.1. Dependent variable measurement: Office and emergency department visits. Visits will be captured for the same period that secure messages are collected: January 1 through December 31, 2017. This is consistent with published literature (Harris et al., 2009; Liss et al., 2014; Meng et al., 2015; Shimada et al., 2013; Zhou et al., 2007). Office visits include all visits to a VCU Health outpatient setting, identified based on the nursing unit to which the encounter is associated. The office visit metric is the count of outpatient visits the patient had at VCU Health clinics between January 1 and December 31, 2017. Emergency department visits will be similarly identified and counted, inclusive of all visits to VCU Health emergency departments during the study period (January 1 through December 31, 2017).

4.4.1.2. Dependent variable measurement: Medication possession ratio. Medication adherence will be assessed over the same time period as the other healthcare utilization measures (January 1 through December 31, 2017). Medication adherence is calculated using the prescription-based medication possession ratio (MPR), estimated as the sum of days' medication supply for the calendar year excluding supply from last refill, over the number of days included in the refills (measured as the number of days between the most recent refill in the calendar year and the first fill in the calendar year) (L. T. Tang et al., 2017). L. T. Tang et al. (2017) found that this prescription-based MPR demonstrated stronger associations with patient outcomes and less variability in estimates of adherence for patients with polytherapy than other adherence measures.

Data used to calculate the MPR include dosing information (e.g., 2 tabs per day for 30 days), date(s) in which the patient refilled each prescription, and the number of refills. For each medication prescribed for the patient in 2017, dosing information will be used to estimate the number of days' supply the patient was prescribed; the number of days will be calculated based on number of days between the first fill date to the next refill date (difference between the two dates). This will be calculated *k* times, where *k* represents the number of refills for the selected medication. This calculation will be performed for each hypertension- and diabetes-associated medication. There will, therefore, be two outcomes metrics for MPR: a diabetes MPR and a hypertension MPR. If a patient receives multiple medications for a condition, the average MPR across medications associated for a specific condition will be used in final analyses (L. T. Tang et al., 2017). To minimize the information abstracted from the EHR, only the calculated MPR for each condition-specific medication will be captured during chart review, with a differentiator by condition.

Because these analyses use condition-specific outcomes, each analysis will include only those individuals with the condition relevant for the condition-specific MPR. Patients with both hypertension and diabetes will be included in both the hypertension medication MPR and diabetes medication MPR analyses, with a covariate that indicates that they have both conditions.

4.4.1.3. Independent variable measurement: Taxa counts. The independent variables for this study are the message taxa. These will be estimated as aggregated counts of the number of taxa assigned to messages sent in 2017 for each patient. If a message is assigned more than one taxon, each will be counted. The taxa applied through content analysis should be mutually exclusive and exhaustive (Krippendorff, 2019); therefore as with an in-person visit, if a patient discusses multiple issues with a clinician or a clinician responds by providing a number resources or different information, these should be reflected in coding output and aggregated taxa counts. Each taxon is therefore represented as its own unit in the analyses and there may be more assigned taxa than messages. Prior research demonstrated that fewer than one-quarter of messages are assigned multiple taxa (Cronin, Fabbri, et al., 2015; North, Crane, Stroebel, et al., 2013; Sittig, 2003) so the impact may be negligible.

Many of the hypotheses (2-1 through 2-3, 2-6) predict associations based on Level 1 taxa (e.g., *Task-oriented* or *Information seeking*), or whether the taxa are markers for uncertainty. For these hypotheses, analyses for the sub-taxa under the stated Level 1 taxon will be analyzed as described in the preceding paragraph. An additional analysis will sum the sub-taxa counts within the Level 1 taxon for an analysis that uses the grouping at the Level 1 taxon. Appendix D lists each taxon, its parent taxa, and the its anticipated association with uncertainty. When taxa groupings are necessary, the metric will be the sum of the counts for all taxa within that grouping.

Hypotheses 2-2b, 2-3b, and 2-4b include in the analytic population patients who did not use the patient portal to initiate a message to their clinician in 2017. For these analyses, the patients who did not use the portal will receive a zero value for the taxon count.

4.4.1.4. Independent variable measurement: Non-response. Hypotheses 2-5a and 2-5b explore the association between healthcare utilization and the lack of a clinician response to a patient-initiated thread. Message threads will be coded as clinician non-response if the thread only included patient-generated messages. All threads will be assigned a bivariate value for this variable: either Yes, if a clinician responded via secure messaging at least once; or No if the only messages in the thread were patient-generated. As with the taxa metric, the number of non-responses will be summed for the calendar year for the final analysis to provide for a continuous value as the independent variable.

The analysis for Hypothesis 2-5b, which compares patients who initiated at least one thread for which no response was received to patients who did not use the patient portal to initiate a message, will be based on a bivariate variable created for this regression model. In this model, patients with at least one non-response value will be coded as “Non-response,” while patients who did not use the portal will be coded as “No messaging” (essentially a 1/0 variable). This will permit comparison of healthcare utilization across the two populations.

4.4.1.5. Covariates. Analyses for all hypotheses will include covariates identified through Research Paper 1's descriptive analyses as statistically relevant. Since oversampling was not done, identifying statistical associations by individual taxa may be difficult for some patient characteristics; associations may only be detectable in the grouped taxa analyses. In addition, patients' illness severity will be included, operationalized as the baseline glycemic levels (A1C) for patients with diabetes, and baseline systolic blood pressure (SBP) and diastolic blood pressure (DBP) for patients with hypertension. The baseline measurement is the most recent measurement obtained in 2016 before the study period begins. This illness severity covariate will be included for all regression models.

The other covariate included in the analyses is an indicator of patients' health conditions. This element will capture whether the patient has only diabetes, only hypertension, or both conditions. In the analyses exploring office or emergency department visits, the covariate will include all three options and will be converted to the appropriate dummy variables. For condition-specific MPR analysis, however, only patients with the relevant condition will be included; in those situations, the covariate will be dichotomous (only selected condition versus both conditions).

4.4.2 Study sample. Appendix F). As such, for patients with each condition it is expected that statistical differences may be

Table 4-4 displays an assessment of whether a one-unit change in visits and MPR is possible given the proposed sample sizes (see Chapter 2, section 2.7 for details and Appendix F indicates the estimated number of patients with at least one message coded for each taxon). Because the proposed outcomes for office and emergency department visits do not vary based on the patient's health condition (i.e., diabetes or hypertension), the full patient sample of patients with messages is used for the office and emergency department regression models; an indicator for health condition will be included in analyses as a covariate (dummy variable that includes the options for only diabetes, only hypertension, or both conditions). Assuming the study sample's messaging is similar to the pilot study's messaging habits, a statistical difference for office or emergency department visits should be detectable for all taxa except *Preventive care or physical exam.* The medication possession ratio, however, is condition-specific; to detect a one-unit change in MPR with for 80 percent power, a sample size of 116 is required (see Appendix F). As such, for patients with each condition it is expected that statistical differences may be

Table 4-4.

Estimated Sample Sufficiency for Healthcare Services Outcomes by Taxa[a]

Taxa	Percent of pilot study patients with at least one message	Sufficient sample size to measure statistical change in visits	Sufficient sample size to measure statistical change in MPR
Patient Task-Oriented Requests			
Medication refills and renewals requests	54.8	Yes	Yes
New or change medication request	26.0	Yes	Yes
Other administrative	57.5	Yes	Yes
Referral request	17.8	Yes	No
Scheduling request	--	--	--
Cancellation	26.7	Yes	Yes
Follow-up	22.7	Yes	Yes
Laboratory test or diagnostic procedure	25.3	Yes	Yes
New condition or symptom	26.7	Yes	Yes
Preventive care or physical exam	6.7	No	No
Reschedule	40.0	Yes	Yes
Patient Information Seeking			
Logistical information	64.4	Yes	Yes
Symptoms/Condition	41.1	Yes	Yes
Patient Information Sharing			
Clinical update	34.2	Yes	Yes
Response to clinician's message	57.5	Yes	Yes
Self-reporting	16.4	Yes	No
Clinician Responses			
Task-oriented/Recommendation to schedule an appointment	32.9	Yes	Yes
Action responses	--	--	--
Acknowledgement	34.2	Yes	Yes
Denies	27.4	Yes	Yes
Fulfills request	76.7	Yes	Yes
Partially fulfills request	63.0	Yes	Yes
Information seeking	35.6	Yes	Yes
Information sharing	--	--	--
Deferred	35.6	Yes	Yes
Medical guidance	63.0	Yes	Yes
Orientation to procedures, treatments, or preventive behaviors	43.8	Yes	Yes
Social Communication			
Appreciation and praise	37.0	Yes	Yes
Complaints	23.3	Yes	Yes
Life issues	27.4	Yes	Yes

[a] The pilot study sampled from patients who wrote at least one non-*Task-oriented* message; these results may therefore underestimate the proportion of *Task-oriented* taxa (and clinical responses to *Task-oriented* messages) that may occur in a sample of patients who wrote all messages.
MPR=Medication Possession Ratio

detectable for all but two taxa (*Referral request* and *Preventive care or physical exam*).

4.4.4 Analysis. Appendix C lists the research question and hypotheses for Research Paper 2, the focus of which is to explore the association between taxa and the selected healthcare utilization outcomes (office and emergency department visits, and condition-specific MPRs). The hypotheses associated with this paper focus the expected association between selected taxa (or taxa groupings) and the outcomes of interest. Research Papers 2 and 3 propose to use linear regression and will include covariates identified in Chapter 2 as having a statistical association with at least one taxon.

Each outcome metric for healthcare utilization is measured as a continuous variable. Linear regression allows for identification of a one-unit change in the selected outcome (i.e., office visit, emergency department visit, or condition-specific MPR) as use of the taxon of interest increases, while controlling for appropriate patient and clinician characteristics. Each regression analysis will include appropriate covariates (i.e., patient and clinician characteristics identified through the analyses described in Chapter 2) and the frequency with which the selected taxon was sent to, or received by, the patient. Table 4-3 (above) lists the dependent and independent variables associated with each hypothesis; a regression analysis will be conducted for each independent and dependent variable combination. At a minimum, each hypothesis is associated with four regression analyses (one for each outcome, or dependent, variable). If multiple taxa apply to a hypothesis, then a regression model will be completed for each taxon for each dependent variable. Hypothesis 2-1a, for example, involves 28 regression models (six taxa, one taxa grouping, and four outcomes). Based on the hypotheses associated with this research paper, the taxa of interest include *Task-oriented* sub-taxa not associated with uncertainty (e.g., *Medication refills and renewals requests*), *Information sharing* sub-taxa, and *Deferred* and clinician-generated *Appreciation or praise* taxon. The output of all regression analyses will permit an understanding of the change in each of the selected healthcare utilization metrics associated with the use of the taxa or taxa grouping included in each model.

A linear regression model is appropriate because the study employs continuous outcome measures (percentages, continuous numeric values, and count data). The independent variables are continuous (taxa counts); the covariates include a combination of continuous, dichotomous, and categorical elements. Categorical elements will be converted to dummy variables for these analyses. Data cleaning steps will identify outliers, leverage, and influence, and appropriate steps will be conducted to reduce those data points' influence should any exist. Other quality assurance steps will be conducted to ensure the model assumptions hold for linearity, homogeneity of variance, normality, multicollinearity, and independence. Appropriate adjustments will be made if any of these issues are identified.

4.5 Limitations

Research Paper 2 only examines healthcare utilization within the VCU Health system. Care received outside of VCU Health will not be measured. VCU Health provides comprehensive care, is a Level 1 trauma center, has one of only two National Cancer Institute-designated cancer centers in the state, and includes more than 700 physicians across 200 specialties. As such, it provides comprehensive care and most patients may not need to go beyond VCU Health to receive care. This will, however, be recognized as a study limitation and is a limitation shared with other publications (Chung et al., 2017; Harris et al., 2009; Liss et al., 2014; North, Crane, Chaudhry, et al., 2013).

Not all patient-generated messages receive a secure message response—a clinician or staff member may call a patient to have a more detailed discussion, for example. Those non-message responses will not be coded and in some cases, there will not be documentation of such a response in the clinical chart. It is likely that a phone call response to a secure message would serve to reduce a patient's uncertainty in the same way that an electronic message might, with associated improvements in patient outcomes. Not being able to code and document such a response should result in a bias towards the null, or a Type II error (i.e., it appears that uncertainty is not managed through messaging although it may have been through another communication modality) (Aschengrau & Seage III, 2003). Thus, study findings will present a conservative estimate of the association between secure messaging taxa and healthcare utilization. Similarly, any communication conducted outside the secure messaging modality is not captured in these analyses. The hope is that by having two comparison groups—those who did not use the secure messaging functionality during the study period and those who did but sent messages coded with other taxa—that some of that variation can be controlled.

The sample is based on patient-initiated messages that were saved to the patient's chart. This likely excludes some messages for which there was no clinical message response. The lack of a clinical response to any patient communication is likely associated with an increase in uncertainty (Brashers et al., 2002), but this cannot be assessed through the available data. It is unknown how many messages are not saved to the clinical chart. If a patient sent a message that was not saved to his or her chart because there was no clinical response, it is likely that regardless of the message content (e.g., indicative of uncertainty or not), the lack of a response would increase uncertainty as the patient waited for a response from their credible clinical authority (Mishel, 1984, 1988; Mishel et al., 1991; Street, Makoul, et al., 2009). In this scenario, the patient might increase use of healthcare services with no corresponding indication of messaging use. Patients' trust and satisfaction with their clinicians and the healthcare system might also decline as a result, possibly leading to poorer outcomes (Street, Makoul, et al., 2009). Because the study sample shows no record of these patients' messages, they would be counted as not sending messages, resulting in a bias away from the null, or an increased likelihood of a Type I error (Aschengrau & Seage III, 2003).

Finally, the MPR calculation averages the medication possession of the patient over the course of the year. It is possible that a patient may initiate use of secure messaging for prescription refills part-way through the calendar year; in that situation, an MPR that is averaged over the year may not be sensitive enough to detect a change. There is, unfortunately, unlikely to be adequate sample size if the MPR were estimated quarterly. The estimates for the association between MPR and message taxa will therefore be a conservative estimate of effect, with the expectation that there is a bias towards the null for the MPR analyses.

5. Research Paper 3: Associations Between Message Content and Health Outcomes

5.1 Introduction

The goal of this paper is to demonstrate associations between secure message taxa and patients' health outcomes, as measured by A1C levels for patients with diabetes and blood pressure control for patients with hypertension. This chapter reviews published literature that explored relationships between secure messaging and patient health outcomes, discusses in more detail the health outcomes of interest for this research (hypertension and diabetes), and describes the proposed methodology for the research.

To date, published research that explored associations between secure messaging and patients' health outcomes focused on quantifying the number of messages sent rather than exploring the content of those messages. This research is novel because it applies a theory-based taxonomy to both patient and clinician message content and explores which taxa are associated with changes in patient health outcomes. Research Paper 3 will therefore address the following question: Which patient-generated and clinician-generated message taxa are associated with improved glycemic levels and blood pressure control? Table 5-1 lists the associated hypotheses for this paper.

5.2 Secure Messaging and Health Outcomes

This section reviews literature published about patient health outcomes and secure messaging. In addition, it describes health outcomes of interest for the two health conditions being studied (diabetes and hypertension).

Health outcomes analyzed in secure messaging research are extensive: human immunodeficiency virus (HIV) viral load, smoking cessation, anxiety levels among patients diagnosed with general anxiety disorder, low-density lipoprotein (LDL) levels, glycemic control among patients with diabetes, and blood pressure control among patients with hypertension. Table 5-2 lists the outcomes included in each study and the observed directionality of the association. Most studies cited in Table 5-2 are non-experimental observational studies using secondary data sources. Of the three randomized controlled trials identified from the literature review, two found a positive association between health outcomes and SM use (Houston et al., 2015; Ralston et al., 2014) and the third found no association (Greenwood et al., 2014).

Table 5-1.

Research Paper 3 Hypotheses

Research Paper 3 Hypotheses
3-1a. Patients who sent messages assigned *Task-oriented* content not associated with uncertainty (e.g., *Medication refills and renewals requests*), will have improvements in their A1C and blood pressure, compared to patients who sent messages not coded as *Task-oriented* that were not associated with uncertainty.
3-1b. Patients who sent messages assigned *Task-oriented* content not associated with uncertainty (e.g., *Medication refills and renewals requests*), will have improvements in their A1C and blood pressure, compared to patients who did not use the patient portal to initiate a message thread.
3-2a. Patients who received messages assigned clinician *Information sharing* taxa (excluding *Defer)* will have improvements in their A1C and blood pressure, compared to patients who did not receive messages assigned *Information sharing* taxa.
3-2b. Patients who received messages assigned clinician *Information sharing* taxa (excluding *Defer)* have improvements in their A1C and blood pressure, compared to patients who did not use the patient portal to initiate a message thread.
3-3a. Patients who sent messages assigned *Information sharing* taxa will have improvements in their A1C and blood pressure, compared to patients who sent messages coded with other taxa.
3-3b. Patients who sent messages assigned *Information sharing* taxa will have improvements in their A1C and blood pressure, compared to patients who did not use the patient portal to initiate a message thread.
3-4a. Patients who received messages assigned the clinician *Praise or appreciation* taxon will have improvements in their A1C and blood pressure, compared to patients received non-*Praise or appreciation* messages from clinicians
3-4b. Patients who received messages assigned the clinician *Praise or appreciation* taxon will have improvements in their A1C and blood pressure, compared to patients who did not use the patient portal to initiate a message thread.
3-5a. Patients who did not receive a response to their initiated thread will have no change in their A1C and blood pressure, compared to patients who received a response to the thread they initiated.
3-5b. There will be no differences in the changes in A1C or blood pressure when comparing patients who did not received a response to their initiated thread and patients who did not use the patient portal to initiate a message in 2017.
3-6a. Patients who received messages assigned clinician *Defer* or *Deny* taxa will have poorer A1C and blood pressure, compared to patients who received messages assigned the clinician *Information sharing* or *Fulfill* taxa.
3-6b. There will be no difference in the changes in A1C or blood pressure when comparing patients who received messages assigned clinician *Defer* or *Deny* taxa and patients who did not use the patient portal to initiate a message in 2017.

Table 5-2.

Reported Health Outcomes in Secure Messaging Literature

Outcome (DV)	**SM Use Associated with Poorer Health Outcome**	**SM Use Associated with Improved Health Outcome**	**No Association**
Anxiety levels	N/A	Among patients who received SM-based cognitive behavior therapy, content analysis identified a decrease over time in words representing anxiety and words with negative implications (Dirske, Hadjistavropoulos, Hesser, & Barak, 2015)	N/A

Outcome (DV)	SM Use Associated with Poorer Health Outcome	SM Use Associated with Improved Health Outcome	No Association
Blood pressure (BP)	N/A	• 2-4% decrease in HEDIS BP measure performance (Zhou et al., 2010) • Intervention group (SM with pharmacist) had higher rate of controlled BP (Ralston et al., 2014) • Low intensity SM use associated with small improvement in SBP (Price-Haywood et al., 2018) • SM use associated with improvements in DBP* (Price-Haywood et al., 2018)	• BP control among patients with diabetes no different between SM users and non-users (Harris et al., 2009) • No association between BP control and SM use; no evidence that prolonged SM use is associated with increased BP control (Shimada et al., 2016) • Patients with medium and high intensity SM use demonstrated no statistical improvement in SBP (Price-Haywood et al., 2018)
Diabetes Recognition Program (DRP) scores	N/A	Small increase (0.1) in patient panel using SM resulted in a 4.7 point increase in DRP score; strong association with the process measures that constitute the DRP and small statistical association with SM and DRP outcome measures (Bredfeldt, Compton-Phillips, & Snyder, 2011)	N/A
Discharge readiness and post-discharge coping	N/A	Coping significantly improved among the intervention (SM users) group compared to the control group(Schneider & Howard, 2017)	No difference between intervention and control groups in discharge readiness scores (Schneider & Howard, 2017)
A1C	Higher rates of poor control associated with higher levels of SM use in prior year (Harris et al., 2013)	• Controlled glycemic levels were highest among patients with highest level of SM use* (Harris et al., 2009) • SM use associated with improved performance on HEDIS measure for A1C control* (Zhou et al., 2010) • Good glycemic control increased with higher levels of SM use both in prior quarter and prior year (Harris et al., 2013) • Patients with uncontrolled A1C at baseline were more likely to achieve control if used SM 2 or more years* (Shimada et al., 2016) • Increased SM frequency associated with improved A1C HEDIS measure performance*; association similar with patient-initiated and physician-initiated SMs (Chung et al., 2017) • Higher levels of SM intensity were associated with greater decreases in glycemic control, but this was association was not consistent across strata (Price-Haywood et al., 2018)	• Patients with better glycemic control sent the same number of messages as patients with poorer glycemic control (Harris et al., 2013) • No difference by mode of diabetes self-management (SM, phone, in-person) (Greenwood et al., 2014)
HIV viral load	N/A	N/A	No statistical difference between SM users and non-SM users; no evidence of dose-response effect (McInnes et al., 2017)
Smoking cessation	N/A	Patients who received an automated motivational push message had higher odds of quitting smoking than those who did not receive the intervention (Houston et al., 2015)	N/A

*Statistical evidence of dose-response effect. A1C=glycated hemoglobin; BP=blood pressure; DBP=Diastolic BP; HEDIS=Healthcare Effectiveness Data and Information Set; HIV=Human immunodeficiency virus; SBP=Systolic BP. DRP=Diabetes Recognition Program (a combined score created by the National Committee for Quality Assurance (NCQA) based on a review of performance on glycemic control, blood pressure control, eye and nephropathy examinations, and smoking cessation activities from 25 patient charts per clinician).

The study by Harris et al. (2013) was novel because it explored the differences in outcome depending on when the SM measurements were taken, examining the impact of both short-term (message volume in the three months (i.e., quarter) preceding outcome measurement) and long-term (message volume in the year preceding outcome measurement) exposure. Harris and his colleagues found that good glycemic control (using both <7% and <8% as thresholds) was associated with high message volume in both the preceding quarter and year; the association was stronger in the quarter-based analyses than those that used a preceding year timeframe. They also noted an inverse relationship between poor glycemic control and message volume in their unadjusted models; much of that association was eliminated in models that adjusted for covariates. The same effects were observed when examining the association between SM use and A1C screening.

Another differentiator among the research was the message types included in the studies. For example, Chung et al. (2017) included only "medical advice request" messages and excluded non-clinical communication as well as messages normally responded to by medical assistants or midlevel clinicians. Price-Haywood et al. (2018) also included only medical advice messages and further limited their sample to patient-initiated medical advice messages. Several studies included all messages, but noted that the patient portal had separate functionality for appointment requests and prescription refills (Harris et al., 2009; Harris et al., 2013). McInnes et al. (2017) noted that in addition to appointment requests and prescription refills, health logs, providers' notes, and preventive services reminders were also separate functionalities on the patient portal and therefore not included in their analyses.

The only conditions for which more than one study was published were hypertension and diabetes. The research on the association of diabetes and secure messaging is stronger, with five published studies identifying a positive associated between secure messaging use and patient outcomes. The results for hypertension, however, were more mixed with an equal number of studies finding a positive and no association.

5.2.1 Diabetes and hypertension outcomes measurement. This section reviews the types of health outcomes studied for the conditions of interest, diabetes and hypertension. Diabetes is identified through the use of a variety of tests (i.e., A1C, fasting plasma glucose, the 2-hour plasma glucose during a 75-g oral glucose tolerance test); an A1C value of 6.5 percent or greater is considered diagnostic for diabetes (American Diabetes Association, 2018b). Hypertension is defined as having a systolic blood pressure (SBP) over 129 mm Hg and a diastolic blood pressure (DBP) over 79 mm Hg (Whelton et al., 2018).

For both diabetes and hypertension, patients' clinical goals are frequently based on individual risk factors such as age, other comorbid conditions, weight, baseline measures, and disease duration (American Diabetes Association, 2018b; Garber et al., 2018; Qaseem et al., 2017; Whelton et al., 2018). The American Diabetes Association's recommended A1C goal for most adults with diabetes is <7 percent (American Diabetes Association, 2018b). For younger, more motivated patients early in their disease progression, a more stringent target of <6.5 percent might be achievable. A1C goals for older patients with more comorbidities, however, might be set higher at <8 percent.

Guidance for hypertension clinical goals are less clear. Clinical guidance released by the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines recommended that the goal for most patients with hypertension should be a blood pressure value of <130/80 (Whelton et al., 2018). Published also in 2017, however, was a joint statement from the American College of Physicians and American Academy of Family Physicians that recommended that adults over 60 years of age with a SBP over 150 mm mercury (Hg) should strive for a value less than 150 unless they had high cardiovascular risk levels (i.e., stroke or ischemic attack), in which case the recommendation is for a SBP of less than 140 mm Hg (Qaseem et al., 2017). The argument behind these recommendations was that the benefits in achieving lower blood pressure (i.e., 130/80) for these populations is minimal while treatment to achieve these lower levels is accompanied with increased risks for side effects that outweigh the benefits.

Table 5-3 lists the health outcomes used by secure messaging researchers for patients with diabetes or hypertension. Consistent with targets that change based on patients' risk factors, dichotomous measures of controlled A1C and blood pressure used different thresholds to identify controlled states. Continuous measurements were used to detect changes over time for both A1C and blood pressure in several studies (Greenwood et al., 2014; Price-Haywood et al., 2018; Ralston et al., 2014). Two studies reported outcomes based on HEDIS performance measures (Chung et al., 2017; Zhou et al., 2010).

Table 5-3.

Patient Health Outcome Measurement Types

Type of Outcome Measure	Variable Type	Study
Glycemic control	Change over time (continuous)	Greenwood et al. (2014); Price-Haywood et al. (2018)
	Dichotomous (controlled <7%)	Harris et al. (2009); Harris et al. (2013); Shimada et al. (2016)
	Dichotomous (controlled <8%)	Harris et al. (2013)
	Dichotomous (uncontrolled <9%)	Harris et al. (2013)
	HEDIS measure performance	Chung et al. (2017); Zhou et al. (2010)
Controlled BP (mm Hg)	Continuous (both diastolic and systolic)	Price-Haywood et al. (2018); Ralston et al. (2014)
	Dichotomous (controlled ≤130/80)	Harris et al. (2009)
	Dichotomous (controlled <140/80)	Shimada et al. (2016)
	HEDIS measure performance	Chung et al. (2017); Zhou et al. (2010)
Low-density lipoprotein control	Dichotomous (controlled <100mg/Dl)	Harris et al. (2009); Shimada et al. (2016)
	HEDIS measure performance	Chung et al. (2017); Zhou et al. (2010)

BP=Blood pressure; HEDIS=Healthcare Effectiveness Data and Information Set; Hg=mercury

5.2.2. Glycemic control and secure messaging use. As shown in Table 5-3 above, seven studies explored the association between secure messaging and glycemic levels among patients with diabetes. The single randomized controlled trial reported no difference in diabetes self-management among patients who used secure messaging, phone, and in-person communication (Greenwood et al., 2014). Five of the other six studies found a positive association between secure messaging and glycemic levels among patients with diabetes (Chung et al., 2017; Harris et al., 2009; Price-Haywood et al., 2018; Shimada et al., 2016; Zhou et al., 2010). Harris et al. (2013) compared the impact of message volume in the quarter and year preceding the measured A1C value and noted that effect sizes for glycemic control were larger when comparing message volume in the quarter preceding the outcome measure than in the year preceding the outcome measure, and higher message volumes was associated with better glycemic control. In regression analyses that controlled for covariates, however, the association between poor glycemic control and message volume no longer demonstrated a dose-response effect. The study also found that patients with good and poor glycemic control exchanged the same number of messages (Harris et al., 2013).

Several other studies identified evidence of a dose-response effect; that is, increased message volume (number of messages sent) or intensity (number of threads initiated) was associated with larger improvements in glycemic control (Chung et al., 2017; Harris et al., 2009; Zhou et al., 2010). Price-Haywood et al. (2018) noted that higher levels of message intensity were associated with greater decreases in glycemic control. In stratified regression analyses, however, the researchers found that association was only true among patients with diabetes whose A1C was <8 percent; there was no association between intensity and A1C change in patients whose A1C was ≥8 percent. In addition, Shimada et al. (2016) reported that patients with more experience using secure messaging (two or more years) were more likely to achieve glycemic control.

No studies explored an association between message content and patients' health outcomes; all identified associations were based on patients' message volume and intensity. In addition, the analyses did not examine the impact of clinician message content or use. Research Paper 3 will explore both aspects.

5.2.3 Controlled blood pressure and secure messaging use. The findings from studies that examined the impact of secure messaging on blood pressure control were less consistent than those for glycemic control. Five studies examined the association between blood pressure and secure messaging use. Three found an improvement in blood pressure control associated with SM use (Price-Haywood et al., 2018; Ralston et al., 2014; Zhou et al., 2010). Ralston et al. (2014) conducted a randomized controlled trial that included education and outreach by a pharmacist via secure messaging, so some of the effect identified in that study may be the result of information provided in the secure message by the pharmacist or the increased attention paid to the intervention group by the pharmacist. The improved outcome identified by Price-Haywood et al. (2018) was between DBP and secure messaging use, but their study found no improvements in SBP and SM use. Two other studies found no association between blood pressure control and SM use: Harris et al. (2009) examined blood pressure control among patients with diabetes and hypertension and noted no difference between secure message users and non-users; Shimada et al. (2016) found that not only was there no association between blood pressure and SM use, but that prolonged SM use, identified as having an association with glycemic control, was not associated with controlled blood pressure.

5.3 Methods for Research Paper 3

As the third study in this series, the methods for Research Paper 3 build on those reported in Chapters 2 and 4. The study population will be the same: VCU Health patients with diabetes, hypertension, or both conditions who were registered with the VCU Health patient portal. The unit of measurement for all analyses is the patient. Analyses will use the messages coded for Research Paper 1 (Chapter 2). Patient and clinician characteristics also described in Chapter 2 will be applied in this study's models.

Table 5-4 lists the hypotheses that will be tested for this paper, the analytic cohort for each hypothesis, and the independent and dependent variables to be included in each analysis. Further detail is provided below the table.

Table 5-4.

Research Paper 3 Hypotheses and Associated Analytic Strategies

Hypothesis	Analytic Cohort	Independent Variables	Dependent Variables
3-1a. Patients who sent messages assigned *Task-oriented* content not associated with uncertainty (e.g., *Medication refills and renewals requests*), will have improvements in their A1C and blood pressure, compared to patients who sent messages not coded as *Task-oriented* that were not associated with uncertainty.	All patients who initiated at least one message thread in 2017	Taxon counts: 1. Medication refills and renewals requests 2. Other administrative 3. Cancellation 4. Follow-up 5. Preventive care or physical exam 6. Reschedule 7. Grouping of these 6 taxa	Change in: 1. A1C 2. SBP 3. DBP
3-1b. Patients who sent messages assigned *Task-oriented* content not associated with uncertainty	Patients who sent *Task-oriented* content not associated with	Taxon counts:	Change in: 1. A1C 2. SBP

Hypothesis	Analytic Cohort	Independent Variables	Dependent Variables
(e.g., *Medication refills and renewals requests*), will have improvements in their A1C and blood pressure, compared to patients who did not use the patient portal to initiate a message thread.	uncertainty AND patients who did not use the patient portal to initiate a message thread in 2017	1. Medication refills and renewals requests 2. Other administrative 3. Cancellation 4. Follow-up 5. Preventive care or physical exam 6. Reschedule 7. Grouping of these 6 taxa	3. DBP
3-2a. Patients who received messages assigned clinician *Information sharing* taxa (excluding *Defer)* will have improvements in their A1C and blood pressure, compared to patients who did not receive messages assigned *Information sharing* taxa.	All patients who initiated at least one message thread during 2017	Taxon counts: 1. Medical guidance 2. Orientation to procedures, treatments, or preventive behaviors 3. Grouping of these 2 *Information sharing* taxa	Change in: 1. A1C 2. SBP 3. DBP
3-2b. Patients who received messages assigned clinician *Information sharing* taxa (excluding *Defer)* have improvements in their A1C and blood pressure, compared to patients who did not use the patient portal to initiate a message thread.	Patients who sent messages coded with *Information sharing* taxa AND patients who did not use the patient portal to initiate a message thread in 2017	Taxon counts: 1. Medical guidance 2. Orientation to procedures, treatments, or preventive behaviors 3. Grouping of these 2 Information sharing taxa	Change in: 1. A1C 2. SBP 3. DBP
3-3a. Patients who sent messages assigned *Information sharing* taxa will have improvements in their A1C and blood pressure, compared to patients who sent messages coded with other taxa.	All patients who initiated at least one message thread during 2017	Taxon counts: 1. Clinical update 2. Response to clinician's message 3. Self-reporting 4. Grouping of these 3 *Information sharing* taxa	Change in: 1. A1C 2. SBP 3. DBP
3-3b. Patients who sent messages assigned *Information sharing* taxa will have improvements in their A1C and blood pressure, compared to patients who did not use the patient portal to initiate a message thread.	Patients who sent messages coded with *Information sharing* taxa AND patients who did not use the patient portal to initiate a message thread in 2017	Taxon counts: 1. Clinical update 2. Response to clinician's message 3. Self-reporting 4. Grouping of these 3 *Information sharing* taxa	Change in: 1. A1C 2. SBP 3. DBP
3-4a. Patients who received messages assigned the clinician *Praise or appreciation* taxon will	All patients who initiated at least one	Praise or appreciation taxon counts (clinician-generated)	Change in: 1. A1C 2. SBP

Hypothesis	Analytic Cohort	Independent Variables	Dependent Variables
have improvements in their A1C and blood pressure, compared to patients received non-*Praise or appreciation* messages from clinicians	message thread during 2017		3. DBP
3-4b. Patients who received messages assigned the clinician *Praise or appreciation* taxon will have improvements in their A1C and blood pressure, compared to patients who did not use the patient portal to initiate a message thread.	Patients who sent Information sharing AND patients who did not use the patient portal to initiate a thread in 2017	Praise or appreciation taxon counts (clinician-generated)	Change in: 1. A1C 2. SBP 3. DBP
3-5a. Patients who did not receive a response to their initiated thread will have no change in their A1C and blood pressure, compared to patients who received a response to the thread they initiated.	All patients who initiated at least one message thread during 2017	Non-response count	Change in: 1. A1C 2. SBP 3. DBP
3-5b. There will be no differences in the changes in A1C or blood pressure when comparing patients who did not received a response to their initiated thread and patients who did not use the patient portal to initiate a message in 2017.	Patients who did not receive a response to their initiated thread AND patients who did not use the patient portal to initiate a thread in 2017	No response/No messaging	Change in: 1. A1C 2. SBP 3. DBP
3-6a. Patients who received messages assigned clinician *Defer* or *Deny* taxa will have poorer A1C and blood pressure, compared to patients who received messages assigned the clinician *Information sharing* or *Fulfill* taxa.	All patients who received messages coded as *Defer* or *Deny* AND all patients who received messages coded as *Information sharing* or *Fulfill*	Taxon counts: 1. Defer 2. Deny 3. Grouping of these 2 taxa	Change in: 1. A1C 2. SBP 3. DBP
3-6b. There will be no difference in the changes in A1C or blood pressure when comparing patients who received messages assigned clinician *Defer* or *Deny* taxa and patients who did not use the patient portal to initiate a message in 2017.	Patients who received messages assigned clinician *Defer* or *Deny* taxa AND patients who did not use the patient portal to initiate a thread in 2017	Taxon counts: 1. Defer 2. Deny 3. Grouping of these 2 taxa	Change in: 1. A1C 2. SBP 3. DBP

A1C=Glycemic level (hemoglobin A1C); DBP=Diastolic blood pressure; SBP=Systolic blood pressure

5.3.1 Measures. Research Paper 3 focuses on the association between taxa and patients' health outcomes. The independent variables in Research Paper 3 are the same as was described in Chapter 4. The outcomes of interest, however, include those commonly used to measure health status for patients with diabetes and hypertension. For patients with diabetes this is measured as a percentage of glycated hemoglobin. Health status for patients with hypertension is measured as changes in blood pressure, both SBP and DBP. More details on how the outcome measures are operationalized are provided in the subsections below.

Because taxa counts (the independent variables) will be aggregated for the year, using the health outcome measurement taken after the end of the measurement period is most relevant. Harris et al. (2013) found that the dose-response association between message volume and health outcomes was detectable when message volume from the preceding year was used, although the effect size was smaller than when message volume from the prior quarter was used.

5.3.1.1. Dependent variable measurement: Diabetes outcome measure. The health outcome measured for patients with diabetes is changes in A1C percentage, which is the percentage of glycated hemoglobin. Change in outcome is measured as the difference between the post-measurement period value (the first measured value in 2018) and the baseline value (the most recent measured value obtained in 2016). Figure 5-1 demonstrates the health status measurements in relation to the measurement period. The study is powered to detect a one-unit change in A1C, which translates to a one percentage point change.

Figure 5-1. Health Status Measurements

Clinical guidelines recommend that patients with diabetes see their primary care provider at least twice a year ("3. Comprehensive Medical Evaluation and Assessment of Comorbidities:Standards of Medical Care in Diabetes—2018," 2018; Whelton et al., 2018), so the expectation is that patients should have at least two A1C measurements in a calendar year. Only measurements obtained during a patient visit will be used for the baseline and outcome measurements (i.e., self-reported values are excluded). Therefore, a baseline measurement for each patient is the most recently measured health status prior to the start of the secure messaging measurement period (i.e., January 1, 2017); this baseline value will be included as a covariate in regression analyses representing health status or illness severity.

5.3.1.2. Dependent variable measurement: Hypertension outcomes measures. Two outcomes detect changes in health status among patients with hypertension: (1) DBP and (2) SBP. Similar to how the diabetes outcome was operationalized, a change in DBP and SBP is measured as the difference between the post-measurement period value (the first measured value in 2018) and the baseline value (the most recent measured value obtained in 2016). The study is powered to detect an eight-unit change in each hypertension health outcome. Self-reported values will not be used; only DBP and SBP obtained in a clinical setting will be used for the outcome measurement.

5.3.1.3. Independent variable measurement: Taxa counts. The independent variables for Research Paper 3 are operationalized the same as in Research Paper 2. For analyses that include a single taxon, the number of occurrences within 2017 per patient will be summed. If a grouping of taxa is included in the analysis, the number of taxa occurrences will be summed across all taxa included in the grouping. Additional detail on how this is operationalized is available in Chapter 4. Inclusion of taxa counts in the analyses applies for Hypotheses 3-1 through 3-4, and 3-6.

5.3.1.4 Independent variable measurement: No response. Hypotheses 3-5a and 3-5b explore the association between healthcare utilization and the lack of a clinician response to a patient-initiated thread. Similar to how the non-response elements were operationalized for Research Paper 2, clinician non-response for Research Paper 3 will be coded as positive if the thread only included patient-generated messages. As with the taxa metric, the number of non-responses will be summed for the calendar year for the final analysis to provide for a continuous value as the independent variable.

Testing of Hypothesis 3-5b involves a comparison of patients who initiated at least one thread for which no response was received to patients who did not use the patient portal to initiate a message. In this model, patients with at least one non-response value will be coded as “Non-response,” while patients who did not use the portal will be coded as “No messaging” (i.e., a dichotomous 1/0 variable).

***5.3.1.5. Covariates*.** Analyses for all hypotheses will include covariates identified through the Research Paper 1 as statistically relevant. Similar to Research Paper 2, patients' illness severity will be included, operationalized as the baseline A1C for patients with diabetes, and baseline SBP and DBP for patients with hypertension. The baseline measurement is the most recent measurement obtained in 2016 before the study period begins. This illness severity covariate will be included for all regression models.

5.3.2 Analytic methods. Research Paper 3 will leverage linear regression in the same fashion as was described for Research Paper 2; refer to Chapter 4 for more details. Each hypothesis will include a minimum of three regression analyses: one for each health outcome (A1C, SBP, and DBP). Additionally, a regression model will be conducted for each taxon and outcome measure combination listed for each hypothesis in Table 5-4. Hypothesis 3-1a, for example, includes a regression model for each taxon listed (N=6) and one for the taxa grouping, applied across the three outcomes for a total of 21 models.

5.3.3 Study sample size.

Table 5-5 displays the percent and estimated number of patients for whom at least one message was coded with the selected taxon, based on the sample of patients with that condition (refer to Appendix F for details on sample size estimates and Chapter 2, Section 2.7 for sample size rationale). Similar to the MPR analyses, the proposed metrics for health outcomes differs by health condition, which means the largest number of patients is of those with the health condition under investigation. Assuming the study sample's messaging is similar to the pilot study's messaging habits, a statistical difference should be detectable for most taxa for the SBP and DBP outcomes, excluding only *Preventive care or physical exam* for the DBP outcome. If the required sample size to detect a one-unit change in A1C is 122 (see Appendix F), then there is sufficient sample to detect a one-unit change most taxa.

5.4 Limitations

Many of the study limitations noted in Chapters 2 and 4 apply to this research as well. In addition, demonstrating improvement in diabetes and hypertension outcomes requires significant self-care and

Table 5-5.

Estimated Sample Sufficiency for Patient Health Outcomes by Taxa[a]

Taxa	Percent of patients from pilot study with at least one message	Sufficient sample size to measure statistical change: A1C (%)	DBP	SBP
Patient Task-Oriented Requests				
Medication refills and renewals requests	54.8	Yes	Yes	Yes
New or change medication request	26.0	Yes	Yes	Yes
Other administrative	57.5	Yes	Yes	Yes
Referral request	17.8	Yes	Yes	Yes
Scheduling request	--	--	--	--
Cancellation	26.7	Yes	Yes	Yes
Follow-up	22.7	Yes	Yes	Yes
Laboratory test or diagnostic procedure	25.3	Yes	Yes	Yes
New condition or symptom	26.7	Yes	Yes	Yes
Preventive care or physical exam	6.7	No	Yes	No
Reschedule	40.0	Yes	Yes	Yes
Patient Information Seeking				
Logistical information	64.4	Yes	Yes	Yes
Symptoms/Condition	41.1	Yes	Yes	Yes
Patient Information Sharing				
Clinical update	34.2	Yes	Yes	Yes
Response to clinician's message	57.5	Yes	Yes	Yes
Self-reporting	16.4	Yes	Yes	Yes
Clinician Responses				
Task-oriented/ Recommendation to schedule an appointment	32.9	Yes	Yes	Yes
Action responses	--	--	--	--
Acknowledgement	34.2	Yes	Yes	Yes
Denies	27.4	Yes	Yes	Yes
Fulfills request	76.7	Yes	Yes	Yes
Partially fulfills request	63.0	Yes	Yes	Yes
Information seeking	35.6	Yes	Yes	Yes
Information sharing	--	--	--	--
Deferred	35.6	Yes	Yes	Yes
Medical guidance	63.0	Yes	Yes	Yes
Orientation to procedures, treatments, or preventive behaviors	43.8	Yes	Yes	Yes
Social Communication				
Appreciation and praise	37.0	Yes	Yes	Yes
Complaints	23.3	Yes	Yes	Yes
Life issues	27.4	Yes	Yes	Yes

[a] The pilot study sampled from patients who wrote at least one non-Task-oriented message; these results may therefore underestimate the proportion of Task-oriented taxa (and clinical responses to Task-oriented messages) that

may occur in a sample of patients who wrote all messages. A1C=Glycated hemoglobin; DBP=Diastolic blood pressure; SBP=Systolic blood pressure

management ("3. Comprehensive Medical Evaluation and Assessment of Comorbidities:Standards of Medical Care in Diabetes—2018," 2018; Whelton et al., 2018). While patient-clinician communication is a factor in the overall improvement of patient outcomes, it is not the only factor. Patients' overall health status, social determinants of health, cognitive capacity, and other factors contribute to patients' ability to achieve blood pressure and glycemic control. While some of these factors are included in this Research Paper's analyses, not all are. By selecting a random sample of the VCU Health population of patients with diabetes and hypertension who were registered with the patient portal, the hope is that the comparison groups will have equal likelihood of including patients with those potential confounders.

The issue of the study population's generalizability noted in Chapter 2 may have less significance for this study. The focus of this research is on how secure messages can improve patient outcomes; therefore, the fact that the study population is limited to patients who were registered with the VCU Health patient portal is appropriate because the limited study population assumes a level field in terms of technology accessibility. Future studies should explore the difference in outcomes among patients without access to technology and should the findings from this research be successful in demonstrating benefits to secure messaging, interventions that focus on getting access to secure messaging for those patients lacking such access would be critical to ensure health equity.

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Appendix A. Acronyms

A1C	Glycated Hemoglobin
BP	Blood Pressure
CCTR	Center for Clinical and Translational Research
CMC	Computer-Mediated Communication
DBP	Diastolic Blood Pressure
ED	Emergency Department
EHR	Electronic Health Record
FKGL	Flesch-Kincaid Grade Levels
FYI	For your information
HEDIS	Healthcare Effectiveness Data and Information Set
HIV	Human immunodeficiency virus
MCV	Medical College of Virginia
MCVP	MCV Physicians (VCU Physician Practice)
MHV	MyHealthyVet
MPR	Medication Possession Ratio
OV	Office Visit
PHI	Protected Health Information
PPI	Peel Prognostic Index
RFA	Request for Action
RFI	Request for Information
RQ	Research Question
RUIT	Reconceptualized Uncertainty in Illness Theory
Rx	Prescription
SBP	Systolic Blood Pressure
SIP	Social Information Processing Theory
SM	Secure Messaging
TBD	To be determined
UIT	Uncertainty in Illness Theory
VCU	Virginia Commonwealth University

Appendix B. Definitions of Terms

Term	Definition
Active engagement	(from the patient) involves expressions of concern or other feelings and assertive communication, such as offering opinions, asking questions, introducing topics, and interrupting
Clinician-generated secure message	A secure message that was written by a clinician
Clinician-initiated secure message thread	A secure message thread for which a clinician sent the first message
Cognitive capacity	A patient's ability to process information
Credible authority	The amount of trust and confidence a patient held in his or her clinician (Mishel, 1988)
Event congruence	Degree to which an event aligns with a patient's expectations
Event familiarity	Degree to which a patient finds an event is routine, contains recognizable cues, and/or comfortable
Health outcome	Two health outcomes for this study: • Glycated hemoglobin, a measure of how well a patient's blood glucose levels are controlled • Blood pressure, a measure of how well a patient's hypertension is controlled
Healthcare utilization	Patients' use of healthcare within VCU Health, measured as: • Number of office visits • Number of emergency department visits • Medication adherence, as measured through the medication possession ratio
Illusion	Evaluation of uncertainty based on patient's beliefs about the event that are not grounded in fact
Inference	Evaluation of uncertainty based on patient's understanding of the available information
Intrinsic factor	Factor not within patient's or clinician's control
Level 1 taxa	Highest level taxa in the taxonomy; these Level 1 taxa usually have taxa underneath them to provide for more specific coding of message content
Message volume	Number of messages during the study period
Message intensity	Number of message threads during the study period
Medication adherence	Degree to which a patient follows the prescribed treatment regimen (i.e., dosing and frequency); for this study, medication adherence will be estimated using the medication possession ratio
Mutability	Factor can be changed
Patient-centered care	Application of the core values of patient-centeredness to the provision of healthcare
Patient-centered communication	One mechanism by which the core values of patient-centeredness might be applied to the provision of healthcare
Patient-centeredness	A set of core values around which patient care is focused; the core values include considering patients' preferences and needs when providing care, enhancing the clinician-patient partnership, and including patients in the decision-making process when they desire inclusion
Patient-generated secure message	A secure message that was written by a patient
Patient-initiated secure message thread	A secure message thread for which a patient sent the first message
Relational	Technology-mediated communication that supports relationship-building

Term	Definition
Secure message	"Any electronic communication between a provider and patient that ensures only those parties can access the communication. This electronic message could be email or the electronic messaging function of a PHR [personal health record], an online patient portal, or any other electronic means" (Centers for Medicare and Medicaid Services, 2012, p. 54032).
Secure message thread	A set of secure messages constituting an online "conversation", including the initiating message and all subsequent responses
Stimuli frame	Factors that influence a patient's degree of uncertainty, including symptom pattern, event familiarity, and event congruency
Structure providers	A patient's supportive resources, including credible authority, education, and social support
Sub-taxon	A taxon that falls under another taxon (has a parent-level taxon)
Task-oriented	Technology-mediated communication that requests an action
Task-oriented taxon	Requests for tasks to be completed (e.g., action on the part of the clinician or clinical staff, such as an appointment or referral request) and corresponding responses
Taxa	More than one taxon, or classification categories within a taxonomy
Taxon	A single classification category within a taxonomy
Taxonomy	A systematic classification structure
Uncertainty (in illness)	A cognitive state that occurs when patients are unable to make sense or find meaning in illness-related events (Mishel, 1988)

Appendix C. Crosswalk of Study Goals, Objectives, Associated Propositions, Research Questions, and Hypotheses

Table C-1.

Paper 1 Goals, Objectives, Associated Propositions, Research Question, and Hypotheses

Goals:

1. Create a taxonomy to classify secure messages content.
2. Describe which patients and clinicians are using secure messaging based on taxa.

Objectives:

1. Develop a theory-based taxonomy to classify secure messaging based on literature review.
2. Conduct descriptive analysis based on taxonomy of a sample of secure messaging, including frequencies by taxon and patient and clinical characteristics.

Associated Propositions:

P7: Secure messaging content will vary by patient demographic characteristics and health status.

P8: Secure messaging content will vary by clinicians' demographic characteristics and the number of secure messages they send.

Research Question:

Among patients with hypertension and/or diabetes, does taxon use vary by patient demographic characteristics or clinician characteristics?

Hypotheses 1-1. There will be differences in patient demographic characteristics by taxa.

1-2. There will be differences in clinician characteristics by taxa.

Table C-2.

Paper 2 Goals, Objectives, Associated Propositions, Research Question, and Hypotheses

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Goal:
Understand which types of secure messages, if any, are associated with changes in healthcare utilization among patients with hypertension and diabetes.
Objective:
Analyze patient utilization of healthcare services associated with different message taxa.
Associated Propositions:

P1: Patient messages that include content related to medication refills, referrals, and scheduling, will be associated with improved patient outcomes.
P2: Patients whose clinicians respond with information sharing message content will have improved outcomes.
P3: Patients who shared information with their clinicians using secure messaging will have improved health outcomes and reduced healthcare utilization.
P4: Patients whose clinicians sent messages of praise or appreciation will have reduced healthcare utilization and improved health outcomes.
P5: Patients whose clinicians do not respond or otherwise defer information sharing will poorer outcomes.

Research Question:
Which patient-generated and clinician-generated message taxa are associated with reduced office and/or emergency department visits, or improved medication adherence?
Hypotheses:

2-1a. Patients who sent messages assigned *Task-oriented* content not associated with uncertainty (e.g., *Medication refills and renewals requests*), will have fewer office and emergency department visits, and higher MPRs, compared to patients who sent messages not coded as *Task-oriented* that were not associated with uncertainty.

2-1b. Patients who sent messages assigned *Task-oriented* content not associated with uncertainty (e.g., *Medication refills and renewals requests*), will have fewer office and emergency department visits, and higher MPRs, compared to patients who did not use the patient portal to initiate a message thread.

2-2a. Patients who received messages assigned clinician *Information sharing* taxa (excluding *Defer)* will have fewer office and emergency department visits, and higher MPRs, compared to patients who did not receive messages assigned *Information sharing* taxa.

2-2b. Patients who received messages assigned clinician *Information sharing* taxa (excluding *Defer)* will have fewer office and emergency department visits, and higher MPRs, compared to patients who did not use the patient portal to initiate a message thread.

2-3a. Patients who sent messages assigned *Information sharing* taxa will have fewer office and emergency department visits, and higher MPRs, compared to patients who sent messages coded with other taxa.

2-3b. Patients who sent messages assigned *Information sharing* taxa will have fewer office and emergency department visits, and higher MPRs, compared to patients who did not use the patient portal to initiate a message thread.

2-4a. Patients who received messages assigned the clinician *Praise or appreciation* taxon will have fewer office and emergency department visits, and higher MPRs, compared to patients received non-*Praise or appreciation* messages from clinicians

2-4b. Patients who received messages assigned the clinician *Praise or appreciation* taxon will have fewer office and emergency department visits, and higher MPRs, compared to patients who did not use the patient portal to initiate a message thread.

2-5a. Patients who did not received a response to their initiated thread will have more office and emergency department visits, and lower MPRs, compared to patients who received a response to the thread they initiated.

2-5b. There will be no difference in office visits, emergency department visits, or MPR between patients who did not received a response to their initiated thread and patients who did not use the patient portal to initiate a message in 2017.

2-6a. Patients who received messages assigned clinician *Defer* or *Deny* taxa will have more office and emergency department visits, and lower MPRs, compared to patients who received messages assigned the clinician *Information sharing* or *Fulfill* taxa.

2-6b. There will be no difference in office visits, emergency department visits, or MPR between patients who received messages assigned clinician *Defer* or *Deny* taxa and patients who did not use the patient portal to initiate a message in 2017.

Table C-3.

Paper 3 Goals, Objectives, Associated Propositions, Research Question, and Hypotheses

Goal:
Understand which types of secure messages, if any, are associated with changes in health outcomes among patients with hypertension and diabetes.
Objective:
Analyze patient health outcomes associated with different message taxa.
Associated Propositions:

P1: Patient messages that include content related to medication refills, referrals, and scheduling, will be associated with improved patient outcomes.

P2: Patients whose clinicians respond with information sharing message content will have improved outcomes.

P3: Patients who shared information with their clinicians using secure messaging will have improved health outcomes and reduced healthcare utilization.

P4: Patients whose clinicians sent messages of praise or appreciation will have reduced healthcare utilization and improved health outcomes.

P5: Patients whose clinicians do not respond or otherwise defer information sharing will poorer outcomes.

Research Question:
Which patient-generated and clinician-generated SM taxa are associated with improved HbA1c levels and blood pressure control?
Hypotheses:

3-1a. Patients who sent messages assigned *Task-oriented* content not associated with uncertainty (e.g., *Medication refills and renewals requests*), will have improvements in their A1C and blood pressure, compared to patients who sent messages not coded as *Task-oriented* that were not associated with uncertainty.

3-1b. Patients who sent messages assigned *Task-oriented* content not associated with uncertainty (e.g., *Medication refills and renewals requests*), will have improvements in their A1C and blood pressure, compared to patients who did not use the patient portal to initiate a message thread.

3-2a. Patients who received messages assigned clinician *Information sharing* taxa (excluding *Defer)* will have improvements in their A1C and blood pressure, compared to patients who did not receive messages assigned *Information sharing* taxa.

3-2b. Patients who received messages assigned clinician *Information sharing* taxa (excluding *Defer)* have improvements in their A1C and blood pressure, compared to patients who did not use the patient portal to initiate a message thread.

3-3a. Patients who sent messages assigned *Information sharing* taxa will have improvements in their A1C and blood pressure, compared to patients who sent messages coded with other taxa.

3-3b. Patients who sent messages assigned *Information sharing* taxa will have improvements in their A1C and blood pressure, compared to patients who did not use the patient portal to initiate a message thread.

3-4a. Patients who received messages assigned the clinician *Praise or appreciation* taxon will have improvements in their A1C and blood pressure, compared to patients received non-*Praise or appreciation* messages from clinicians

3-4b. Patients who received messages assigned the clinician *Praise or appreciation* taxon will have improvements in their A1C and blood pressure, compared to patients who did not use the patient portal to initiate a message thread.

3-5a. Patients who did not receive a response to their initiated thread will have no change in their A1C and blood pressure, compared to patients who received a response to the thread they initiated.

3-5b. There will be no differences in the changes in A1C or blood pressure when comparing patients who did not received a response to their initiated thread and patients who did not use the patient portal to initiate a message in 2017.

3-6a. Patients who received messages assigned clinician *Defer* or *Deny* taxa will have poorer A1C and blood pressure, compared to patients who received messages assigned the clinician *Information sharing* or *Fulfill* taxa.

3-6b. There will be no difference in the changes in A1C or blood pressure when comparing patients who received messages assigned clinician *Defer* or *Deny* taxa and patients who did not use the patient portal to initiate a message in 2017.

Appendix D. Proposed Secure Message Taxonomy

Appendix Table D-1.

Definitions for Proposed Taxa

Patient- or Clinician-Generated?	Level 1 Taxon	Level 2 Taxon	Level 3 Taxon	Marker of Uncertainty?	Definition
Patient	Information seeking	Logistics	--	Yes	Questions about medication or other treatment management (e.g., change in prescription, medication dosage), clinical processes, healthcare settings, or a patient's care plan; how to interpret laboratory results; why a test is being performed or a medication is necessary; how to prepare for the test or procedure upcoming diagnostic procedures; or what routine is needed for the medication
Patient	Information seeking	Symptoms	--	Yes	Questions to clinicians about the presence or absence of symptoms, symptom duration, symptom severity (increasing or decreasing), or other questions about the relevance of symptoms specific to a health condition, including questions related to symptoms associated with side effects of medications, treatments, or procedures
Patient	Information sharing	Clinical update	--	Unlikely	Patient sharing information with clinician that does not require immediate action or a response; includes reporting results of clinical tests, procedures, or outcomes of visits with a different clinician or healthcare facility
Patient	Information sharing	Response to clinician's message	--	Unknown	Patient reporting symptoms/condition status in response to a clinical question, providing an update to clinician, or otherwise responding to clinician's comment in preceding message; does not apply when message includes information seeking content
Patient	Information sharing	Self-reporting	--	Unlikely	Patient sharing information with clinician that does not require immediate action or a response; includes messages where patient is reporting self-measured biomedical results not in response to a clinical question sent via SM
Patient	Task-oriented	Medication refills and renewals requests	--	Unlikely	Request for medication refill or renewal
Patient	Task-oriented	New or change medication request	--	Yes	Request for a new medication or switch to a different medication

Patient- or Clinician-Generated?	Level 1 Taxon	Level 2 Taxon	Level 3 Taxon	Marker of Uncertainty?	Definition
Patient	Task-oriented	Other administrative	--	Unlikely	Requests for sick notes, contact information, medical records, patient portal access, or information about billing or insurance; technology-related questions related to interfacing with the patient portal or other patient-facing technology
Patient	Task-oriented	Referral requests	--	Yes	Request for referral to other healthcare facility or clinician
Patient	Task-oriented	Scheduling request	Cancellation	Unlikely	Request that scheduled appointment be cancelled
Patient	Task-oriented	Scheduling request	Follow-up	Unlikely	Request for an appointment relative to an existing health condition
Patient	Task-oriented	Scheduling request	Laboratory test or diagnostic procedure	Possibly	Request for a laboratory test or diagnostic procedure (e.g., x-ray, ultrasound) order
Patient	Task-oriented	Scheduling request	New condition or symptom	Yes	Patient request for an appointment relative to a newly identified health condition or new symptom for existing condition; new patient appointment; or clinician requests patient make appointment
Patient	Task-oriented	Scheduling request	Preventive care or physical exam	Unlikely	Request for a preventive care or routine physical exam
Patient	Task-oriented	Scheduling request	Reschedule	Unlikely	Request for appointment to be changed to another date or time
Clinician	Action responses	Acknowledge	--	N/A	The response includes a recognition that the request for action or information is made, but no indication is provided about whether the request will be fulfilled
Clinician	Action responses	Denies	--	N/A	The response indicates that the request will not be fulfilled
Clinician	Action responses	Fulfills request	--	N/A	The response includes documentation that the request action was completed
Clinician	Action responses	Partially fulfills request	--	N/A	The response indicates that there are additional steps that are necessary to fulfill the request, or that only part of the request can or has been completed
Clinician	Information seeking	--	--	N/A	Clinicians' requests for information or clarity around patients' condition or symptoms, or symptom severity or duration
Clinician	Information sharing	Deferred	--	N/A	Clinical responses that refer the patient to another clinician for a response, postpone an answer pending additional clinical information (e.g., wait for laboratory test results)

Patient- or Clinician-Generated?	Level 1 Taxon	Level 2 Taxon	Level 3 Taxon	Marker of Uncertainty?	Definition
Clinician	Information sharing	Medical guidance	--	N/A	Clinician provides treatment decisions, gives care instructions, instructs the patient on the best next steps in his or her care plan, interprets diagnostic procedure or laboratory results, or provides information on symptoms or the patient's health condition
Clinician	Information sharing	Orientation to procedures, treatments, or preventive behaviors	--	N/A	Clinical responses that explain what a patient might expect during a treatment or diagnostic procedure, or in a new healthcare setting or situation
Clinician	Task-oriented	Recommendation to schedule an appointment	--	N/A	Clinician suggests that patient schedule an appointment
Both	Social communication	Appreciation and praise	--	No	Content that expresses gratitude or offers acknowledgement or appreciation of a service provided, health status, or another act
Both	Social communication	Complaints	--	No	Expressions of frustration or displeasure
Both	Social communication	Life issues	--	No	Communication about aspects of the patients' life not specifically related to health

Appendix E: Taxonomies Reported by More than One Secure Messaging Publication

Appendix Table E- 1.

TORP Categories

Patient request for information	
• Medication or treatment • Other administrative issues • Other requests for information • Other physicians • Patient-provider relationship • Physical examination	• Prevention • Psychosocial problems • Symptoms, problems, diseases • Tests or diagnostic procedures • Third-party payer or managed care issue
Patient request for action	
• Administrative action – other • Administrative action to third-party payer • Laboratory test, x-ray, or other study • Medications or treatments	• Other request for action • Physical examination • Physician referral • Referral to non-physician
Clinical Response	
• Ignore • Acknowledge only • Fulfill (performs action or gives information) • Partially fulfill	• Negotiate, with fulfillment • Negotiate, with partial fulfillment • Negotiate, with denial • Deny

From Kravitz et al. (1999).

Appendix Table E-2.

Vanderbilt University Medical Center's Consumer Health Taxonomy

Clinical Information Needs	
• **Normal anatomy and physiology*** • **Problems (diseases or observations)**: definition, epidemiology, risks, etiology, pathogenesis/natural hx, clinical presentation, differential diagnosis, related diagnosis, prognosis • **Management**: definition, goals/strategy, tests, interventions, sequence/timing, personnel/setting	• **Interventions**: definition, goals, mechanism of action, efficacy, indications, contraindications, preparation, technique/administration, monitoring, post-intervention care, advantages/disadvantages, costs/disadvantages, adverse effects • **Tests:** definition, goals, physiologic basis, efficacy, indications, contraindications, preparation, technique/administration, interpretation, post-test care, advantages/benefits, costs/disadvantages, adverse effects
Medical Needs	
• Appointments/scheduling • Medical equipment • Personnel/referrals • Prescriptions • Problems	• Follow-up • Management • Tests • Interventions
Logistical Needs	
• Contact information/communication* • Facility/policies • Insurance/billing • Interventions • Transportation	• Medical records • Personal documentation • Portal/health information technologies • Tests
Social Needs	
• Acknowledgement • Complaints • Emotional needs or expression*	• Relationship communications • Miscellaneous
Other	
• "Communications that are incomplete or unintelligible" (Cronin, Fabbri, et al., 2015, p. 1862)	

From Cronin, Fabbri, et al. (2015) and (Sulieman et al., 2017)
*Added or modified by Sulieman et al. (2017).

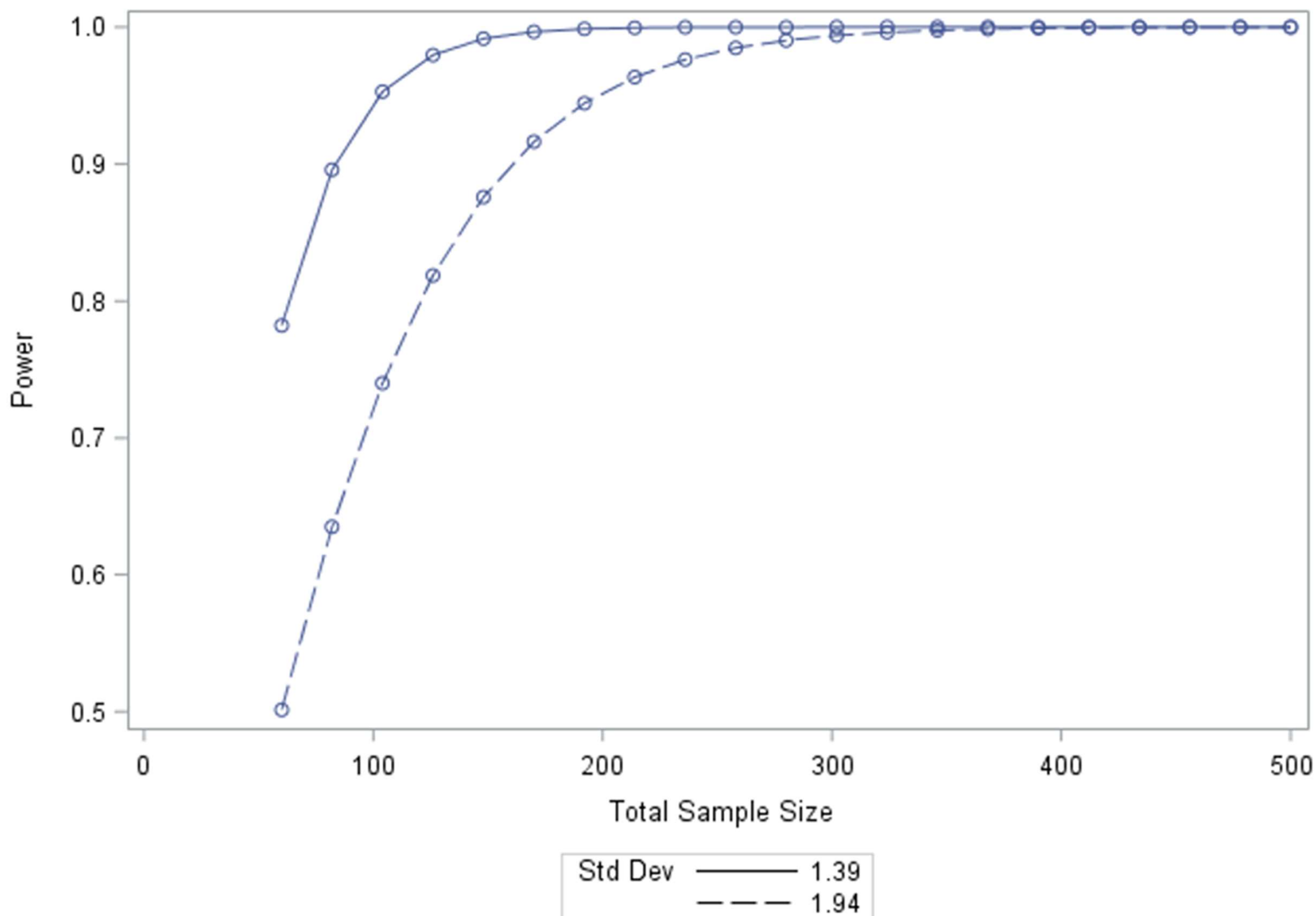
Appendix F. Power Calculations for Proposed Study Outcomes

Appendix Table F- 1.

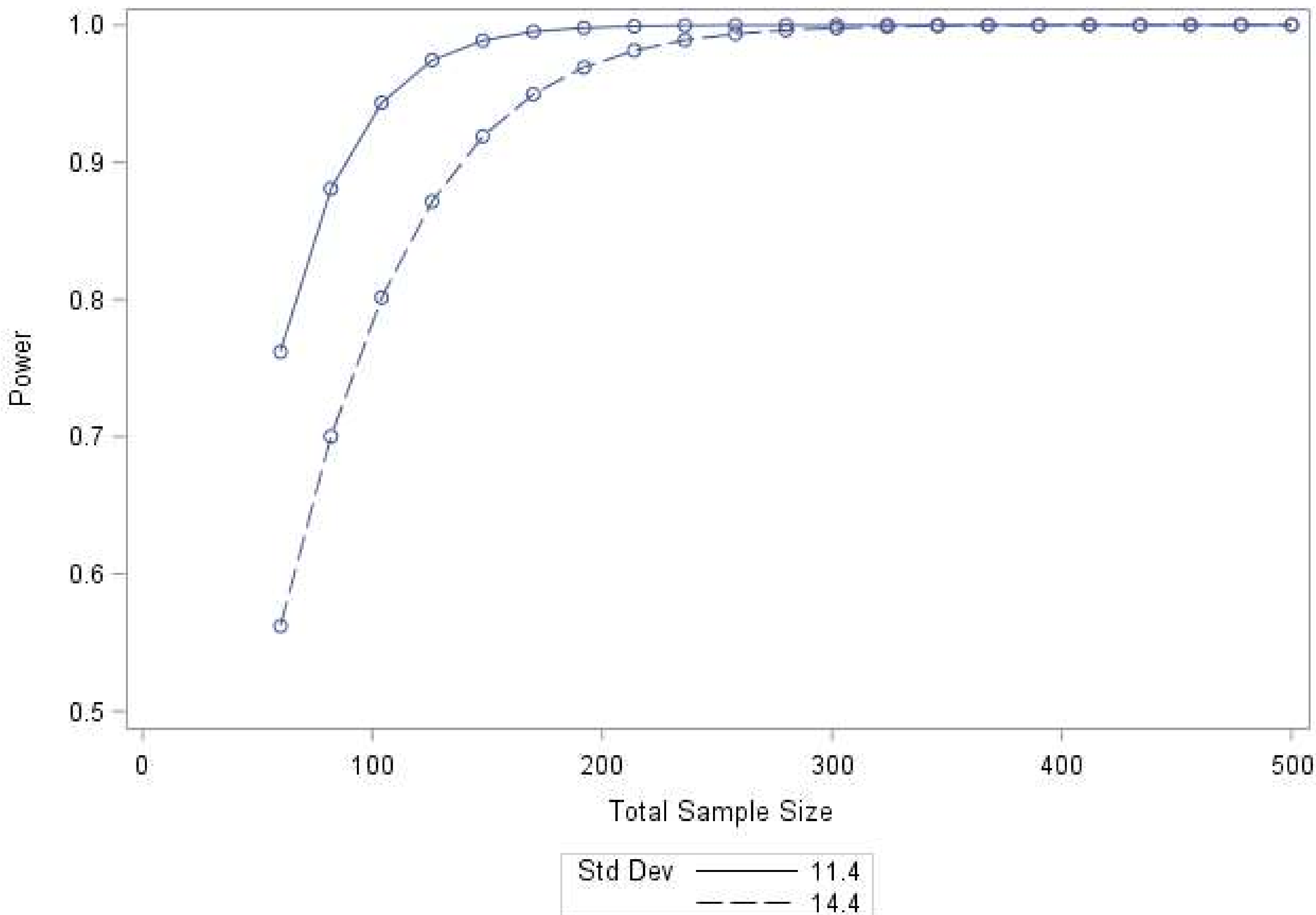
Estimated Sample Sizes Needed for 80 Percent Power to Detect Difference in Two-Sample Mean

Outcome (DV)	Min. Estimated Sample Size	Max. Estimated Sample Size
A1C	64	122
DBP	36	46
SBP	66	104
OV	140	--
MPR	116	--

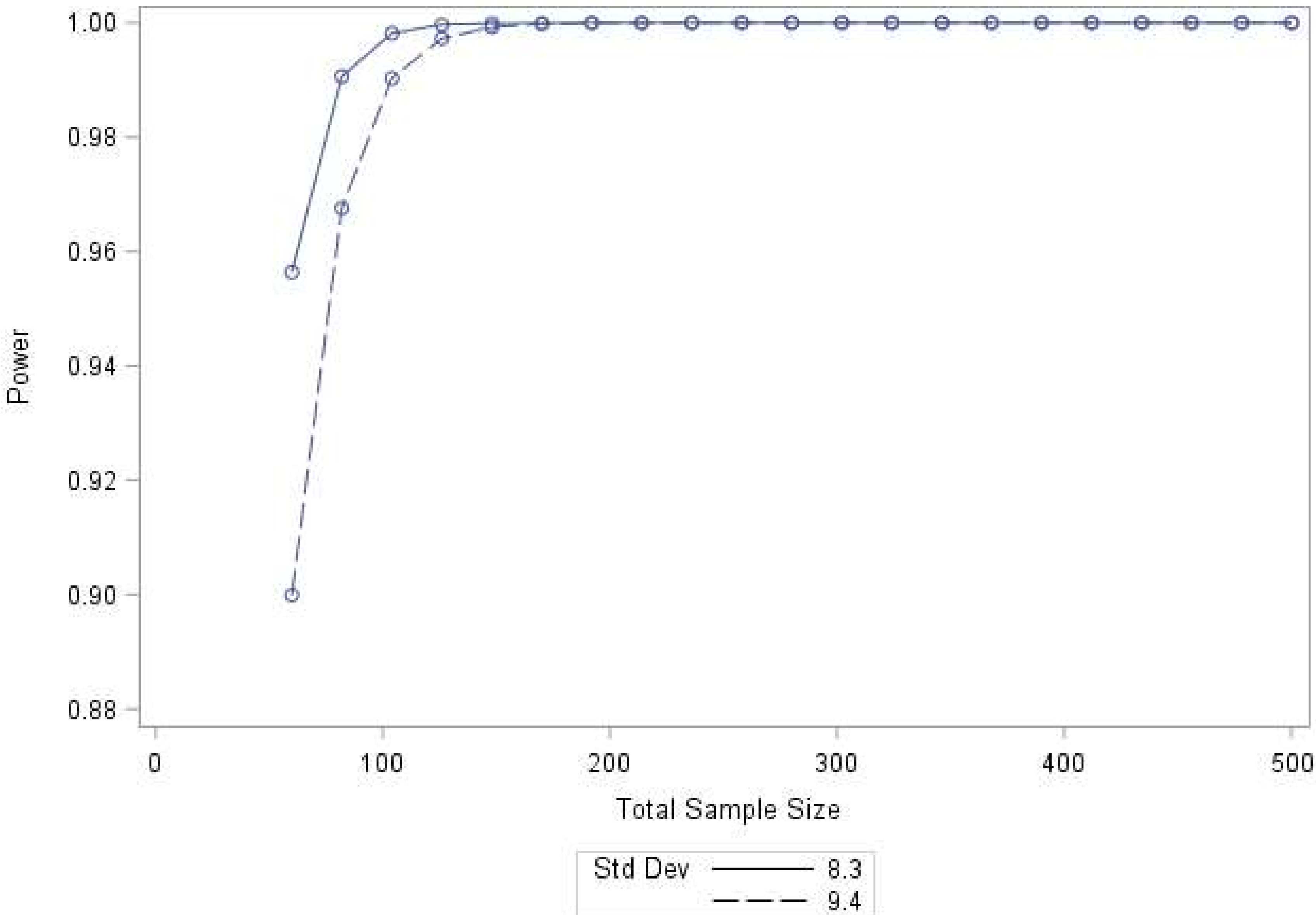
AC1=Glycated hemoglobin; DBP=Diastolic blood pressure; DV=Dependent variable; MPR=Medication possession ratio; OV=Office and emergency department visits; SBP=Systolic blood pressure



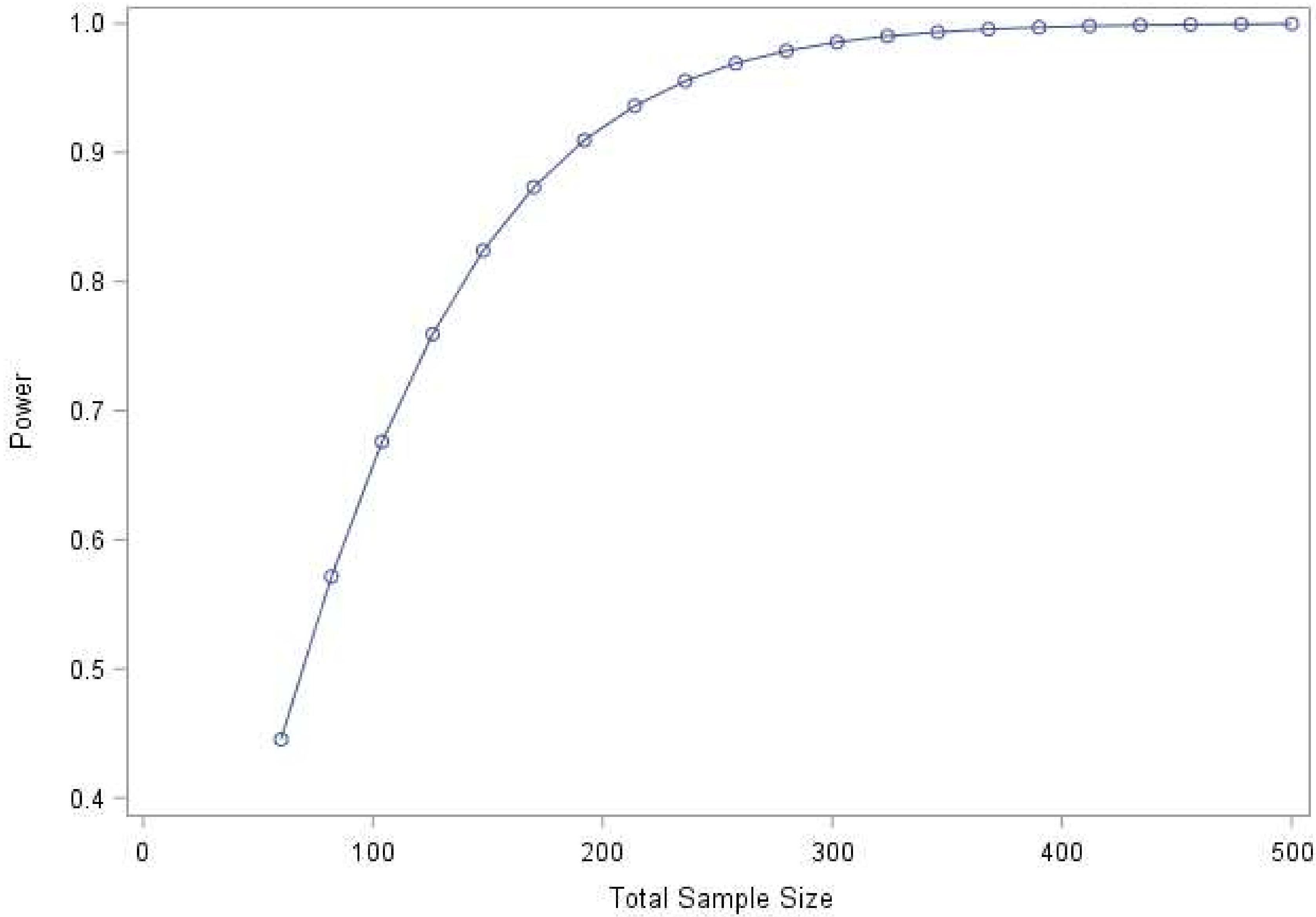
Appendix Figure F- 1. Sample Size Estimations by Power to Detect Change in Glycated Hemoglobin



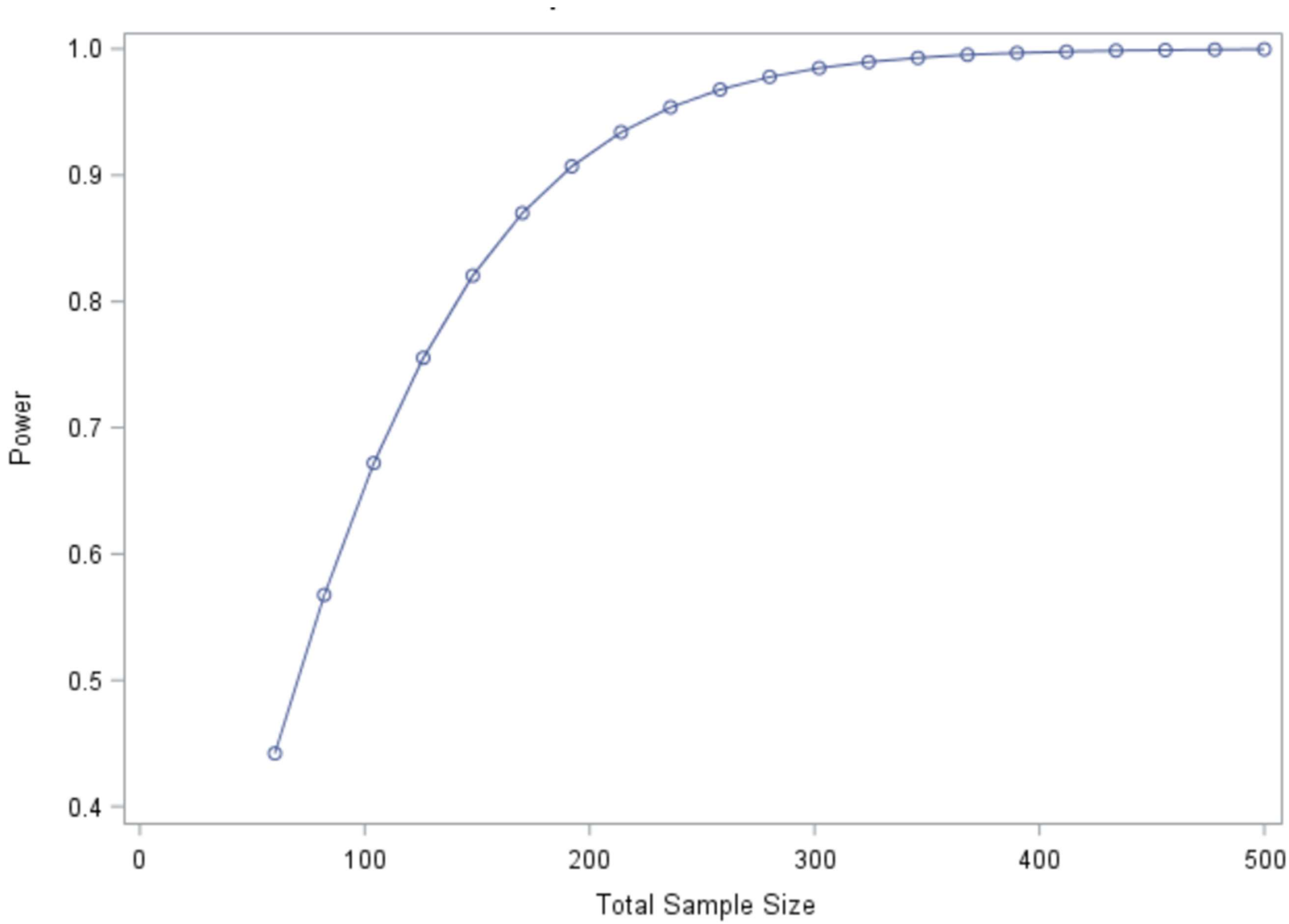
Appendix Figure F- 2. Sample Size Estimations by Power to Detect Change in Systolic Blood Pressure



Appendix Figure F-3. Sample Size Estimations by Power to Detect Change in Diastolic Blood Pressure



Appendix Figure F-4. Sample Size Estimations by Power to Detect Change in Number of Office Visits



Appendix Figure F-5. Sample Size Estimations by Power to Detect Change in Medication Possession Ratio

Appendix Table F-2.

Additional Patients that Would Need to be Oversampled to Detect Statistical Differences Office Visits by Selected Demographic

Taxa	Males	Blacks	60+ y.o.	<60 y.o.
Patient Task-Oriented Requests				
Medication refills and renewals requests	--	--	--	--
New or change medication request	1192	608	283	169
Other administrative	--	--	--	--
Referral request	850	1702	282	1702
Scheduling request	--	--	--	--
Cancellation	311	894	99	311
Follow-up	1767	457	1243	20
Laboratory test or diagnostic procedure	806	1138	391	142
New condition or symptom	1243	311	311	99
Preventive care or physical exam	9594	2629	9594	1758
Reschedule	274	161		
Patient Information Seeking				
Logistical information	--	--	--	--
Symptoms/Condition	--	--	--	--
Patient Information Sharing				
Clinical update	169	608	--	283
Response to clinician's message	--	--	--	--
Self-reporting	853	4268	609	1195
Clinician Responses				
Task-oriented/Recommendation to schedule an appointment	848	167	423	--
Action responses	--	--	--	--
Acknowledgement	2	715	--	88
Denies	606	281	--	423
Fulfills request	--	--	--	--
Partially fulfills request	--	--	--	--
Information seeking	326	235	--	--
Information sharing	--	--	--	--
Defer	76	424	--	168
Medical guidance	--	--	--	--
Orientation to procedures, treatments, or preventive behaviors	--	--	--	--
Social Communication				
Appreciation and praise (clinician-generated)	--	113	--	--
Appreciation and praise (patient-generated)	139	1132	--	281
Complaints	423	1189	167	605
Life issues	423	849	281	75

Appendix Table F-3.

Additional Patients that Would Need to be Oversampled to Detect Statistical Differences in Outcomes for Patients with Diabetes, by Selected Demographic

Taxa	Medication Adherence				Glycemic Level (A1C)			
	Male	Black	60+ y.o.	<60 y.o.	Male	Black	60+ y.o.	<60 y.o.
Patient Task-Oriented Requests								
Medication refills and renewals requests	118	--	--	--	154	--	--	--
New or change medication request	1125	641	372	278	1213	704	421	322
Other administrative	--	--	--	--	10	--	--	--
Referral request	842	1548	371	1548	915	1658	420	1658
Scheduling request								
Cancellation	395	878	220	395	445	953	261	445
Follow-up	1602	516	1167	154	1714	572	1257	191
Laboratory test or diagnostic procedure	805	1081	462	255	877	1166	515	298
New condition or symptom	1168	395	395	220	1258	445	445	261
Preventive care or physical exam	8087	2316	8087	1594	8534	2465	8534	1706
Reschedule	364	271	77	--	413	315	110	--
Patient Information Seeking								
Logistical information	--	35	--	--	--	66	--	--
Symptoms/Condition	136	136	--	35	172	172	--	66
Patient Information Sharing								
Clinical update	278	641	--	372	322	704	--	421
Response to clinician's message	--	--	--	--	--	--	--	--
Self-reporting	845	3674	643	1128	918	3893	705	1215
Clinician Responses								
Task-oriented/Recommendation to schedule an appointment	840	276	488	--	913	320	542	--
Action responses								
Acknowledgement	139	730	30	210	176	797	61	250
Denies	640	371	136	488	702	419	172	543
Fulfills request	--	--	--	--	--	--	--	--
Partially fulfills request	--	--	--	--	--	--	--	--
Information seeking	408	332	120	47	458	379	156	79
Information sharing	--	--	--	--	--	--	--	--
Defer	200	489	--	277	240	544	--	321
Medical guidance	--	35	--	--	24	66	--	--
Orientation to procedures, treatments, or preventive behaviors	136	136	35	--	173	173	67	--
Social Communication								
Appreciation and praise (clinician-generated)	--	232	--	--	--	273	--	--
Appreciation and praise (patient-generated)	253	1076	--	371	296	1161	--	419
Complaints	488	1123	276	639	543	1210	320	702
Life issues	488	841	371	200	543	914	419	240

Appendix Table F-4.

Additional Patients that Would Need to be Oversampled to Detect Statistical Differences in Outcomes for Patients with Hypertension, by Selected Demographic

Taxa	Systolic blood pressure				Diastolic blood pressure			
	Male	Black	60+ y.o.	<60 y.o.	Male	Black	60+ y.o.	<60 y.o.
Patient Task-Oriented Requests								
Medication refills and renewals requests	47	--	--	--	--	--	--	--
New or change medication request	950	516	274	190	102	--	--	--
Other administrative	--	--	--	--	--	--	--	--
Referral request	696	1329	274	1329	--	270	--	270
Scheduling request								
Cancellation	296	728	138	296	--	4	--	--
Follow-up	1377	404	988	79	291	--	119	--
Laboratory test or diagnostic procedure	663	910	355	170	--	85	--	--
New condition or symptom	988	296	296	138	119	--	--	--
Preventive care or physical exam	7191	2017	7191	1370	2863	574	2863	288
Reschedule	268	184	10	--	--	--	--	--
Patient Information Seeking								
Logistical information	--	--	--	--	--	--	--	--
Symptoms/Condition	63	63	--	--	--	--	--	--
Patient Information Sharing								
Clinical update	190	516	--	275	--	--	--	--
Response to clinician's message	--	--	--	--	--	--	--	--
Self-reporting	698	3235	517	952	--	1113	--	103
Clinician Responses								
Task-oriented/Recommendation to schedule an appointment	694	189	378	--	--	--	--	--
Action responses								
Acknowledgement	66	596	--	129	--	--	--	--
Denies	514	273	63	379	--	--	--	--
Fulfills request	--	--	--	--	--	--	--	--
Partially fulfills request	--	--	--	--	--	--	--	--
Information seeking	306	239	49	--	--	--	--	--
Information sharing	--	--	--	--	--	--	--	--
Deferred	121	379	--	190	--	--	--	--
Medical guidance	--	--	--	--	--	--	--	--
Orientation to procedures, treatments, or preventive behaviors	63	63	--	--	--	--	--	--
Social Communication								
Appreciation and praise (clinician-generated)	--	149	--	--	--	--	--	--
Appreciation and praise (patient-generated)	168	906	--	273	--	83	--	--
Complaints	378	948	189	514	--	101	--	--
Life issues	379	695	273	120	--	--	--	--

6. Look Who's (Electronically) Talking: Differences in Patient and Clinician Characteristics Associated with Email Message Content

Dawn Heisey-Grove, Ph.D. (c), M.P.H.
Ph.D. candidate, Virginia Commonwealth University

Jonathan DeShazo, Ph.D., M.P.H.
Associate Professor and Blick Scholar, Virginia Commonwealth University

Laura McClelland, Ph.D.
Associate Professor, Virginia Commonwealth University

Leonard Friedman, Ph.D. M.P.H., FACHE
Professor, The George Washington University

Kevin Jackson, Ph.D., RRT
Assistant Professor, Norfolk State University

Alexander Tartaglia, D. Min.
Senior Associate Dean and Katherine I. Lantz Professor, Virginia Commonwealth University

6.1 Abstract

Background

As the number of secure electronic messages increases between patients and clinicians, there is a need to explore and understand how patients and clinicians are using those messages, and what they are saying in them. In this research, we explored the patient and clinical staff characteristics associated with content exchanged in secure messages.

Methods

We randomly sampled 1031 patients with hypertension and/or diabetes from a large urban health system in Virginia. After coding all messages that were part of threads initiated by our sampled patients in 2017, we conducted four sets of analyses to identify associations between (1) patient characteristics and the types of messages they sent; (2) clinical staff characteristics and the types of messages they sent; (3) patient characteristics and the types of messages they received from clinic staff; and (4) staff characteristics and the types of messages patients sent to them. We used logistic regression to estimate odds ratios to estimate the strength of the associations.

Results

We coded 18309 patient- and clinician-generated messages. We found that younger patients were less likely to share clinical updates (OR=0.77; 95% CI: 0.65-0.91) and request prescription refills (OR=0.77; 95% CI: 0.65-0.90), but more likely to send scheduling requests (OR=1.41; 95% CI: 1.19-1.68). Females were less likely to self-report biometrics (OR=0.78; 95% CI: 0.62-0.98) but more likely to respond to a clinician (OR=1.20; 95% CI: 1.02-1.42). Compared to white patients, black patients were 2.68 times more likely to request preventive care (95% CI: 1.30-5.51) but less likely to request a new or changed prescription (OR=0.72; 95% CI: 0.53-0.98) or laboratory or other diagnostic procedures (OR=0.66; 95% CI: 0.46-0.95).

Clinic staff were less likely to share medical guidance with younger (OR=0.84; 95% CI: 0.71-0.99) and uninsured patients (OR=0.21; 95% CI: 0.06-0.72), but were two times more likely to share

medical guidance with patients with public payers (95% CI: 1.27-3.24) compared to patients with private payers. Clinic staff were less likely to send confirmation that requests were fulfilled to female patients (OR=0.81; 95% CI: 0.68-0.97) and patients who lived in rural areas (OR=0.56; 95% CI: 0.33-0.94).

Conclusion

We present the first application of a theoretically based taxonomy developed specifically to code secure message content. This research is important in highlighting that electronic message communication between patients and clinicians may perpetuate health disparities along patient demographic and health condition factors, if not handled correctly. A significant amount of future research can be hypothesized based on these findings.

6.2 Introduction

Secure exchange of electronic messages between patients and clinicians provides an opportunity for patients to engage with their clinicians between office visits. The Institute of Medicine (IOM) noted that secure messaging and other forms of health information technology (IT) may help improve health care safety, timeliness, efficiency, and efficacy (Institute of Medicine, 2001). A recent literature review found that health IT may also promote patient engagement and empowerment by improving patients' preparation for, and recall of, clinical encounters (Rathert et al., 2017).

Relational communication, necessary to support patient-centered communication, is possible through technology-mediated communication such as secure messaging, given sufficient time (Tidwell & Walther, 2002; Walther, 1992a, 1995; Walther et al., 2010). Patient-centered communication practices may therefore apply to secure messaging communication between patient and clinician. Patient-centered care is generally interpreted as care that considers patients' values and preferences while fostering bidirectional information sharing to support shared decision-making (Epstein et al., 2010). Communication that provides information at levels that patients can understand leads to better diagnoses, development of appropriate treatment and self-care plans, improvements in patients' adherence to those plans, and evidence-based decision-making that leads to improved health outcomes (Street, Makoul, et al., 2009). The question then becomes whether secure messages being exchanged between patients and clinicians include this type of content.

Secure message content has been analyzed in a variety of ways by researchers, but the focus has primarily been on patient-generated message content rather than clinician-generated content. Only six articles explored clinician-generated content and two of those classified content thematically (e.g., use of partnership-building language or complexity of medical decisions) rather than with content analyses using an applied classification system, or taxonomy (Alpert et al., 2017; Anand et al., 2005; Hogan et al., 2018; Mirsky et al., 2016a; Robinson et al., 2017; Roter et al., 2008). Of the studies that explored patient-generated content, most used a taxonomy unique to that research, limiting comparability and generalizability. Further, these articles did not quantify content use by patient or clinician characteristics, but instead reported overall taxa (i.e., taxonomic categories) frequencies as they occurred within the study populations.

Since theory provides rationale for understanding the world and supports objectivity in research (Jaccard & Jacoby, 2010), it is critical that the concepts captured in any taxonomy are grounded in good theory. A theory-based taxonomy developed specifically for secure messaging should permit comparisons of message content across healthcare environments and may provide a better understanding of how both patients and clinicians are using secure messaging. Through this research, we developed a theoretically based taxonomy, grounded in prior published taxonomies, and applied that taxonomy to a set of patient-initiated message threads.

A thread includes the initiating message and all patient and clinician responses. The message thread is thought to be most similar to in-office communication. Consistent with the premises of the Uncertainty in Illness Theory (Mishel, 1988) and patient-centered communication (Street, Makoul, et al., 2009), our taxonomy includes categories (or taxa) for patients seeking information to alleviate uncertainty around their health status (e.g., symptoms, condition) and healthcare delivery processes; it includes task-oriented requests that might be used to support self-care or address uncertainty. We included social communication and information sharing taxa for both patient- and clinician-generated messages since these taxa may indicate communication that fosters trust-building between patients and clinicians. For content from clinic staff, the taxonomy also includes action responses based on the Taxonomy of Requests by Patients (Kravitz et al., 1999) as leveraged by other researchers. Additional taxa for clinician-generated messages classifies clinicians' information sharing content. Appendix Table 6-1 lists all taxa and their definitions.

In this paper, we present differences across patient and clinic staff characteristics associated with the use of each taxon. We explored (1) whether patient demographic and health characteristics were associated with the message content they generated; (2) clinic staff characteristics were associated with the message content they generated; (3) whether the content clinic staff sent to patients was associated with the patients' demographic or health characteristics; and (4) whether the content of messages sent by patients to clinic staff varied by the staffs' characteristics.

6.3 Methods

Study Population. Our study included a random sample of adult patients with diabetes, hypertension, or both conditions from among patients of the Virginia Commonwealth University Health System (VCUHS). Our sampling frame included patients registered with the VCUHS patient portal who had at least two VCUHS outpatient visits or one inpatient visit in 2016 with diagnosis codes for either diabetes (ICD-10-DM E11) or hypertension (ICD-10-DM I10), and at least one VCUHS outpatient visit between January and June 2018. We included all threads initiated by the sampled patients that were started, completed, and saved to patients' charts between January 1 and December 31, 2017. We also included all clinic staff who responded to, or were the intended recipient of, at least one of those sampled threads. This research was approved by the VCU Institutional Review Board under an expedited category 5 review.

Patient characteristics. We included categorical variables representing patients' demographic and geography-based characteristics, as well as elements for health status and healthcare access. Demographic characteristics included age, sex and race (black, other, white). Geography-based characteristics included rural or urban home location based on Rural Urban Commuting Area (United States Department of Agriculture Economic Research Service, 2019) codes, and travel distance between clinic and home. We approximated patients' travel distance to each clinic by estimating the distance between the centroids of patients' home zip codes and the clinics to which patients directed their messages. If patients sent threads to different clinics during 2017, we used the average distance across threads. We recorded patients' addresses as missing if they were located outside Virginia and excluded these from analyses that used this variable.

We included patients' health status markers based on health condition (i.e., diabetes, hypertension, or both conditions), the number of comorbidities ranging from one to nine from a list of ICD-10-DM that occurred frequently within the sampled population (diabetes, hypertension, lipoprotein disorders, overweight and obesity, joint disorders, gastroesophageal reflux disease, back or spine pain, soft tissue disorders, and sleep disorders), and baseline glycemic and blood pressure control. Among patients with diabetes, we used baseline HbA1c laboratory values to create a dichotomous measure for glycemic control (A1C <=7.0). We included measures of both diastolic (DBP) and systolic (SBP) blood pressure control for patients with hypertension and defined controlled blood pressure as DBP<80 and SBP<120. If more than one blood pressure was recorded for a single day, we used the average across those blood pressure values.

Finally, we incorporated elements for patients' healthcare access using payer type (private, public, uninsured, or other), the number of threads initiated by patients in 2017, and their number of outpatient visits.

Characteristics of clinic staff. At VCUHS, clinical teams triage patient messages. That means the intended recipient is not always the individual who responds to a given message. We therefore performed two sets of analyses for clinic staff: one where the clinic staff was the message sender and the other where the clinic staff was the intended recipient of the patient-generated message. We reference messages sent by any clinic staff as 'clinician-generated.'

We identified the patient's intended recipient in two ways: for the initial patient-generated message in each thread, the intended recipient was the clinic staff to whom the message was addressed; we assumed the intended recipient for all subsequent patient-generated messages was the sender of the clinician-generated message most recently preceding the patient-generated message. If a clinician-generated message did not precede the patient-generated message, we used the same intended recipient as the most recently preceding patient-generated message.

VCUHS messages typically included the clinic staff member's name and a general mailbox to support message triage. We used this information to identify the sender and intended recipients. Some messages included only the general mailbox label and no staff name; in these situations, we could not assign a staff identity. Messages lacking a staff name were not included in regression analyses based on clinic staff characteristics.

Where a staff name was available, we matched names with the National Plan & Provider Enumeration System (NPPES) (U.S. Centers for Medicare & Medicaid Services) based on first and last name; middle name was referenced when available and first and last name was insufficient to make a match. From NPPES, we obtained the clinician type (e.g., physician, nurse practitioner, psychologist) and clinical specialty. For staff not found in NPPES, we used the Virginia Department of Health Professions License Verification system (Virginia Department of Health Professions), which provided information on clinician type (e.g., registered or licensed practical nurse). We referenced the information available in the electronic health record system for any remaining staff lacking a credential type. Clinic staff types were grouped to the six most frequently occurring types (i.e., administrative staff, licensed practical nurse, nurse practitioner, physician, registered nurse, and other clinicians). The other clinicians' category included pharmacists, physician assistants, medical assistants, podiatrists, social workers, and medical technicians.

We categorized clinical specialty as either primary care or specialty. We included family and internal medicine, geriatrics, pediatrics, and obstetrics and gynecology in the primary care category. Physician assistants, registered nurses, pharmacists, social workers, medical technicians, case managers, counselors, and administrative staff were assigned a value of not applicable for specialty.

We estimated message volume for each staff member for 2017, which was based on those messages saved to patients' charts. Message volume included all messages sent by staff members to the VCUHS population (not just our sampled population), regardless of whether they were sent in response to a patient-initiated thread or were part of a clinically initiated thread. Clinic staff lacking a known message volume were not included in regression analyses that used clinic staff characteristics.

Content Analysis. The full message thread provided the contextual unit for coding; coding units could be no longer than a single message and were frequently shorter, with multiple codes applying to a single message. A taxon was assigned only once to a given message. We coded using QSR International's NVivo 12 software, with primary coder DHG reading and assigning taxa to all messages and a second coder, JDS, doing the same for a random ten percent sample of messages. Six batches of messages were created; after each batch, the codes from DHG and JDS were compared, discrepancies were reconciled, and the DHG re-coded the messages accordingly. Midway through the coding process, and again at the end, DHG recoded all messages based on clarified taxonomy definitions. Once the taxonomy definitions were finalized and all messages had been coded based on those definitions, DHG selected and coded a ten percent random sample of messages to estimate retest reliability.

We estimated interrater and intrarater reliability using kappa coefficients. Appendix Table 6-2 presents these results. Based on interpretations provided by Cicchetti (1994) where excellent clinical significance is associated with a kappa between 0.75 and 1.00, good between 0.60 and 0.74, and fair between 0.40 and 0.59, our two coders' reliability was primarily fair (41 percent of taxa), with 19 percent of taxa having excellent agreement and 11 percent having good agreement. Taxa with poor agreement were clinician-generated request denials and recommendations to schedule. We had insufficient sample to estimate a kappa for five taxa. DHG's intrarater reliability was primarily excellent (48 percent of taxa) and good (41 percent of taxa).

Data Analysis. We explored the associations between taxa and both the senders' and intended recipients' characteristics. We report here on four analysis sets as associations between taxa and (1) patients' characteristics when the patient was the sender (patient-as-sender); (2) the characteristics of clinic staff when they sent the message (clinic staff-as-sender); (3) patients' characteristics when the patient was the intended recipient of messages sent by the clinic staff (patient-as-recipient); and (4) the characteristics of clinic staff when they were the intended recipients of messages sent by patients (staff-as-recipient).

Within each of these analysis sets, we estimated within group differences using Chi-square. We estimated adjusted odds ratios using separate logistic regression models where each taxon was the dependent variable and the patient or clinic staff characteristics were the independent variables. We conducted all analyses using SAS v9.4.

Analysis set 1: Characteristics for patient-as-sender. We tested whether patients' message content differed based on their characteristics. For each taxon, we created a dichotomous variable that was coded as positive if the patient sent at least one message coded with the taxon. These analyses focused on taxa specific to patient-generated message content. This analysis set included additional regression models per taxon in which the baseline health status measures were added as independent variables: one regression model for baseline glycemic control and another for baseline blood pressure control. We included only the patient population with the condition of interest (i.e., diabetes for the models with glycemic control and hypertension for the models with blood pressure control) in these additional models.

Analysis set 2: Characteristics for clinic staff-as-sender. This analysis set explored whether message content sent by clinic staff varied based on their characteristics. We created dichotomous variables for each clinician-generated taxon and coded the variables positive if clinic staff sent at least one message coded with that taxon. These analyses focused on taxa associated with clinician-generated content.

Analysis set 3: Characteristics for patient-as-recipient. These analyses focused on taxa specific to clinician-generated message content since they explored whether message content clinic staff sent to patients differed based on patients' characteristics. We also included clinic non-response in these analyses, which we defined as a patient-initiated thread that included no messages from clinic staff.

We created a dichotomous variable for each clinician-generated taxon and coded each variable positive if the patient received at least one message with content relevant to the taxon. As with analysis set 1, we included additional regression models with independent variables for baseline glycemic control and baseline blood pressure control; these models used only those patients with the relevant health condition (diabetes and hypertension, respectively).

Analysis set 4: Characteristics for clinic staff-as-recipient. This final analytic set focused on the characteristics of clinic staff associated with patient-generated messages to explore whether patients' message content varied based on the type of clinic staff to whom they sent messages. These analyses focused on taxa specific to patient-generated message content. We created a dichotomous variable for each patient-generated taxon and coded the variable positive if the clinician was the intended recipient for at least one patient-generated message coded with that taxon.

6.4 Results

Our patient study population included 1031 patients who generated 7346 patient-initiated threads during 2017. Our message sample included 18309 messages, of which slightly more than half (56 percent) were patient-generated (n=10163). On average in 2017, each patient initiated seven threads (median=4) with 1.4 messages per thread for a total of ten messages per year. Twenty-three percent of patients had both diabetes and hypertension; 39 percent of patients had only diabetes. Among those patients with diabetes, 27 percent (n=174) did not have a baseline glycemic value.

Our average patient received messages from 3.7 different staff during 2017; most threads included a single clinic staff member (mean=1.2). Our clinic staff (senders and intended recipients) population totaled 708; of those, 674 (95%) sent at least one message. Clinic staff responded to an average of nine sampled patients (median=3, max=223) across an average of 15.8 threads (median=3.5, max=348). Staff averaged 21.5 response messages (median=5, max=416) across the sampled patient population.

Characteristics for patient-as-sender. Table 6-1 presents the percentage of patients who sent at least one message coded for each taxon. A majority of patients sent messages with Information sharing and Information seeking content. The smallest percentage of messages sent by patients were Appreciation or praise, Complaints, Self-reporting, and Referral requests. Appendix Table 6-3 lists the distribution of the taxa by patients' characteristics and the within group Chi-square estimates.

Table 6-1.

Percentage of Patients who Sent at Least One Message Coded with Selected Taxon

Patient-generated taxa	Percentage [95% CI]
Information seeking	63.24 [60.29, 66.19]
Logistics	40.74 [37.73, 43.74]
Medical guidance	53.73 [50.68, 56.78]
Information sharing	66.15 [63.26, 69.04]
Sharing clinical update	46.46 [43.41, 49.51]
Self-reporting	10.57 [8.69, 12.45]
Response to clinician's message	50.44 [47.38, 53.49]
Prescription request	58.87 [55.87, 61.88]
Prescription refill or renewal	48.88 [45.83, 51.94]
New or change prescription	28.42 [25.66, 31.18]
Referral request	11.25 [9.32, 13.18]
Other administrative request	30.26 [27.45, 33.07]
Scheduling request	66.54 [63.65, 69.42]
Cancellation	20.66 [18.18, 23.14]
Follow-up	23.38 [20.79, 25.96]
New condition or symptom	19.40 [16.98, 21.82]
Preventive care	8.24 [6.56, 9.93]
Reschedule	38.12 [35.15, 41.09]
Laboratory test or diagnostic procedure	14.06 [11.94, 16.19]
Social communication	21.73 [19.20, 24.25]
Appreciation of praise	6.50 [4.99, 8.01]
Complaints	9.31 [7.53, 11.09]
Life issues	12.12 [10.13, 14.12]

Table 6-2 displays the odds ratios estimated as statistically significant with a p-value of less than 0.05 for the associations between summary-level taxa and patient characteristics. We observed differences by age, sex, race, number of comorbidities, distance to clinic, payer type, baseline glycemic level, the

Table 6-2.

Odds Ratio Estimates [and 95% Confidence Intervals] of the Associations Between Patient Characteristics with Summary-Level Patient-Generated Taxa (Patient-as-Sender)

Patient characteristics	Information seeking	Information sharing	Prescription requests	Other administrative requests	Scheduling requests	Social communications
18-59 vs. 60+ years	--	--	0.78 [0.66-0.93]	--	1.41 [1.19-1.68]	--
Female vs Male	--	--	0.83 [0.71-0.98]	--	--	--
9-16 vs 40+ miles to clinic	--	1.38 [1.05-1.82]	--	--	--	--
17-39 vs 40+ miles to clinic	--	--	--	--	--	1.42 [1.06-1.90]
Public vs Private payer	--	--	--	--	0.66 [0.46-0.96]	--
Controlled vs Uncontrolled baseline A1C[a]	1.41 [1.11-1.80]	--	--	--	N.R.	N.R.
Initiated 1 vs >7 threads	0.19 [0.14-0.26]	0.16 [0.11-0.22]	0.21 [0.15-0.28]	0.24 [0.15-0.39]	0.25 [0.19-0.34]	0.33 [0.19-0.57]
Initiated 2 vs >7 threads	0.42 [0.30-0.58]	0.41 [0.30-0.57]	0.54 [0.39-0.74]	0.59 [0.39-0.89]	0.58 [0.43-0.80]	0.44 [0.25-0.76]
Initiated 5-7 vs >7 threads	1.39 [1.03-1.88]	1.90 [1.35-2.67]	1.67 [1.24-2.25]	1.45 [1.07-1.98]	--	--
1-5 vs >20 outpatient visits	0.70 [0.50-0.98]	--	--	--	--	--
6-10 vs >20 outpatient visits	--	--	--	--	0.72 [0.54-0.95]	--

Notes: Each column represents two regression models, in which the dependent variable is the taxon and the independent variables are the patient characteristics (table rows) included in the analysis: the first regression includes all patient characteristics excluding baseline A1C and BP; the second includes baseline A1C modeled with patients with diabetes. Included in the models but not in this table because they were not statistically significant at p<0.05: race, number of comorbidities, baseline BP, health condition, and rural/urban home location. A1C=glycemic level, N.R.=Not Reliable, model did not converge. --=Not statistically significant at p-value<0.05.
[a] Model included only patients with diabetes (controlled defined as A1C≤7.0)

number of threads the patient initiated, and the patients' outpatient visit count. Appendix Table 6-4 presents the odds ratio estimates for all taxa. Several models could not converge on a maximum likelihood estimate: the Referral request taxon regression model; the models that included baseline glycemic levels and blood pressure values for the Preventive care and all Social communication taxa; and the model for Self-reporting that included baseline glycemic levels.

Demographic characteristics. Younger patients sent fewer clinical updates (OR=0.77; 95% CI: 0.65-0.91) and prescription refill and renewal requests (OR=0.77; 95% CI: 0.65-0.90). They were more likely to send task-oriented scheduling requests, specifically for follow-up appointments (OR=1.44; 95% CI: 1.20-1.73), appointments for new conditions or symptoms (OR=1.60; 95% CI: 1.31-1.95), and rescheduling (OR=1.20; 95% CI: 1.03-1.41). Female patients were less likely to self-report biometrics (OR=0.78; 95% CI: 0.62-0.98) and request prescription refills (OR=0.82; 95% CI: 0.70-0.97), but more likely to respond to a clinician's comment or question (OR=1.20; 95% CI: 1.02-1.42) and seek medical guidance (OR=1.19; 95% CI: 1.01-1.40).

In adjusted analyses, black patients were less likely to request a new or changed medication (OR=0.72; 95% CI: 0.53-0.98) or laboratory or other diagnostic procedure (OR=0.66; 95% CI: 0.46-0.95), and to request an appointment be canceled (OR=0.73; 95% CI: 0.53-1.00), compared with white patients. Conversely, black patients were 2.68 times (95% CI: 1.30-5.51) more likely to request preventive care appointments than white patients. Patients of other races were 2.2 times (95% CI: 1.38-3.58) more likely to request a new or changed medication compared to white patients. In unadjusted analyses, we observed a difference (p=0.03) between races' requests for appointment rescheduling, but this was not significant in adjusted analyses.

Geography-based characteristics. We observed no statistical differences between rural and urban home location in either the adjusted or unadjusted analyses. We observed that patients who lived closer to their clinics were more likely to request follow-up appointments, respond to a clinician, and self-report biometrics, compared to patients who lived 40 or more miles from their clinics. Patients who lived closest to their clinics were less likely to share clinical updates or seek logistical information.

Patient health status. Patients with diabetes only were more likely to request a new or changed medication (OR=1.33; 95% CI: 1.06-1.66) and less likely to request that an appointment be rescheduled (OR=0.79; 95% CI: 0.64-0.97), compared to patients with both diabetes and hypertension. Patients with hypertension only were more likely to seek medical guidance (OR=1.38; 95% CI: 1.11-1.72) and less likely to self-report biometrics (OR=0.70; 95% CI: 0.50-0.98) than patients with both conditions.

Patients with controlled A1C levels were more likely to seek logistical information (OR=1.30; 95% CI: 1.00-1.64), cancel appointments (OR=1.35; 95% CI: 1.04-1.75), and less likely to request prescription renewals (OR=0.78, 95% CI: 0.62-0.98), compared to patients with uncontrolled A1C levels. Patients with controlled BP were less likely to request follow-up appointments (OR=0.72; 95% CI: 0.54-0.98) and more likely to schedule appointments for new conditions (OR=1.31; 95% CI: 1.01-1.70), compared to patients with uncontrolled hypertension.

Healthcare access. In unadjusted analyses, we observed differences by payer type for patients' requests for follow-up appointments (p=0.01), appointments for new or changed conditions (p=0.03), rescheduling (p<0.01), and overall scheduling requests (p<0.01). In adjusted analyses, the only significant finding was among uninsured patients, who were 2.46 times (95% CI: 1.06-5.74) more likely to reschedule appointments compared to patients with private payers.

Patients with the fewer outpatient visits were less likely to seek medical guidance, reschedule visits, and share clinical updates. They were more likely to send complaints, request appointments for preventive care and new or changed conditions, and request new or changed prescriptions, compared to patients with more than 20 outpatient visits during the year. Across most taxa, patients who initiated one or two threads were less likely to send each taxon, and patients who initiated between five and seven threads were more likely to send a selected taxon than patients who initiated more than seven threads.

Characteristics for clinic staff-as-sender. Among the 674 clinic staff who sent messages to our sampled patients, the most common staff types were registered nurses (38 percent), physicians (26 percent), and administrative staff (14 percent). These staff types also sent the most messages (n=2678, n=2380, and n=1927, respectively). Appendix Table 6-5 lists the number of clinic staff by characteristic as well as the percentages by taxa and unadjusted Chi-square within group estimates. We excluded 33 clinic staff (4.9 percent) from regression analyses due to missing staff type or message volume.

Table 6-3 lists the percentages of staff who sent at least one message with content coded for each taxon. Nine in ten clinic staff shared information with their patients, although only slightly more than half shared medical guidance. Almost two-thirds of clinic staff sent at least one message that fulfilled a patient's request. Social communication content was rare among clinic staff; no clinic staff sent complaints and only two sent content coded as life issues; therefore, we present only results associated with the Appreciation or praise taxon throughout this paper.

Table 6-3.

Percentage of Clinic Staff who Sent at Least One Message Coded with Selected Taxa (Staff-as-Sender)

Clinician-generated taxon	Percentage [95% CI]
Recommendation to schedule an appointment	25.37 [22.08, 28.66]
Information seeking	52.52 [48.74, 56.30]
Deferred information sharing	51.78 [48.00, 55.56]
Information sharing summary	89.02 [86.65, 91.39]
Medical guidance	57.57 [53.83, 61.31]
Orientation to processes & procedures	73.00 [69.64, 76.36]
Social communication: Appreciation or praise	10.68 [8.34, 13.02]
Request denial	16.02 [13.25, 18.80]
Action responses	75.52 [72.26, 78.77]
Acknowledge	31.90 [28.37, 35.43]
Fulfills request	64.24 [60.62, 67.87]
Partially fulfills request	37.09 [33.44, 40.75]

We observed significant unadjusted differences by clinical specialty (p<0.001) and message volume (p<0.001) for the Appreciation and praise taxon; however, the regression model did not converge to support adjusted analyses. Table 6-4 presents estimates of the associations between the other taxa and clinic staff characteristics. We observed a statistically significant difference between clinical specialty and only one taxon (request acknowledgements): staff for whom specialty was not relevant were less likely to send acknowledgements than primary care clinicians.

Across most taxa, staff who sent fewer than 2001 messages were less likely to send messages with the selected taxon, compared to staff with the highest message volume. In adjusted analyses, staff who sent the second highest number of messages (between 2001 and 3400) were more likely to partially fulfill requests, seek information, and share medical guidance. All three nurse staff types were more likely, while administrative staff were less likely, to partially fulfill patients' requests compared with physicians. Registered nurses were more likely, and administrative staff less likely, to send almost all taxa compared to physicians. Nurse practitioners were 2.54 times more likely (95% CI: 1.08-6.00) to share medical guidance with patients.

Characteristics for patient-as-recipient. Table 6-5 displays the percentage of patients who received from clinic staff at least one message coded with the selected taxon. Almost two in three patients initiated at least one thread that received no response from the clinic. Three-quarters of patients received at least one message from clinic staff with information sharing content. Two-thirds of patients received message content that fulfilled their request. Few patients received messages that denied their requests or provided appreciation or praise.

Table 6-6 presents the estimated associations between patient characteristics and the clinician-generated taxa those patients received. Models for the Denies and Social communication taxa, those that controlled for baseline A1C and BP values for the Information sharing taxon, and the model that included baseline glycemic values for the Partially fulfills taxon, produced unreliable results. Appendix Table 6-6 presents the unadjusted percentages and Chi-square estimates of significant within group differences. In unadjusted analyses, younger patients ($p<0.01$), those who lived in rural areas ($p<0.01$), those with the smallest number of comorbidities ($p<0.0001$), and patients with non-private payers ($p<0.01$), were more

Table 6-4.

Odds Ratio Estimates [and 95% Confidence Intervals] of the Associations between Clinic Staff Characteristics and Clinician-Generated Taxa (Staff-as-Sender)

Staff characteristics	Action response			Request denials	Recommendation to schedule	Information Seeking	Deferred information sharing	Information sharing		
	Acknowledge	Fulfills	Partially fulfills					Medical guidance	Orient to processes & procedures	Summary
Administrative staff vs Physician	0.31 [0.15-0.65]	--	0.22 [0.11-0.42]	2.40 [1.14-5.07]	0.19 [0.07-0.47]	--	0.58 [0.34-0.97]	0.04 [0.02-0.10]	--	0.26 [0.14-0.51]
Licensed practical nurse vs Physician	2.86 [1.41-5.83]	--	1.99 [1.04-3.80]	--	--	--	--	--	--	--
Nurse practitioner vs Physician	--	--	2.34 [1.08-5.08]	--	--	--	--	2.54 [1.08-6.00]	--	--
Registered nurse vs Physician	1.73 [1.05-2.84]	--	1.76 [1.16-2.69]	2.42 [1.28-4.59]	1.98 [1.24-3.15]	--	1.94 [1.29-2.90]	1.55 [1.01-2.38]	1.96 [1.25-3.05]	1.97 [1.02-3.80]
No applicable vs Primary care specialty	0.41 [0.22-0.77]	--	--	--	--	--	--	--	--	--
<=1000 vs >3400 messages	0.35 [0.23-0.52]	0.39 [0.29-0.52]	0.38 [0.26-0.54]	0.40 [0.22-0.71]	0.45 [0.30-0.67]	0.37 [0.27-0.50]	0.46 [0.34-0.62]	0.29 [0.21-0.41]	0.4 [0.29-0.55]	0.3 [0.19-0.48]
1001-2000 vs >3400 messages	0.63 [0.45-0.88]	0.71 [0.53-0.95]	0.53 [0.39-0.74]	--	--	0.45 [0.34-0.61]	0.54 [0.41-0.73]	0.69 [0.50-0.96]	0.63 [0.46-0.87]	--
2001-3400 vs >3400 messages	--	--	1.51 [1.10-2.07]	--	--	1.63 [1.19-2.24]	--	1.71 [1.18-2.50]	--	--

Notes: Each column represents a separate regression analysis; each cell includes the estimated odds ratio with the 95% confidence interval in brackets. The regression analysis for the Appreciation or praise taxon did not converge and is not reported here. We excluded 33 clinic staff from these regression models because they were missing message volume and staff type. --=Not statistically significant at p-value<0.05.

Table 6-5.

Percentage of Patients who Received at Least One Message Coded with Selected Clinician-Generated Taxa (Patient-as-Recipient)

Clinician-generated taxa	Percentage [95% CI]
No response	64.69 [61.77, 67.62]
Information seeking	53.54 [50.49, 56.59]
Deferred information sharing	48.79 [45.73, 51.84]
Information sharing	77.40 [74.84, 79.96]
Orientation to processes & procedures	69.64 [66.83, 72.45]
Medical guidance	48.79 [45.73, 51.84]
Recommendation to schedule an appointment	16.49 [14.22, 18.76]
Social communication: Appreciation or praise	6.01 [4.56, 7.47]
Request denial	9.21 [7.45, 10.98]
Action responses	74.39 [71.72, 77.06]
Acknowledge	24.64 [22.00, 27.27]
Fulfills request	66.54 [63.65, 69.42]
Partially fulfills request	27.45 [24.72, 30.18]

likely to receive responses than their counterparts. In adjusted analyses, however, the only patient characteristic statistically associated with clinic non-response was the number of threads initiated by the patient. Patients who initiated the smallest number of threads were less likely to experience non-response compared to patients who initiated the largest numbers of threads. Conversely, patients who initiated the second highest number of threads were more likely to have at least one unresponded thread compared to patients who sent the most threads.

Demographic characteristics. In unadjusted analyses, a higher proportion of younger patients received request denials ($p<0.001$). In adjusted analyses, younger patients were less likely to receive acknowledgement of their requests, confirmation of partial request fulfillment, and medical guidance. Females were less likely to receive confirmation that their request was fulfilled. Unadjusted analyses revealed differences by race for acknowledgements ($p<0.01$), Recommendation to schedule an appointment ($p<0.01$), and Information seeking ($p=0.03$), but these differences were not statistically significant in adjusted analyses.

Table 6-6.

Odds Ratio Estimates [and 95% Confidence Intervals] of the Associations Between Patient Characteristics and Clinician-Generated Taxa (Patient-as-Recipient)

	Action Responses						Information sharing			
Patient characteristics	Acknowledge	Fulfills request	Partially fulfills	Recommendation to schedule an appointment	Information seeking	Deferred information sharing	Medical guidance	Orient to processes & treatments	Summary	No response
18-59 vs 60+ years	0.83 [0.69-0.99]	--	0.76 [0.64-0.91]	--	--	--	0.84 [0.71-0.99]	--	--	--
Female vs Male	--	0.81 [0.68-0.97]	--	--	--	--	--	--	--	--
Rural vs urban home location	--	0.56 [0.33-0.94]	--	--	--	--	--	--	--	--
Hypertension only vs Both conditions	1.33 [1.04-1.69]	--	--	--	--	--	--	--	--	--
Controlled vs Uncontrolled baseline BP[a]	--	--	--	N.R.	--	--	--	0.76 [0.60-0.98]	--	--
Other vs Private payer	--	--	--	--	1.54 [1.00-2.37]	--	--	--	--	--
Public vs Private payer	--	--	--	--	--	--	2.02 [1.27-3.24]	--	--	--
Uninsured vs Private payer	--	--	--	--	--	--	0.21 [0.06-0.72]	--	--	--
Initiated 1 vs >7 threads	0.25 [0.14-0.44]	0.15 [0.11-0.20]	0.12 [0.06-0.26]	0.15 [0.06-0.39]	0.14 [0.10-0.20]	0.27 [0.19-0.37]	0.25 [0.18-0.35]	0.18 [0.13-0.24]	0.15 [0.10-0.20]	0.21 [0.16-0.28]
Initiated 2 vs >7 threads	0.5 [0.31-0.83]	0.47 [0.34-0.65]	0.52 [0.31-0.86]		0.55 [0.40-0.76]	0.48 [0.35-0.67]	0.47 [0.33-0.65]	0.43 [0.31-0.6]	0.36 [0.25-0.52]	0.46 [0.34-0.63]
Initiated 5-7 vs >7 threads	1.92 [1.37-2.68]	1.62 [1.17-2.23]	1.95 [1.38-2.76]	1.96 [1.28-3.00]	1.80 [1.35-2.41]	1.69 [1.29-2.23]	1.47 [1.12-1.94]	1.76 [1.25-2.47]	1.91 [1.22-2.98]	1.81 [1.32-2.48]

Notes: Each column represents one regression analysis, in which the dependent variable is the taxon and the independent variables are the patient characteristics (table rows). Included in the analysis but not listed in the table because they were not statistically significant are race, distance between home and clinic, number of comorbidities, health condition, baseline glycemic level, and number of outpatient visits. The models for the Denies and Appreciation/Praise taxa did not converge.

--= Not statistically significant at p-value<0.05. N.R.=not reliable model did not converge, BP=blood pressure. Baseline BP: Controlled=systolic BP <120 and diastolic BP <80.

[a] Only in a separate model that only included patients with hypertension (n=597 after 36 patients excluded for missing data).

Geographic-based characteristics. In unadjusted analyses, smaller percentages of patients living further from the clinic received information seeking messages from clinic staff ($p<0.01$). In adjusted analyses, patients living in rural areas were less likely to receive confirmation that their request was fulfilled.

Patient health status. In adjusted analyses, patients with hypertension only were more likely to receive acknowledgement of their request compared with patients who had both diabetes and hypertension. We observed no statistically significant associations in adjusted analyses between clinician-generated taxa and number of comorbidities, baseline A1C control, or baseline BP control.

Healthcare access. Patients with public payers were more than two times more likely, and uninsured patients were 79 percent less likely, to receive medical guidance compared to patients with private payers. Patients with other payer types were 1.54 times more likely to receive information seeking messages from clinic staff than patients with private payers.

Although we identified statistically significant within group differences across taxa for the number of outpatient visits in unadjusted analyses, we detected no associations in adjusted analyses. Similar to the patient-as-sender analyses, we identified associations between the number of patient-initiated threads and all clinician-generated taxa, with patients who initiated the fewest threads being least likely to receive messages coded with the taxa.

Characteristics for clinic staff-as-recipient. Patients sent an average of 18.3 messages (median=5.0; max=1506) to 567 unique clinic staff. Patients most commonly directed messages to physicians (n=5736 messages; 294 staff) and primary care clinicians (n=4387 messages; 155 staff). Appendix Table 6-7 displays the number of clinic staff by characteristic.

Table 6-7 presents the percentages of clinic staff by the types of message content they received from patients. Almost three-fourths of the clinic staff received at least one information seeking or information sharing message. The smallest percentage of clinicians received messages with appreciation

Table 6-7.

Percentage of Clinic Staff who Received at Least One Message with Selected Patient-Generated Taxa (Staff-as-Recipient)

Patient-generated taxa	Percentage [95% CI]
Information seeking	72.66 [68.98, 76.34]
Logistics	53.97 [49.85, 58.08]
Medical guidance	58.02 [53.95, 62.10]
Information sharing	72.49 [68.80, 76.17]
Clinical update	52.38 [48.26, 56.50]
Response to clinician's message	45.68 [41.57, 49.79]
Self-reporting	11.64 [8.99, 14.29]
Prescription requests	49.74 [45.61, 53.86]
Prescription renewal or refill	43.56 [39.47, 47.66]
New/change prescription request	29.10 [25.35, 32.85]
Referral request	16.58 [13.51, 19.65]
Other administrative request	40.56 [36.51, 44.62]
Scheduling request	40.92 [36.86, 44.98]
Social communication	32.10 [28.24, 35.95]
Praise or appreciation	10.05 [7.57, 12.54]
Complaints	18.87 [15.64, 22.10]
Life issues	16.58 [13.51, 19.65]

or praise. Appendix Table 6-7 displays the percentage by staff characteristic for each taxon and the within group Chi-square estimates.

Table 6-8 displays the odds ratio estimates of associations between clinic staff characteristics and the summary-level patient-generated taxa they received. We excluded 21 staff in these regression models due to missing staff type and message volume. Appendix Table 6-8 presents the estimated associations between the patient-generated sub-taxa and clinic staff characteristics.

The only differences we observed by specialty were between staff with no applicable specialty and primary care clinicians. The no-specialty staff were less likely to receive logistical information seeking requests and prescription refill requests from patients. Staff with the lowest message volume were less likely to receive messages from patients with the associated taxon, compared to staff with the highest message volumes. Conversely, staff with the second highest message volume were more likely to receive

Table 6-8.

Odds Ratio Estimates [and 95% Confidence Intervals] of the Associations Between Clinic Staff Characteristics and Summary-Level Patient-Generated Taxa (Staff-as-Recipient)

Staff characteristics	Information seeking	Information sharing	Prescription request	Scheduling requests	Social communication
Administrative staff vs Physician	--	--	0.06 [0.02-0.21]	--	--
Nurse practitioner vs Physician	--	--	3.32 [1.48-7.46]	--	--
Registered nurse vs Physician	--	2.04 [1.11-3.73]	0.45 [0.25-0.81]	0.51 [0.31-0.86]	--
N/A vs Primary care specialty	0.55 [0.34-0.9]	--	0.62 [0.39-0.98]	--	--
<=1000 vs 3400 messages	0.34 [0.23-0.48]	0.43 [0.3-0.6]	0.33 [0.23-0.47]	0.43 [0.32-0.59]	0.40 [0.29-0.56]
1001-2000 vs 3400 messages	--	0.55 [0.38-0.8]	--	--	--
2001-3400 vs 3400 messages	--	--	--	--	1.44 [1.00-2.07]

Notes: Each column represents a separate regression analysis, in which the dependent variable was the taxon and the independent variables were the clinic staff characteristics (table rows) included in the analysis.
N/A=no applicable specialty; --=Not statistically significant at p-value <0.05.

social communication, medical guidance requests, responses to their questions, and laboratory or other diagnostic procedure requests compared to staff who sent the most messages.

Administrative staff were less likely to receive medical guidance requests, clinical updates, and laboratory or other procedure scheduling requests, compared to physicians. They were 2.69 times more likely (95% CI: 1.19-6.09) to receive responses to their questions. Registered nurses were also more likely to receive responses to their messages (OR: 3.96, 95% CI: 2.2-7.15), but were less likely to receive requests for laboratory or other diagnostic procedures, prescriptions, and referrals. Nurse practitioners were 3.52 times more likely (95% CI: 1.55-7.99) to receive prescription requests than physicians.

6.5 Discussion

Our research presents the first analyses that associated differences between message content and patient and clinic staff characteristics. We identified that patients' message content varied based on their age, sex, home location, and health condition. Clinician-generated content varied primarily based on clinic staff type and message volume. The messages that patients received from clinic staff varied based on patients' age, sex, health condition, and payer status. Finally, patients sent different content based on clinic staff type and message volume.

Clinic non-response. Of concern from a patient-centered communication approach is the fact that two-thirds of patients initiated at least one message thread to their clinical team but received no response. Fortunately, it appears that the likelihood of non-response is associated strongly with the number of threads initiated by the patient and not by the patient's other characteristics.

It is likely that at least some threads received a response through another modality (e.g., phone, office visit); however, we were unable to measure responses outside of secure messaging. A recent qualitative study reported that half of the messages they identified as lacking a response had evidence of a response elsewhere in the patients' charts (Lanham, Leykum, & Pugh, 2018). If that percentage were extrapolated to our study population, a large percentage of the patients would still have at least one thread lacking a response from their clinical team. Important to note is that the IOM's *Crossing the Quality Chasm* report recommended that patient care be provided in the form needed by the patient and be responsive to patient choices and preferences (Institute of Medicine, 2001). If patients opt to communicate with their clinic staff via secure messaging, it is likely that patients desire a response through that communication modality. A response through another modality may not demonstrate the best patient-centered practices. Further research into the types of patient-initiated messages that lacked responses, and exploration of whether responses occurred through other modalities and what those responses were, is needed to understand whether there are certain contexts when a response through an alternate modality might be appropriate.

Patient-as-sender. Patients who trust their clinicians may be more open to sharing information with their clinicians (Epstein & Street, 2007). Lafata et al. (2013) reported a positive association between patients' age and trust in their clinician and Sohl et al. (2015) found that non-Hispanic white patients and male patients were more likely to disclose information to clinicians. Consistent with those findings, we observed that younger patients were less likely to share clinical updates with their clinical team; and women were less likely than men to self-report biometrics through secure messaging. Since sharing relevant clinical information with the care team can be important to continuity of care and ongoing patient engagement, it will be important to better understand why these populations might not be taking advantage of secure messaging in this way.

Our study found that black patients were less likely to request changes to their prescriptions or request laboratory or other diagnostic procedures, while patients of other races were more likely to request prescription changes, compared to white patients. These two request types, unlike some of the other task-oriented request taxa, involve a more active involvement from the patient to be aware of a medical need and outreach to the clinician to request clinical action for a change in care. Two-thirds of studies in a literature review of the effects of race on patient-physician communication reported that black patients had fewer acts of participation during their physician visits (Shen et al., 2018). If requests for a new or changed medication and laboratory or other diagnostic procedure are considered more participatory in nature, then our findings are consistent with the studies reported in the Shen et al. (2018) review.

We observed that patients who lived closest to the VCUHS clinic were less likely to seek certain types of information and share clinical updates compared to those who lived further. The population of Richmond, Virginia where VCUHS is primarily located includes a majority of people who are under 65 years of age (87 percent), black (48 percent), female (53 percent); 24 percent live in poverty, and 14 percent are uninsured (United States Census Bureau, 2018). We controlled for many of these characteristics but did not have data to control for poverty or education. The differences we detected based on travel distance to clinic may therefore not fully reflect a communication choice based on travelling distance but rather be a proxy for other characteristics. Analyses that incorporate metrics to better capture potential confounders will be important in helping to determine if the distance that patients travel impacts their secure messaging communication.

Patient-as-recipient. Younger patients were less likely to receive acknowledgements and indications of partial fulfillment. We observed differences by age for task-oriented requests, although directionality varied (e.g., younger patients were more likely to send scheduling requests but less likely to make prescription requests). It may be that the difference in action responses from staff was associated with the preceding request type. It is unclear whether these data represent differential fulfillment rates for younger patients or a difference in the way that clinic staff communicate based on patient age. Females were less likely to receive fulfillment responses but only one type of task-oriented request differed statistically by patient sex. Further research is needed to determine if differences in fulfillment rates are based on patients' demographic characteristics or the nature of the requests made of clinic staff. Research that explores the differences in responses among subsets of patients who sent messages with selected taxa could determine whether these responses vary among patients requesting that type of information. For example, do clinic staff respond to prescription requests differently based on patient characteristics, while scheduling requests receive standard responses regardless of patient demographics? Our research did not explore the paired call-response nature of the secure message thread. Because a thread is most like a discussion between patient and clinician during an office visit, future research should explore the best approach to analyzing paired taxa in threads to understand the associations between a patient request and the staff response to that request.

Clinic staffs' message responses did not vary by patient race, although unadjusted within group percentages did exhibit statistical differences. The literature about differences in patient-clinician communication by race is mixed, but a recent literature review found that the majority of vignette studies detected no association between clinicians' implicit bias and treatment recommendations (Maina, Belton, Ginzberg, Singh, & Johnson, 2018). A small observational study found no differences in verbal communication by race but higher nonverbal communication scores for white patients (Elliott, Alexander, Mescher, Mohan, & Barnato, 2016). Conversely, another review noted that five of six observational and patient-reported measure-based studies found that physicians provided blacks with less information than whites (Shen et al., 2018). The fact that our study found no differences in message content from clinic staff by patient race may be because the taxonomy is based solely on the text in the message and did not leverage any nonverbal cues in the messages. Research has found evidence that nonverbal cues in email messages (e.g., differential use of upper- and lower-case letters, spelling and grammar errors, and emoticons) can impact recipients' assessment of the senders' competence, as well as change the recipients' interpretation of the emotional intent of the message (Brown et al., 2016; Walther & D'Addario, 2001). A thematic coding of secure messages by Lanham et al. (2018) found tone mismatches in about 16 percent of 70 messages reviewed; such mismatches could reduce patient engagement and limit patients' understanding and acceptance of any guidance provided. Comparison of message content through the more objective lens of this taxonomy paired with a more subjective evaluation of message tone and non-verbal cues may be helpful in determining if there are more subjective differences in message content by race or other characteristics.

Sharing medical guidance from clinicians varied by payer type. Compared to patients with private payers, clinic staff were more likely to send messages with medical guidance to patients with public payer types, and less likely to send that content to uninsured patients. An analysis of the Medical Expenditure Panel Survey found that patients without insurance—compared to patients with public insurance—were less likely to report that their provider always listened and explained things in a way that the patient understood (DeVoe, Wallace, & Fryer Jr, 2009). Our study's findings may be an indicator from the patient-clinician communication standpoint of why patients without insurance might report those perceptions. An analysis of the pairings of patient- and clinician-generated content within each thread might yield more insight on what the patient asked and why clinical responses differed by payer type.

Patients with other payer types were more likely to receive information seeking content from their clinic staff. This category included specialty insurance for transplant recipients and personal injury—patients who may have more complex issues around their care, self-management, and healthcare administrative processes. The fact that clinic staff were asking more of this population may be reflective of the complexity of the questions asked by patients. In addition, prior studies have shown that written forms of communication may present challenges for individuals with low health literacy or processing capacity (Byron, 2008; Morrow, 2016). Since cognitive ability may decline during illness (Mishel, 1988, 1999), it is possible that patients' messages when they were ill may be less coherent. Our research did not explore the reading level or complexity of the messages, nor did we account for patients' education or literacy level. It would be interesting to examine which types of patient-generated content were associated with the clinician-generated information seeking messages for this patient population.

Clinic staff-as-sender. Differences in the types of messages sent by staff were likely reflective of the fact that many practices triage messages through a team of nurses, physician assistants, pharmacists, and physicians, with physicians generally responding only to the more complicated messages (Heyworth et al., 2013; Ozkaynak et al., 2014; Wooldridge et al., 2016). Consistent with that, we found administrative staff were less likely than physicians to share information and make recommendations to schedule appointments. In a triage system where physicians generally respond to the most complex messages, it makes sense that registered nurses and nurse practitioners were more likely than physicians to send most types of messages as our data showed.

Prior research has shown that almost 20 percent of in-office visits with a primary care physician were suitable for another modality (Pelak et al., 2015). Our research demonstrates that much information sharing and action responses to messages is handled by registered nurses and nurse practitioners, although physicians still send the second highest number of messages. Since messages could be coded with more than one taxon, it is possible that nurse respondents sent messages that addressed more than one content area, compared with physicians whose responses may have been more targeted.

Clinic staff-as-receiver. The trends we observed relative to the types of messages staff received also appears consistent with a triage response system in which patients were more likely to send prescription requests to nurse practitioners over physicians, and more likely to send referral and laboratory and diagnostic procedure requests to physicians.

As would be expected, patients sent most of their information seeking messages to physicians, nurse practitioners, and registered nurses. Although there were no differences by staff type for the clinician-generated Information seeking taxon, patients were almost four times more likely to send Responses to clinician's messages to registered nurses and three times more likely to send them to administrative staff, possibly indicating one of two things: (1) those staff types asked more questions of patients, or (2) those staff types are better at soliciting responses from patients. As noted previously, patient information sharing is a marker of trust with the clinical provider, so higher occurrences of the patient and clinical team engaging in an electronic bidirectional dialogue represented by this taxon might lead to strong trust or be a marker of existing trust. Alternatively, registered nurses and administrative staff were high volume users of secure messaging, so they may be more comfortable with the communication modality and better able to ask questions in a manner with which the patient is comfortable. Analyses of the pairings of the patient- and clinician-generated taxa within a thread might begin to explain how this communication worked: were patients responding to questions more frequently asked by registered nurses more often than other clinic staff or were they preferentially responding to these staff?

6.6 Limitations

In addition to the limitations mentioned above, there were several other major limitations with this research, not the least of which was the taxa coding reliability. Our interrater reliability was primarily fair and we identified three taxa with poor agreement. More refinement in the taxa definitions is needed to improve coding accuracy. The challenge in many of these codes is the ambiguity inherent in most communication. For example, clinic staff rarely deny a request outright but rather defer to another staff member or until a future office visit or pending diagnostic results. Patients may phrase questions indirectly; for example, "Are my lab results ready?" is most likely a request for the results themselves and a response that answers only the stated question with an affirmative would likely not provide the answer that the patient is truly seeking. As we continue to work with and refine the taxonomy, our hope is that we can identify better examples for coders to more reliably code messages. The results of this study should be viewed with circumspection given the interrater reliability scores. We do not believe the validity of the taxonomy is at risk, however, since we selected taxa used by other researchers and organized it around theoretical constructs.

The coding process itself was also less-than-ideal. Ideally, the coders would be independent from the taxonomy developer, and would synchronously code all messages (Krippendorff, 2019). We expect that future applications of the taxonomy would employ independent coders and the refinement of taxa definitions to support those coders should result in a more specific set of definitions.

This study is based on messages saved to patients charts because other messages were available for extraction at the time of this study. This means that messages sent by patients and any responses not saved to patient charts were not part of the analysis. It is likely that this would most significantly impact the non-responses, as those messages sent by patients for which there was no clinic response seem to be the ones least likely to be saved to the patient chart. If that is true, the non-response rates we report in this study are underestimates. We have no way to determine if there were trends by staff characteristics in saving messages to patients charts and so have no way to estimate whether this would further impact the associations we observed between taxa and patient and clinic staff characteristics.

Our missing data may have significant impacts on the results, particularly missing baseline glycemic values among patients with diabetes. More than a quarter of our patients with diabetes were missing those baseline values, so all analyses that required those values should be viewed with caution. Additional analyses should be conducted to better understand how the patients with missing values differ from the population with those values.

We were also missing just under five percent of data on clinic staff but that translated to almost 10 percent of clinician-generated messages not included in analyses that used clinic staff characteristics. It is again difficult to understand the impact of this loss of data to the overall trends, but the unadjusted comparisons of the staff with unknown characteristics revealed likely within group differences.

6.7 Conclusion

Many of the unanswered questions that arose from this research focus could be resolved through an analysis of the paired taxa within message threads: this should permit a better understanding of the context of the clinical response. Until that time, however, it is important to recognize that similar to in-person communication, differences exist in communication patterns based on patient and clinic staff characteristics.

This research demonstrates clear differences in how patients and clinic staff used secure messaging to communicate, based not only on their respective characteristics but those of the individuals with whom they communicated. Based on theories of technology-mediated communication, these differences could be expected: text-based communication like secure messaging permits selective self-presentation by giving senders time to thoughtfully craft messages (Walther, 1996). Clinic staff and administrators should evaluate how secure messaging is used to ensure that disparities in care are not perpetuated via this communication modality.

6.8 References

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6.9 Appendix

Appendix Table 6-1.

Taxa Definitions

Generated by	Level 1 Taxon	Level 2 Taxon	Level 3 Taxon	Definition
Patient	Information seeking	Logistics	--	Questions about healthcare process, timing, medication or other treatment management (e.g., change in prescription, medication dosage), clinical processes, healthcare settings, or a patient's care plan; how to interpret laboratory results; why a test is being performed or a medication is necessary; how to prepare for the test or procedure upcoming diagnostic procedures; or what routine is needed for the medication; based on question intent
		Seeking medical guidance	--	Questions to clinicians about the presence or absence of symptoms, symptom duration, symptom severity (increasing or decreasing), why something is; questions that require medical guidance or information; or other questions about the relevance of symptoms specific to a health condition, including questions related to symptoms associated with side effects of medications, treatments, or procedures; treatment changes in context of symptoms/health condition (not process-related questions); generic questions about "is there something I can take for X symptom"; based on question intent
	Information sharing	Clinical update	--	Patient sharing information with clinician that does not require immediate action or a response (and may not require action at all); includes reporting results of clinical tests, procedures, or outcomes of visits with a different clinician or healthcare facility; do not code as clinical update if used as context for the question/request; clinical update with symptoms ONLY if there's a new concept broached in addition to the symptoms question
		Response to clinician's message	--	Patient reporting symptoms/condition status in response to a clinical question, providing an update to clinician, or otherwise responding to clinician's comment in preceding message; does not apply when message includes information seeking content; unless it's a brand new question, additional requests (e.g., asking the same question a the 2nd or 3rd time) are "response to clinician"
		Self-reporting	--	Patient sharing information with clinician that does not require immediate action or a response; includes messages where patient is reporting self-measured biomedical results not in response to a clinical question sent via secure messaging; implicit expectation that the clinician is expecting the information. Should not be coded when biomedical information is provided in context of asking an information seeking question
	Task-oriented request	Prescription-related request	Prescription refills and renewals requests	Request for prescription refill or renewal
			New or change prescription request	Request for a new prescription or switch to a different medication

Generated by	Level 1 Taxon	Level 2 Taxon	Level 3 Taxon	Definition
		Other administrative	--	Requests for sick notes, contact information, medical records, patient portal access, or information about billing or insurance; technology-related questions related to interfacing with the patient portal or other patient-facing technology; requests for call or email
		Referral requests	--	Request for referral to other healthcare facility or clinician
		Scheduling request	Cancellation	Request that scheduled appointment be cancelled
			Follow-up	Request for an appointment relative to an existing health condition
			Laboratory test or diagnostic procedure	Request for a laboratory test or diagnostic procedure (e.g., x-ray, ultrasound) order
			New condition or symptom	Patient request for an appointment relative to a newly identified health condition or new symptom for existing condition; new patient appointment; or clinician requests patient make appointment
			Preventive care or physical exam	Request for a preventive care or routine exam
			Reschedule	Request for appointment to be changed to another date or time
Clinic staff	Action response	Acknowledge	--	The response includes a recognition that the request for action or information is made, but no indication is provided about whether the request will be fulfilled. Includes indications of forwarding to another provider in response to a patient's action request. Should not be paired with another action response.
		Fulfills request	--	The response includes documentation that the request action was completed
		Partially fulfills request	--	The response indicates that there are additional steps that are necessary to fulfill the request, or that only part of the request can or has been completed; Use this taxon if there's a chance that the step doesn't happen.
	Denies request		--	The response indicates that the request will not be fulfilled; must be on its own
	Information seeking	--	--	Clinicians' requests for information or clarity around patients' condition or symptoms, or symptom severity or duration; when no response is expected, then do not code as information seeking.
	Deferred information sharing	--	--	Clinical responses that refer the patient to another clinician for a response, postpone an answer pending additional clinical information (e.g., wait for laboratory test results)
	Information sharing	Medical guidance	--	Answer requires medical training/ provision of clinical information Clinician provides treatment decisions, gives care instructions, dietary guidance, instructs the patient on the best next steps in his or her care plan, interprets diagnostic procedure or laboratory results, or provides information on symptoms or the patient's health condition; Code if answer required medical decision-making
		Orientation to procedures, treatments, or preventive behaviors	--	Clinical responses that explain what a patient might expect during a treatment or diagnostic procedure, or in a new healthcare setting or situation; apply code if answers are process-related

Generated by	**Level 1 Taxon**	**Level 2 Taxon**	**Level 3 Taxon**	**Definition**
	Recommendation to schedule an appointment	--	--	Clinician suggests that patient schedule an appointment; a deferred recommendation to schedule (e.g., if-then statement) is medical guidance, not recommendation to schedule
Patient or Clinic staff	Social communication	Appreciation and praise	--	Content that expresses gratitude or offers acknowledgement or appreciation of a service provided, health status, or another act. Code "thank you" only when it references a specific action/service; general message closings of thank you should not be coded
		Complaints	--	Expressions of frustration or displeasure
		Life issues	--	Communication about aspects of the senders' life not specifically related to health

Appendix Table 6-2.

Secure Message Taxa Interrater and Intrarater Reliability

Taxa	Interrater reliability		Intrarater reliability	
	Final round Kappa estimates [95% CI]	Reliability interpretation	Kappa estimates [95% CI]	Reliability interpretation
Patient-and clinician-generated Social communication				
--summary--	0.55 [0.29 ,0.81]	Fair	0.67 [0.57, 0.77]	Good
Appreciation/praise	0.57 [0.28, 0.86]	Fair	0.79 [0.67, 0.91]	Excellent
Complaints	N/A	N/A	0.72 [0.52, 0.92]	Good
Life issues	0.50 [-0.10, 1.00]	Fair	0.40 [0.17, 0.62]	Fair
Clinician-generated				
Action responses				
Fulfilled request	0.74 [0.56, 0.92]	Good	0.85 [0.80, 0.89]	Excellent
Acknowledge	0.58 [0.33, 0.84]	Fair	0.75 [0.66, 0.84]	Excellent
Partially fulfill request	0.49 [0.14, 0.83]	Fair	0.54 [0.42, 0.66]	Fair
Denies	-0.01 [-0.02, 0.00]	Poor	0.43 [0.18, 0.69]	Fair
Information seeking	0.85 [0.75, 0.96]	Excellent	0.88 [0.85, 0.92]	Excellent
Information sharing				
--summary--	0.75 [0.65 ,0.85]	Excellent	0.77 [0.73, 0.80]	Excellent
Medical guidance	0.86 [0.76, 0.95]	Excellent	0.83 [0.79, 0.87]	Excellent
Orientation	0.47 [0.30, 0.65]	Fair	0.63 [0.58, 0.67]	Good
Deferred information sharing	0.52 [0.20, 0.83]	Fair	0.68 [0.61, 0.74]	Good
Recommendation to schedule	-0.01 [-0.03, 0.00]	Poor	0.69 [0.54, 0.85]	Good
Patient-generated				
Information seeking				
--summary--	0.72 [0.59 ,0.85]	Good	0.81 [0.77, 0.85]	Excellent
Medical guidance	0.67 [0.51, 0.83]	Good	0.81 [0.76, 0.86]	Excellent
Logistics	0.29 [0.04, 0.54]	Poor	0.69 [0.62, 0.75]	Good
Information sharing				
--summary--	0.71 [0.59 ,0.82]	Good	0.86 [0.83, 0.88]	Excellent
Self-reporting	1.00 [1.00, 1.00]	Excellent	0.89 [0.82, 0.95]	Excellent
Response to clinician	0.51 [0.33, 0.70]	Fair	0.85 [0.82, 0.89]	Excellent
Clinical update	0.57 [0.36, 0.78]	Fair	0.68 [0.62, 0.74]	Good

Taxa	Interrater reliability		Intrarater reliability	
	Final round Kappa estimates [95% CI]	Reliability interpretation	Kappa estimates [95% CI]	Reliability interpretation
Prescription request				
--summary--	0.83 [0.68 ,0.97]	Excellent	0.89 [0.85, 0.93]	Excellent
Prescription refill/renewal	0.82 [0.61, 1.00]	Excellent	0.88 [0.82, 0.93]	Excellent
New or changed Rx	0.56 [0.24, 0.87]	Fair	0.69 [0.58, 0.80]	Good
Scheduling request				
--summary--	0.45 [0.15 ,0.75]	Fair	0.90 [0.86, 0.93]	Excellent
Cancellation	N/A	N/A	0.95 [0.89, 1.00]	Excellent
Reschedule	N/A	N/A	0.90 [0.84, 0.95]	Excellent
New condition/ symptom	0.66 [0.05, 1.00]	Good	0.86 [0.76, 0.96]	Excellent
Preventive care	N/A	N/A	0.67 [0.39, 0.94]	Good
Follow-up appointment	0.49 [0.06, 0.92]	N/A	0.61 [0.45, 0.77]	Good
Lab or other diagnostic procedure	0.40 [-0.15, 0.94]	Fair	0.60 [0.40, 0.80]	Good
Other task-oriented request				
Referral	1.00 [1.00, 1.00]	Excellent	0.78 [0.64, 0.92]	Excellent
Other administrative	0.48 [0.17, 0.79]	Fair	0.72 [0.62, 0.81]	Good

Appendix Table 6-3.

Percentage of Patients who Sent at Least One Patient-Generated Message with Assigned Taxon, by Patient Characteristics

		Information seeking			Information sharing				Task-oriented requests												Social communication			
									Prescription request					Scheduling request										
Patient characteristics	Number of patients	Logistics	Medical guidance	Summary	Sharing clinical update	Self-reporting biometrics	Response to clinician's msg	Summary	Prescription refills/renewals	New/change prescription	Summary	Referral request	Other administrative	Cancellation	Follow-up	New condition or symptom	Preventive care	Reschedule	Laboratory test or diagnostic procedure	Summary	Appreciation/praise	Complaints	Life issues	Summary
Age (years)																								
18-59	540	40.0	50.2	60.6	41.8	10.6	50.2	64.3	44.8	30.0	55.2	11.3	29.6	19.4	28.2	24.3	9.8	41.5	14.8	72.4	5.7	9.4	11.5	20.6
60+	491	41.6	57.6	66.2	51.5	10.6	50.7	68.2	53.4	26.7	62.9	11.2	31.0	22.0	18.1	14.1	6.5	34.4	13.2	60.1	7.3	9.2	12.8	23.0
p-value		--	**	*	***	--	--	--	***	--	**	--	--	--	****	****	*	**	--	****	--	--	--	--
Sex																								
F	670	41.8	54.9	64.3	46.1	9.7	53.6	67.0	46.3	29.2	56.9	13.1	30.2	20.9	23.6	20.3	9.2	38.7	13.6	66.4	6.0	9.1	10.9	19.7
M	361	38.8	51.5	61.2	47.1	12.2	44.6	64.5	53.7	26.9	62.6	7.8	30.5	20.2	23.0	17.7	6.4	37.1	15.0	66.8	7.5	9.7	14.4	25.5
p-value		--	--	--	--	--	***	--	**	--	*	***	--	--	--	--	--	--	--	--	--	--	*	**
Race																								
Black	416	39.4	52.6	60.1	45.4	12.3	52.4	66.1	52.2	31.0	62.7	12.3	29.8	17.8	26.7	22.8	12.5	42.8	11.3	69.7	6.5	8.2	10.1	19.2
Other	50	34.0	48.0	56.0	48.0	10.0	40.0	64.0	50.0	46.0	64.0	8.0	36.0	28.0	20.0	20.0	2.0	40.0	22.0	72.0	4.0	8.0	6.0	16.0
White	563	42.3	55.1	66.1	47.2	9.4	49.9	66.4	46.5	24.9	55.6	10.8	30.0	22.2	21.3	16.9	5.7	34.6	15.4	63.9	6.6	10.3	14.0	24.0
p-value		--	--	*	--	--	--	--	--	***	*	--	--	--	--	*	****	**	**	--	--	--	*	--
Home location																								
Urban	1005	40.7	53.7	63.3	46.3	10.6	50.6	66.0	49.0	28.6	59.1	11.2	30.2	20.8	26.7	19.3	8.5	38.4	14.1	66.8	6.3	9.2	12.1	21.6
Rural	26	42.3	53.8	61.5	53.8	11.5	46.2	73.1	42.3	23.1	50.0	11.5	34.6	15.4	11.5	23.1	0.0	26.9	11.5	57.7	15.4	11.5	11.5	26.9
p-value		--	--	--	--	*N.R.*	--	--	--	--	--	*N.R.*	--	--	--	--	*N.R.*	--	*N.R.*	--	*N.R.*	*N.R.*	*N.R.*	--
Avg. distance from clinic (miles)																								
0-8	252	37.7	54.4	61.1	43.6	11.1	52.8	65.5	56.4	32.5	66.3	16.7	30.2	19.0	30.6	20.6	9.5	43.2	13.1	67.1	6.8	9.1	12.3	19.8
9-16	259	42.5	53.3	63.7	46.0	10.8	55.6	69.5	44.8	29.3	56.4	8.9	30.1	16.6	23.2	20.5	8.5	35.9	12.7	66.0	5.8	8.5	9.7	18.2
17-39	243	42.4	57.6	66.7	52.7	14.4	51.8	71.2	46.5	29.6	56.8	10.7	31.3	23.5	22.2	21.8	9.5	37.0	19.3	70.0	7.4	11.9	16.0	28.8
>40	234	40.2	50.0	61.1	43.2	6.8	42.7	58.6	45.7	23.5	55.1	7.7	29.9	23.1	17.1	15.8	6.4	37.6	11.5	63.7	6.0	8.1	12.0	21.4
p-value		--	--	--	--	*	**	**	**	--	**	***	--	--	***	--	--	--	*	--	--	--	--	**
Health condition																								
DM	398	39.7	52.5	62.6	48.5	13.3	51.3	67.1	51.3	33.7	61.3	12.3	32.9	20.6	25.9	20.9	8.5	35.7	16.3	68.1	6.3	10.6	11.8	22.1
HTN	394	40.4	56.8	65.2	45.7	6.8	48.7	64.0	43.9	22.3	54.1	10.2	27.2	17.3	20.3	16.2	7.6	37.1	11.9	62.2	6.4	9.9	13.2	22.8
Both	239	43.1	50.6	61.1	44.4	12.1	51.9	68.2	53.1	29.7	62.8	11.3	31.0	26.4	24.3	22.2	8.8	43.9	13.8	71.1	7.1	6.3	10.9	19.2
p-value		--	--	--	--	***	--	--	**	***	**	--	--	**	--	--	--	*	--	**	--	--	--	--
Num. comorbidities																								
1	183	37.2	47.5	62.8	42.1	8.7	45.4	63.9	38.2	21.9	49.2	5.5	23.0	15.3	15.3	12.6	10.9	31.2	13.1	59.6	5.5	5.5	12.6	18.0
2	241	34.4	51.4	59.3	41.1	8.7	49.0	63.1	44.0	25.3	54.4	10.4	27.8	18.7	19.5	14.9	7.9	33.2	17.0	64.7	5.0	8.3	10.8	19.1
3-5	464	44.0	55.0	63.8	48.1	10.8	50.0	66.6	53.2	28.9	62.5	13.4	32.5	22.0	26.3	22.0	7.8	38.8	12.1	66.8	7.3	9.7	10.8	23.1
6-9	134	45.5	62.7	69.4	56.0	14.9	61.2	73.9	56.7	41.8	67.9	13.4	37.3	26.1	30.6	26.9	7.5	50.8	16.4	76.9	7.5	14.2	17.9	26.1
p-value		**	**	--	**	--	**	--	****	****	***	**	**	*	***	***	--	***	--	**	--	*	--	--
Baseline A1C [a]																								

Patient characteristics	Number of patients	Information seeking			Information sharing				Task-oriented requests												Social communication			
									Prescription request					Scheduling request										
		Logistics	Medical guidance	Summary	Sharing clinical update	Self-reporting biometrics	Response to clinician's msg	Summary	Prescription refills/renewals	New/change prescription	Summary	Referral request	Other administrative	Cancellation	Follow-up	New condition or symptom	Preventive care	Reschedule	Laboratory test or diagnostic procedure	Summary	Appreciation/praise	Complaints	Life issues	Summary
Con-trolled	242	46.3	55.4	69.0	47.9	12.8	52.1	69.4	50.4	34.7	61.2	16.1	33.1	27.3	26.4	19.8	7.4	35.5	18.6	69.8	9.1	7.4	11.2	22.3
Uncon-trolled	221	39.4	50.2	59.7	51.6	16.7	52.0	69.2	59.3	33.5	67.4	7.7	30.3	16.7	27.2	20.4	9.5	39.8	14.9	67.4	5.4	10.0	10.9	21.3
p-value		--	--	**	--	--	--	--	*	--	--	***	--	***	--	--	--	--	--	--	--	--	--	--
Baseline BP [b]																								
Con-trolled	140	40.0	55.7	64.3	47.9	8.6	52.9	68.6	42.9	29.3	58.6	10.0	32.9	22.1	16.4	24.3	5.7	40.7	13.6	65.0	7.1	9.3	13.6	22.9
Uncon-trolled	492	41.9	54.3	63.6	44.5	8.9	49.2	64.8	48.8	24.0	57.1	10.8	27.4	20.3	23.4	16.9	8.7	39.2	12.4	65.6	6.5	8.3	12.0	21.1
p-value		--	--	--	--	--	--	--	--	--	--	--	--	--	*	**	--	--	--	--	--	--	--	--
Payer type																								
Other	271	39.5	51.7	60.2	48.0	10.7	52.0	67.9	47.6	28.4	55.0	15.1	35.8	21.4	29.2	25.5	7.8	46.1	13.6	74.5	5.5	10.0	12.9	21.8
Public	412	42.2	56.3	65.0	48.5	9.5	48.5	64.8	50.0	28.6	62.4	9.7	29.6	19.4	18.9	17.5	6.6	36.4	12.1	60.4	8.7	10.2	12.4	23.1
Unin-sured	17	23.5	29.4	47.1	23.5	5.9	23.5	41.2	35.3	11.8	41.2	0.0	17.6	23.5	11.8	23.5	5.9	58.8	5.9	70.6	5.9	11.8	5.9	17.6
Private	331	40.8	53.5	64.4	43.8	12.1	52.9	67.7	49.2	29.0	58.6	10.6	27.2	21.4	24.8	16.6	10.9	32.6	17.2	67.4	4.5	7.6	11.5	20.2
p-value		--	--	--	--	--	*	--	--	--	--	*	*	--	**	**	--	***	--	***	--	--	--	--
Num. threads																								
1	203	8.9	19.7	26.6	14.8	3.5	11.3	26.1	18.7	4.9	23.6	3.0	6.9	6.4	6.4	4.4	2.0	16.3	2.0	35.5	1.5	0.5	3.5	5.4
2	145	19.3	30.3	42.1	25.5	4.1	34.5	49.0	31.7	12.4	41.4	2.1	15.9	15.2	14.5	8.3	4.8	20.0	4.1	55.2	2.8	2.8	2.8	7.6
3-4	199	31.7	51.3	65.8	33.2	7.0	40.2	61.8	39.7	20.6	51.8	5.0	21.6	16.1	15.1	13.6	6.0	38.2	10.6	66.3	4.0	4.0	6.5	13.1
5-7	193	49.2	59.6	70.5	58.0	10.4	60.1	80.8	55.4	31.1	69.4	10.9	31.1	20.7	22.8	20.2	11.4	38.3	15.0	72.5	4.7	8.3	8.8	19.7
>7	291	74.2	86.9	92.8	80.4	21.3	86.3	95.9	80.4	56.4	90.0	26.1	59.1	36.4	45.7	38.8	13.8	62.2	29.2	90.0	14.8	23.0	28.9	47.4
p-value		****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****
Num. outpatient visits																								
1-5	192	30.2	37.0	50.5	34.9	6.8	37.5	56.3	40.6	17.7	49.5	2.6	21.4	13.0	16.2	16.2	10.4	32.8	9.4	60.9	3.1	4.2	8.3	13.0
6-10	244	36.9	48.8	58.2	44.3	11.9	46.7	63.5	45.9	23.0	56.2	7.4	25.0	16.8	20.1	16.0	9.0	25.4	11.1	56.6	6.6	5.3	9.8	18.0
11-15	194	38.7	57.7	68.0	39.2	7.2	55.2	67.0	46.4	26.8	55.2	9.8	27.3	21.6	21.7	18.6	7.2	39.2	11.9	68.6	5.7	7.7	12.4	22.2
16-20	129	47.3	61.2	69.8	53.5	10.1	52.7	71.3	53.5	38.0	65.1	19.4	38.8	27.9	25.6	17.8	10.1	45.0	17.8	71.3	6.2	15.5	11.6	24.8
>20	272	50.0	63.6	70.2	58.5	14.7	58.5	72.4	57.0	37.5	67.6	18.0	39.3	25.4	31.6	26.1	5.9	49.3	19.9	75.7	9.6	14.7	16.9	29.4
p-value		****	****	****	****	**	****	***	***	****	****	****	****	***	***	**	--	****	***	****	*	****	**	****

Notes: This table lists the unadjusted percentages and Chi-square p-values for each within-group set of characteristics.
N.R.=not reliable estimate due to small cell sizes.
A1C=glycemic index, Avg.=average, BP=blood pressure; DM=diabetes; HTN=hypertension; msgs=messages.
Baseline A1C: Controlled <7.0. Baseline BP: Controlled=systolic BP <120 and diastolic BP <80.
[a] Only in a separate model that only included patients with diabetes (n=442 after 195 patients excluded for missing data).
[b] Only in a separate model that only included patients with hypertension (n=597 after 36 patients excluded for missing data).
--Not statistically significant, *p<0.1, **p<0.05, ***p<0.01, ****p<0.001

Appendix Table 6-4.

Odds Ratio Estimates [and 95% Confidence Intervals] of the Associations Between Patient-Generated Taxa and Patient Characteristics

	Information seeking		Information sharing			Task-oriented requests								Social communication		
						Prescription-related		Scheduling								
Patient characteristics	Logistics	Medical guidance	Sharing clinical update	Self-reporting biometrics	Response to clinician's msg	Prescription refills/renewals	New/change prescription	Cancellation	Follow-up	New condition or symptom	Preventive care	Reschedule	Laboratory test or diagnostic procedure	Appreciation/ praise	Complaints	Life issues
18-59 vs 60+ years	--	--	0.77 [0.65 0.91]	--	--	0.77 [0.65 0.90]	--	--	1.44 [1.20 1.73]	1.60 [1.31 1.95]	--	1.20 [1.03 1.41]	--	--	--	--
Female vs Male	--	1.19 [1.01 1.40]	--	0.78 [0.62 0.98]	1.20 [1.02 1.42]	0.82 [0.70 0.97]	--	--	--	--	--	--	--	--	--	--
Black vs White	--	--	--	--	--	--	0.72 [0.53 0.98]	0.73 [0.53 1.00]	--	--	2.68 [1.30 5.51]	--	0.66 [0.46 0.95]	--	--	--
Other race vs White	--	--	--	--	--	--	2.22 [1.38 3.58]	--	--	--	--	--	--	--	--	--
0-8 vs >40 miles from clinic	0.72 [0.54 0.95]	--	0.69 [0.52 0.91]	--	--	--	--	--	1.34 [1.01 1.77]	--	--	--	--	--	--	--
9-16 vs >40 miles from clinic	1.30 [1.00 1.68]	--	--	--	1.47 [1.13 1.91]	--	--	--	--	--	--	--	--	--	--	--
17-39 vs >40 miles from clinic	--	--	--	1.46 [1.02 2.08]	--	--	--	--	--	--	--	--	--	--	--	--
DM vs Both conditions	--	--	--	--	--	--	1.33 [1.06 1.66]	--	--	--	--	0.79 [0.64 0.97]	--	--	--	--
HTN vs Both conditions	--	1.38 [1.11 1.72]	--	0.70 [0.50 0.98]	--	--	--	--	--	--	--	--	--	--	--	--
3-5 vs 6-9 comorbidi-ties	--	--	--	--	--	--	--	--	--	--	--	--	0.68 [0.50 0.93]	--	--	0.69 [0.50 0.96]
Controlled vs Uncontrolled A1C[a]	1.30 [1.03 1.64]	--	--	N.R.	--	0.78 [0.62 0.98]	--	1.35 [1.04 1.75]	--	--	N.R.	--	--	N.R.	N.R.	N.R.

Patient characteristics	Information seeking		Information sharing			Task-oriented requests								Social communication		
						Prescription-related		Scheduling								
	Logistics	Medical guidance	Sharing clinical update	Self-reporting biometrics	Response to clinician's msg	Prescription refills/renewals	New/change prescription	Cancellation	Follow-up	New condition or symptom	Preventive care	Reschedule	Laboratory test or diagnostic procedure	Appreciation/ praise	Complaints	Life issues
Controlled vs Uncontrolled BP[b]	--	--	--	--	--	--	--	--	0.72 [0.54 0.98]	1.31 [1.01 1.70]	N.R.	--	--	N.R.	N.R.	N.R.
Uninsured vs Private payer	--	--	--	--	--	--	--	--	--	--	--	2.46 [1.06 5.74]	--	--	--	--
1 vs >7 threads	0.20 [0.13 0.30]	0.22 [0.16 0.31]	0.25 [0.18 0.36]	0.45 [0.23 0.86]	0.14 [0.09 0.21]	0.26 [0.19 0.36]	0.21 [0.12 0.35]	0.36 [0.22 0.59]	0.33 [0.20 0.53]	0.29 [0.16 0.51]	0.25 [0.11 0.59]	0.36 [0.25 0.51]	0.17 [0.07 0.44]	0.29 [0.09 0.93]	0.12 [0.03 0.62]	0.50 [0.25 0.98]
2 vs >7 threads	0.44 [0.30 0.64]	0.45 [0.32 0.62]	0.46 [0.33 0.65]	--	0.60 [0.44 0.83]	0.61 [0.44 0.84]	0.56 [0.36 0.88]	--	--	0.54 [0.33 0.91]	--	0.50 [0.35 0.72]	--	--	--	0.27 [0.11 0.71]
3-4 vs >7 threads	--	--	0.70 [0.52 0.93]	--	--	--	--	--	--	--	--	--	--	--	--	--
5-7 vs >7 threads	1.97 [1.48 2.62]	1.45 [1.10 1.93]	1.99 [1.50 2.64]	--	1.72 [1.29 2.29]	1.48 [1.13 1.96]	1.74 [1.26 2.39]	--	--	1.55 [1.08 2.24]	1.82 [1.13 2.92]	--	2.13 [1.35 3.34]	--	2.14 [1.12 4.07]	--
1-5 vs >20 OVs	--	0.70 [0.50 0.98]	--	--	--	--	--	--	--	1.53 [1.01 2.31]	1.84 [1.10 3.09]	--	--	--	--	--
6-10 vs >20 OVs	--	--	--	--	--	--	--	--	--	--	--	0.63 [0.47 0.84]	--	--	--	--
11-15 vs >20 OVs	--	--	0.64 [0.47 0.87]	--	--	--	--	--	--	--	--	--	--	--	--	
16-20 vs >20 OVs	--	--	--	--	--	--	1.50 [1.04 2.16]	--	--	--	--	--	--	--	1.65 [1.01 2.71]	--

Notes: Each column represents three regression models, in which the dependent variable is the taxon and the independent variables are the patient characteristics (table rows) included in the analysis: the first regression includes all patient characteristics excluding the baseline A1C and BP for which separate models were run that included only patients with diabetes and hypertension, respectively. Characteristics and taxa not included in the table were not statistically significant in any regression model.

--=Not statistically significant at $p<0.05$. A1C=glycemic index, BP=blood pressure, DM=diabetes, HTN=hypertension, msg=message, N.R.=Not Reliable model did not converge, OV=outpatient visits A1C: Controlled <7.0. BP: Controlled=systolic BP <120 and diastolic BP <80.

[a] Only in a separate model that only included patients with diabetes.

[b] Only in a separate model that only included patients with hypertension.

Appendix Table 6-5.

Percentage of Clinic Staff who Sent at Least One Clinician-Generated Message with Assigned Taxon, by Staff Characteristics

		Action responses								Information sharing			
Clinic staff characteristics	Number of staff (number of messages sent)	Acknowledge	Fulfills	Partially fulfills	Summary	Request denial	Recommendation to schedule an appointment	Information seeking	Deferred information sharing	Medical guidance	Orient to processes, procedures	Summary	Social communication: Appreciation/Praise
Staff type													
Administrative staff	96 (1927)	10.4	77.1	13.5	84.4	24.0	4.2	44.8	38.5	5.2	60.4	68.8	0.0
Licensed Practice Nurse	44 (474)	40.9	63.6	50.0	72.7	6.8	18.2	54.6	59.1	50.0	68.2	93.2	4.6
Nurse Practitioner	54 (503)	51.8	53.7	48.2	81.5	11.1	31.5	59.3	46.3	75.9	75.9	90.7	16.7
Other Clinician Type	33 (158)	9.1	60.6	15.2	66.7	3.0	12.1	27.3	27.3	45.4	75.8	87.9	3.0
Registered Nurse	255 (2678)	36.1	72.6	51.0	82.8	24.3	31.0	58.8	64.7	62.4	83.1	94.1	11.8
Physician	172 (2380)	36.6	53.5	30.8	65.1	7.6	34.3	53.5	48.8	82.0	69.2	94.2	16.9
Unknown	20 (26)	5.0	25.0	5.0	35.0	0.0	0.0	20.0	15.0	25.0	35.0	65.0	5.0
p-value		****	****	****	****	****	****	****	****	****	****	*N.R.*	*N.R.*
Clinical specialty													
Not applicable	433 (5176)	27.2	70.4	39.0	80.1	19.9	21.5	52.0	54.3	47.1	74.1	87.3	6.2
Primary care	129 (2002)	48.8	58.9	41.1	77.5	10.1	38.0	62.0	53.5	84.5	76.7	96.1	24.0
Specialty	88 (937)	37.5	53.4	29.6	61.4	10.2	33.0	48.9	47.7	76.1	72.7	93.2	14.8
Unknown	24 (31)	4.2	20.8	8.3	33.3	0.0	0.0	25.0	12.5	33.3	33.3	66.7	4.2
p-value		****	****	***	****	***	****	***	****	****	****	****	****
Message volume in 2017													
<=1000	159 (479)	13.2	44.0	17.6	59.1	5.0	12.6	28.9	32.7	35.8	55.4	77.4	1.3
1001-2000	159 (789)	22.0	58.5	23.3	73.6	10.1	19.5	35.2	38.4	54.1	67.3	88.7	3.8
2001-3400	133 (1244)	34.6	67.7	46.6	77.4	11.3	32.3	65.4	56.4	72.9	79.0	95.5	15.0
>3400	194 (5550)	56.7	87.1	60.8	93.3	35.0	39.2	80.4	79.9	70.1	90.7	96.4	22.2
Unknown	29 (84)	10.3	37.9	17.2	48.3	3.4	3.4	31.0	20.7	41.4	55.2	75.9	3.4
p-value		****	****	****	****	****	****	****	****	****	****	****	****

Notes: This table lists the unadjusted percentages and Chi-square p-values for each within-group set of characteristics. N.R.=Not Reliable, cell sizes too small. --Not statistically significant, *p<0.1, **p<0.05, ***p<0.01, ****p<0.001

Appendix Table 6-6.

Percentage of Patients who Received at Least One Clinician-Generated Message with Assigned Taxon, by Patients' Characteristics

	Action responses							Information Sharing				
Patient characteristics	Acknowledge	Denies	Fulfills request	Partially fulfills request	Recommendation to schedule an appointment	Information seeking	Deferred information sharing	Medical guidance	Orientation to procedures or processes	Summary	Social communication: Appreciation/praise	No response to patient-initiated thread
Age (years)												
18-59	20.2	12.4	68.5	23.7	17.0	53.5	47.8	45.6	71.1	77.8	6.3	60.7
60+	29.5	5.7	64.4	31.6	15.9	53.6	49.9	52.3	68.0	77.0	5.7	69.0
p-value	****	****	--	***	--	--	--	**	--	--	--	***
Sex												
Female	23.6	9.6	65.4	25.5	17.8	55.1	50.2	49.1	70.4	77.6	5.7	65.8
Male	26.6	8.6	68.7	31.0	14.1	50.7	46.3	48.2	68.1	77.0	6.6	62.6
p-value	--	--	--	*	--	--	--	--	--	--	--	--
Race												
Black	20.2	10.3	68.8	28.1	20.9	58.4	49.8	50.0	70.0	78.9	7.2	64.9
Other	16.0	12.0	62.0	28.0	18.0	46.0	52.0	50.0	72.0	78.0	4.0	60.0
White	28.8	8.2	65.4	26.8	13.1	50.8	48.0	47.8	69.1	76.2	5.3	65.2
p-value	***	--	--	--	***	**	--	--	--	--	--	--
Home location												
Urban	24.5	9.4	66.9	27.2	16.8	53.7	48.8	48.8	69.4	77.2	6.1	65.4
Rural	30.8	0.0	53.8	38.5	3.8	46.2	50.0	50.0	76.9	84.6	3.8	38.5
p-value	--	*N.R.*	--	--	*N.R.*	--	--	--	--	--	*N.R.*	***
Average distance from clinic (miles)												
0-8	24.6	9.9	71.0	30.2	20.6	59.5	51.6	49.2	71.4	80.6	8.3	71.4
9-16	20.5	8.9	64.1	25.9	15.4	54.8	45.6	49.8	70.3	78.4	5.8	62.9
17-39	30.0	10.7	69.6	27.2	17.3	54.7	54.3	52.7	70.4	78.6	7.0	65.0
>40	23.1	8.1	61.5	26.9	11.5	44.9	46.6	44.9	67.5	73.5	3.4	59.8
p-value	*	--	*	--	*	**	--	--	--	--	--	*
Health condition												
Diabetes only	22.1	10.6	67.8	26.1	16.3	56.8	47.2	51.3	71.4	79.2	7.5	64.8
Hypertension only	27.4	7.6	62.4	26.1	16.8	49.2	48.2	48.5	66.2	75.6	2.8	63.4
Both	24.3	9.6	71.1	31.8	16.3	55.2	52.3	45.2	72.4	77.4	8.8	66.5
p-value	--	--	*	--	--	*	--	--	--	--	***	--
Number of comorbidities												
1	18.0	5.5	61.2	19.1	11.5	48.1	41.0	45.9	64.5	74.9	4.9	53.6
2	22.8	7.0	62.7	21.2	10.8	46.1	42.3	46.5	66.8	75.5	4.2	60.6
3-5	25.0	9.3	67.7	30.6	19.8	56.0	51.3	49.6	70.7	78.2	5.4	67.2
6-9	35.1	15.7	74.6	37.3	21.6	65.7	61.2	54.5	78.4	82.1	12.7	78.4
p-value	***	**	**	****	***	****	****	--	**	--	***	****
Baseline A1C [a]												
Controlled	24.8	10.7	72.3	29.3	19.8	55.0	46.7	51.2	75.6	80.6	5.8	65.7
Uncontrolled	25.3	8.6	70.1	27.6	15.8	59.7	50.7	50.7	68.3	77.8	11.3	67.9
p-value	--	--	--	--	--	--	--	--	*	--	**	--
Baseline BP [b]												
Controlled	23.6	9.3	67.1	26.4	15.0	57.9	50.7	52.9	65.0	74.3	7.1	67.1
Uncontrolled	27.0	8.1	65.4	28.9	17.1	49.8	49.4	45.7	69.7	77.0	4.5	64.0
p-value	--	--	--	--	--	*	--	--	--	--	--	--
Payer type												
Other	25.1	15.1	70.8	24.7	18.1	57.9	50.6	43.2	71.6	78.6	6.6	67.5
Public	26.9	7.5	62.4	30.6	16.5	51.9	51.9	52.4	69.4	77.2	5.3	68.4
Uninsured	11.8	0.0	58.8	11.8	5.9	23.5	52.9	11.8	52.9	58.8	0.0	64.7
Private	22.0	7.0	68.6	26.6	15.7	53.5	43.2	50.8	69.2	77.6	6.6	57.7
p-value	--	****	*	--	--	**	--	***	--	--	--	**
Number of threads initiated by patient												
1	5.4	3.0	25.6	2.5	1.5	12.3	16.8	17.2	32.5	41.9	1.5	29.1

Patient characteristics	Action responses: Acknowledge	Action responses: Denies	Action responses: Fulfills request	Action responses: Partially fulfills request	Recommendation to schedule an appointment	Information seeking	Deferred information sharing	Information Sharing: Medical guidance	Information Sharing: Orientation to procedures or processes	Information Sharing: Summary	Social communication: Appreciation/praise	No response to patient-initiated thread
2	9.7	4.8	51.7	9.7	9.0	35.2	27.6	26.9	53.1	63.4	1.4	43.4
3-4	13.1	5.5	67.3	22.1	6.5	44.7	41.7	42.7	69.9	80.9	3.5	64.3
5-7	28.0	6.7	77.7	29.5	17.6	65.3	56.5	54.4	81.9	90.2	4.7	76.7
>7	51.2	19.9	94.5	56.0	36.8	89.7	81.4	82.1	95.5	98.3	14.1	92.4
p-value	****	****	****	****	****	****	****	****	****	****	****	****
Number of outpatient visits												
1-5	14.1	5.7	59.9	16.7	9.4	40.6	32.3	37.0	58.8	69.3	2.6	50.5
6-10	25.4	6.2	61.1	22.5	13.1	47.1	45.1	44.7	62.7	72.1	6.6	62.3
11-15	21.7	9.3	66.0	28.4	16.0	56.7	50.0	51.6	72.7	81.4	3.6	66.0
16-20	26.4	8.5	77.5	35.7	20.9	55.0	50.4	54.3	78.3	86.1	4.7	71.3
>20	32.7	14.7	71.3	34.9	22.8	65.4	62.1	56.3	77.2	80.9	10.3	72.8
p-value	****	***	***	****	****	****	****	****	****	****	***	****

Notes: This table lists the unadjusted percentages and Chi-square p-values for each within-group set of characteristics.
A1C=glycemic index, BP=blood pressure, N.R.=not reliable estimate due to small cell sizes.
Baseline A1C: Controlled <7.0. Baseline BP: Controlled=systolic BP <120 and diastolic BP <80.
[a] Only in a separate model that only included patients with diabetes (n=442 after 195 patients excluded for missing data).
[b] Only in a separate model that only included patients with hypertension (n=597 after 36 patients excluded for missing data).
--Not statistically significant, *p<0.1, **p<0.05, ***p<0.01, ****p<0.001

Appendix Table 6-7.

Percentage of Clinical Staff who were the Intended Recipients of at Least One Patient-Generated Message with Assigned Taxon, by Staffs' Characteristics

		Information seeking			Information sharing				Task-oriented requests												Social communication			
									Prescription-related					Scheduling										
Clinic staff characteristics	Number of staff (number of messages)	Medical guidance	Logistics	Summary	Clinical update	Response to clinician's message	Self-reporting	Summary	Prescription refill or renewal	Change or new prescription	Summary	Referral	Other administrative	Cancellation	Follow-up	New condition or symptom	Preventive care	Reschedule	Laboratory or diagnostic procedure	Summary	Praise or appreciation	Complaints	Life issues	Summary
Staff type																								
Admin.	40 (376)	15.0	57.5	57.5	22.5	80.0	0.0	85.0	5.0	0.0	5.0	5.0	12.5	15.0	7.5	2.5	0.0	35.0	5.0	40.0	2.5	7.5	7.5	12.5
LPN	17 (148)	41.2	64.7	76.5	47.1	64.7	17.6	76.5	29.4	29.4	47.1	23.5	29.4	0.0	0.0	5.9	0.0	11.8	17.6	29.4	0.0	17.6	0.0	17.6
NP	63 (918)	58.7	50.8	66.7	61.9	42.9	11.1	73.0	60.3	39.7	71.4	17.5	49.2	11.1	19.0	14.3	0.0	22.2	25.4	49.2	6.4	20.6	28.6	41.3
Other	27 (136)	37.0	51.8	63.0	37.0	25.9	3.7	55.6	33.3	7.4	33.3	11.1	22.2	3.7	11.1	0.0	0.0	7.4	11.1	25.9	7.4	7.4	7.4	18.5
RN	114 (1222)	36.0	50.9	61.4	39.5	81.6	8.8	86.8	14.0	14.0	21.9	7.0	34.2	5.3	7.9	4.4	2.6	13.2	7.0	24.6	11.4	11.4	11.4	23.7
MD	294 (5736)	76.2	55.8	82.0	62.6	28.6	15.0	67.0	58.5	39.5	64.0	21.8	48.0	6.5	21.8	19.4	4.1	22.1	24.2	48.3	12.6	24.2	19.4	38.8
Unk.	12 (1627)	33.3	33.3	50.0	16.7	41.7	8.3	58.3	41.7	8.3	41.7	16.7	25.0	8.3	16.7	25.0	16.7	8.3	8.3	25.0	0.0	16.7	8.3	16.7
p-value		****	--	****	****	****	*N.R.*	****	****	****	****	*N.R.*	****	*N.R.*	*N.R.*	*N.R.*	*N.R.*	**	*N.R.*	****	*N.R.*	**	*N.R.*	****
Clinical specialty																								
N/A	224 (1975)	35.7	49.6	61.6	38.4	64.7	5.8	78.6	19.6	13.0	25.4	9.8	28.1	5.4	8.9	4.5	1.8	16.5	9.4	29.5	6.7	11.2	8.5	20.1
Primary	155 (4387)	72.9	64.5	80.6	67.7	40.6	22.6	73.6	71.0	49.7	77.4	27.1	53.6	12.3	23.9	24.5	6.4	20.6	31.6	52.9	16.7	27.1	29.0	49.0
Specialty	174 (2159)	75.3	52.3	81.6	59.2	25.9	9.8	64.9	50.0	32.8	56.3	15.5	45.4	4.6	19.5	14.4	0.6	24.7	19.0	46.6	9.2	21.3	16.7	33.3
Unk.	14 (1642)	35.7	28.6	50.0	21.4	42.9	7.1	57.1	42.9	14.3	50	21.4	35.7	7.1	14.3	21.4	14.3	7.1	7.1	21.4	0.0	21.4	7.1	21.4
p-value		****	***	****	****	****	****	**	****	****	****	****	****	**	****	****	*N.R.*	--	****	****	***	***	****	****
Message volume in 2017																								
<=1000	206 (1092)	50.0	39.8	62.6	47.1	22.3	3.9	59.7	35.4	16.0	41.8	8.2	31.6	2.4	11.6	8.2	0	11.6	10.2	31.1	6.3	12.1	6.8	21.4
1001-2000	134 (1320)	59.7	55.2	74.6	48.5	39.6	11.9	68.7	43.3	32.8	51.5	14.2	39.6	6.7	14.9	13.4	3.0	18.7	16.4	41.8	6.7	23.9	15.7	33.6
2001-3400	99 (1859)	69.7	62.6	79.8	58.6	62.6	15.2	83.8	51.5	42.4	58.6	24.2	49.5	5.0	20.2	10.1	6.1	25.2	29.3	48.5	14.1	19.2	27.3	43.4

		Information seeking			Information sharing				Task-oriented requests												Social communication			
									Prescription-related					Scheduling										
Clinic staff characteristics	Number of staff (number of messages)	Medical guidance	Logistics	Summary	Clinical update	Response to clinician's message	Self-reporting	Summary	Prescription refill or renewal	Change or new prescription	Summary	Referral	Other administrative	Cancellation	Follow-up	New condition or symptom	Preventive care	Reschedule	Laboratory or diagnostic procedure	Summary	Praise or appreciation	Complaints	Life issues	Summary
>3400	109 (4240)	62.4	74.3	85.3	66.1	83.5	22.9	93.6	52.3	39.4	56.0	29.4	52.3	17.4	23.9	24.8	4.6	33.9	27.5	54.1	18.4	26.6	27.5	42.2
Unk.	19 (1652)	47.4	36.8	57.9	26.3	36.8	10.5	57.9	42.1	15.8	42.1	10.5	31.6	10.5	15.8	21.0	10.5	10.5	10.5	26.3	5.3	10.5	10.5	21.0
p-value		**	****	****	***	****	****	****	**	****	**	****	***	****	*	****	*N.R.*	****	****	****	***	***	****	****

Notes: This table lists the unadjusted percentages and Chi-square p-values for each within-group set of characteristics.
Admin=administrative staff, LPN=licensed practice nurse, MD=physician, NP=nurse practitioner, N.R.=not reliable estimate due to small cell sizes, RN=registered nurse, Unk=unknown.
--Not statistically significant, *p<0.1, **p<0.05, ***p<0.01, ****p<0.001

Appendix Table 6-8.

Odds Ratio Estimates [and 95% Confidence Intervals] of the Associations Between Clinic Staff Characteristics and the Patient-Generated Taxa They Received

Clinic staff characteristics	Information seeking		Information sharing		Task-oriented requests					Social communication	
								Scheduling requests			
	Medical guidance	Logistics	Clinical update	Response to clinician's message	Prescription refill or renewal	Referrals	Other administrative	Laboratory or diagnostic procedure	Summary	Complaints	Summary
Administrative staff vs Physician	0.16 [0.07, 0.38]	--	0.24 [0.11, 0.52]	2.69 [1.19, 6.09]	0.07 [0.02, 0.25]	0.21 [0.06, 0.77]	0.25 [0.10, 0.63]	0.24 [0.07, 0.88]	--	--	--
Nurse Practitioner vs Physician	--	--	--	--	3.52 [1.55, 7.99]	--	--	--	--	--	--
Other clinician vs Physician					2.51 [1.04, 6.09]						
Registered Nurse vs Physician	--	--	--	3.96 [2.20, 7.15]	0.31 [0.15, 0.6]	0.40 [0.18, 0.88]	--	0.42 [0.19, 0.94]	0.51 [0.31, 0.86]	--	--
Not applicable vs Primary care specialty	--	0.55 [0.34, 0.88]	--	--		--	--	--	--	--	--
<=1000 vs >3400 messages	0.29 [0.20, 0.42]	0.44 [0.32, 0.59]	0.51 [0.37, 0.69]	0.33 [0.24, 0.46]	0.3 [0.21, 0.43]	0.33 [0.21, 0.51]	0.46 [0.33, 0.62]	0.35 [0.23, 0.52]	0.43 [0.32, 0.59]	0.46 [0.31, 0.68]	0.40 [0.29, 0.56]
1001-2000 vs >3400 messages	--	--	0.64 [0.46, 0.88]	0.55 [0.39, 0.78]	0.62 [0.42, 0.91]	--	--	--	--	--	--
2001-3400 vs >3400 messages	1.74 [1.13, 2.68]	--	--	1.59 [1.08, 2.33]		--	--	1.61 [1.07, 2.43]	--	--	1.44 [1.00, 2.07]

Notes: Each column represents a regression model, in which the dependent variable is the taxon and the independent variables are the clinic staff characteristics (table rows).
--=Not statistically significant at p<0.05.

7. What's in a Message: Associations Between Secure Message Content and Healthcare Services Utilization

Dawn Heisey-Grove, Ph.D. (c), M.P.H.
Ph.D. candidate, Virginia Commonwealth University

Jonathan DeShazo, Ph.D., M.P.H.
Associate Professor and Blick Scholar, Virginia Commonwealth University

Laura McClelland, Ph.D.
Associate Professor, Virginia Commonwealth University

Leonard Friedman, Ph.D. M.P.H., FACHE
Professor, The George Washington University

Kevin Jackson, Ph.D., RRT
Assistant Professor, Norfolk State University

Alexander Tartaglia, D. Min.
Senior Associate Dean and Katherine I. Lantz Professor, Virginia Commonwealth University

7.1 Abstract

Background

The secure exchange of electronic messages is an increasingly common form of communication between patients and clinic staff; however, no research has been published to date that examines the association between that secure message content and patient outcomes. Patient-clinician communication functions lead to important intermediate outcomes such as access to care and self-management, which in turn facilitate improved health. Healthcare utilization measurements, like the number of healthcare encounters or medication adherence, may approximate these intermediate outcomes. We present the first research to identify associations between message content and these measures of healthcare utilization.

Methods

Our study population included 2111 adult patients with diabetes and/or hypertension. We created independent variables based on codes derived from a theory-based taxonomy and assigned these codes to 18309 patient- and clinician-generated messages that were part of message threads initiated by patients in 2017. We measured associations between code prevalence and three continuous dependent variables—number of office visits, emergency department visits, and inpatient visits—and two dichotomous measures of adherence for diabetes-related and hypertension-related medications. We used Poisson regression to estimate incident rate ratios (IRR) for the visit count variables, and logistic regression to estimate odds ratios (OR) for medication adherence. We modeled each dependent-independent variable pairing against two cohorts: one that only included patients who initiated message threads, and the second supplemented the first cohort with patients who did not initiate threads during the study period.

Results

Patients who initiated message threads in 2017 had higher numbers of outpatient visits ($p<0.001$) and better hypertension medication adherence ($p<0.01$), compared to patients who did not initiate threads. Among patients who initiated message threads, outpatient visits decreased with increased prevalence of preventive care scheduling requests (IRR=0.92; 95% CI: 0.86-0.98), requests for appointments for new

conditions (IRR=0.95; 95% CI: 0.92-0.99), and clinicians' action responses (IRR=0.98; 95% CI: 0.97-1.00). Patients who initiated message threads and who received higher proportions of denials in response to their requests, or sent more requests for follow-up appointments had more emergency department visits compared to patients who received or sent other message types (IRR=1.17; 95% CI: 1.02, 1.34 and IRR=1.14; 95% CI: 1.07-1.23, respectively). We also identified a slight increase in the number of office visits as the proportion of threads that lacked a clinic response increased (IRR=1.02; 95% CI: 1.00, 1.03). Finally, the odds of being adherent with hypertension medications decreased as the prevalence of reschedule requests increased (OR=0.87; 95% CI: 0.79-0.96).

Conclusion

Our findings indicate that secure message content is associated with some healthcare utilization metrics. This information is relevant in understanding how to better use this communication modality to support patients and their care.

7.2 Introduction

Street, Makoul, et al. (2009) developed a framework that identifies direct and indirect pathways in which patient-clinician communication can influence patient outcomes. Proximal and intermediate outcomes, ranging from improved patient satisfaction, increased trust in the clinician, and improved access to care and self-care skills, have been associated with improved health outcomes in numerous studies. Effective patient-centered communication is moderated by a variety of patient, clinician, and healthcare delivery factors (Epstein et al., 2005), as well as communication modality (e.g., verbal, electronic).

One modality growing in popularity and frequency of use is secure messaging, which is the exchange of electronic text-based messages (i.e., email) between clinic staff and patients via a platform that securely verifies senders' and receivers' identities. Approximately four in ten patients with diabetes used secure messaging between clinical visits (Lyles et al., 2012) and 59 percent of cancer patients selected it as their preferred mode of communication with their clinician, over phone and in person communication (Alpert et al., 2019).

Patients typically forget between 40 and 80 percent of information shared during a healthcare encounter (da Assunção et al., 2013; Kessels, 2003; Tarn & Flocke, 2011). Therefore, between-visit communications using secure messaging should promote information seeking from the patient and information sharing by clinic staff. Some studies that examined patients' message content noted high frequencies of information seeking and sharing behaviors (Alpert et al., 2017; Anand et al., 2005; Bergmo et al., 2005; Cronin, Fabbri, et al., 2015; Hogan et al., 2018; C.-T. Lin et al., 2005; Sittig, 2003; P. C. Tang et al., 2006; White et al., 2004; Zhou et al., 2010).

Other studies, however, reported administrative requests as more common (Byrne et al., 2009; Mirsky et al., 2016a; North, Crane, Stroebel, et al., 2013; Robinson et al., 2017; Ross et al., 2004; Shimada et al., 2017). Understanding how secure messaging is used may help anticipate future healthcare services utilization. For example, Pelak et al. (2015) observed that one-fifth of in-office visits with a primary care physician were suitable for another modality (Pelak et al., 2015). Secure messaging may be an appropriate replacement in some of these situations.

The Street, Makoul, et al. (2009) framework outlines a pathway that starts with communication functions such as information exchange and uncertainty management, and by way of proximal and intermediate outcomes leads to changes in health outcomes. Intermediate outcomes include access to care and self-care skills, which can be approximated by measuring healthcare visits and medication management. To date, findings have been mixed on the association between healthcare visits and messaging use. No study explored the association of message content—what types of requests patients are making and how clinicians are responding—and utilization of healthcare services. Among those studies that examined the association between patients' secure messaging and number of outpatient visits, researchers found positive (Harris et al., 2009; Liss et al., 2014; North, Crane, Chaudhry, et al., 2013), negative (Bergmo et al., 2005; Zhou et al., 2007), and no association (Meng et al., 2015; North, Crane, Chaudhry, et al., 2013). Zhou et al. (2007), Meng et al. (2015), and North, Crane, Chaudhry, et al. (2013) noted spikes in healthcare utilization immediately preceding or following secure messaging use; Meng and North each noted that these spikes dissipated after several months.

Less research is available on the association between secure messaging and emergency department and urgent care visits. Harris et al. (2009) reported an increase in emergency department visits while Shimada et al. (2013) identified decreased urgent care visits at facilities who adopted secure messaging functionality early, although that association did not persist at facilities who adopted the functionality later. Meng et al. (2015) found no difference in emergency and after-hours visits between users and non-users of secure messaging.

Another form of healthcare utilization is medication refill and use. No published research is available on the association between secure messaging and medication adherence; however, several studies found positive associations between use of the refill function in patient portals and adherence (Lyles et al., 2015; Sarkar et al., 2014). Both studies reported better adherence among patients who used the function exclusively for refill requests compared to patients who only occasionally requested refills through the portal, compared to those who did not use the portal for refills at all.

In this research, we explored whether message content sent by patients and clinic staff was associated with healthcare visits and medication adherence. To do this effectively, we developed a theory-based taxonomy designed specifically for secure messages. Our taxonomy includes taxa (i.e., codes) to capture patient uncertainty in the form of information seeking requests, patient self-care behaviors manifested in different task-oriented requests, and content that might foster patient-clinician relationships (e.g., information sharing and social communication). Taxa related to clinical responses include information sharing, information seeking, action responses to address patients' requests (e.g., fulfillment or partial fulfillment), and social communication in the form of appreciation or praise.

Patients reported that effective communication via secure messaging prevented them from booking unnecessary appointments (Alpert et al., 2019). We therefore expected negative associations between the number of healthcare visits and: (1) task-oriented requests reflective of self-care behaviors; (2) information sharing content sent by patients and clinic staff; and (3) social communication that fostered trust between patients and clinicians. Conversely, denying or ignoring patients' secure message requests may lead to increased face-to-face visits as patients seek appropriate responses to their requests. Consistent with this premise, we anticipated positive associations between the number of healthcare visits and: (1) deferrals or denials sent by clinic staff in response to a patient's request; and (2) patient-initiated threads that received no response from clinic staff. We expected associations between taxa and medication adherence to be opposite those of office visits.

7.3 Methods

Study population. Our study population was randomly selected adult patients with diabetes or hypertension registered with the Virginia Commonwealth University Health Services (VCUHS) patient portal before April 2018. The study period is January 1 through December 31, 2017. We identified patients with diabetes and hypertension if they had at least two outpatient visits or one inpatient visit during 2016 with an E11 or I10 (respectively) ICD-10-DM code. We excluded patients who did not have at least one outpatient visit during the first six months of 2018. This research was approved by the VCU Institutional Review Board under an expedited category 5 review.

For the purpose of our analyses we categorized patients who initiated secure message (SM) threads during the study period ("SM users"), patients who did not initiate message threads ("non-SM users"), and the "full population" that includes both.

Dependent variables. Our study examines five dependent variables. Three variables captured the number of times a patient was seen for care within the VCUHS system during 2017: the number of outpatient visits, the number of emergency department visits, and the number of inpatient visits. We did not include patient visits to other healthcare institutions. We included all visits to VCUHS occurring between January 1 and December 31, 2017, and we modeled each of these variables as discrete count values.

Our last two dependent variables estimated diabetes-related and hypertension-related medication adherence based on a prescription-based medication possession ratio (MPR) calculation. We selected diabetes-related medications from the American Diabetes Association's 2018 standards of care guidance (American Diabetes Association, 2018a) and hypertension-related medications based on the jointly-issued clinical practice guidelines from the American College of Cardiology and American Heart Association (Whelton et al., 2018).

To estimate the MPR's denominator, we summed the number of days between the first and last refills in 2017. For the MPR's numerator, we estimated the days supplied across all refills based on medication dosage and supplied quantity. We obtained these data through VCUHS' electronic health record's (EHR) interface with Surescripts, which documents prescribed medications within its network of organizations. If dosing information was missing from this external view, we referenced the VCUHS medication history records. We recorded patients for whom no medications were listed in Surescripts as not having medications during the study period. We classified patients with missing dosing, quantity, or other data necessary to calculate an MPR as having missing data. If only some of a patient's medications were missing data, we estimated an average MPR using the medications for which all necessary data were available.

For each medication, we estimated an MPR; if the MPR exceeded a value of one, we rounded down to one. Our final condition-specific MPR was based on the average of the individual medication MPRs relative to the specific condition. We excluded insulin from our MPR estimates given the challenges associated with accurately measuring insulin adherence (Clifford et al., 2014). We then estimated a dichotomous adherence variable based on the calculated MPR because we could not correct the severe skewness using standard data transformation efforts (Tabachnick & Fidell, 2013). We based our dichotomous MPR cut-point for adherence as greater than 0.8 based on prior publications (Clifford et al., 2014; Khunti et al., 2017; Krass et al., 2015; Schulz et al., 2016).

Independent variables. Our independent variables represent patient- and clinician-generated message content as identified through our theory-based taxonomy. We assigned taxa to all patient- and clinician-generated messages that were part of message threads (i.e., an initiating message and all subsequent responses) initiated by patients between January 1 and December 31, 2017. We excluded threads if the messages within the thread were sent outside that date range or if clinic staff initiated the threads.

The coding process was described in more detail previously (see Chapter 6): a primary coder assigned taxa to all messages and a second coder assigned taxa to a random ten percent sample of messages; discrepant results were discussed and the primary coder recoded all messages based on any changes in taxa definitions. We assigned at least one code (i.e., taxon) to each message but as many taxa as necessary could be assigned to a message to address all concepts included in each message. We counted a taxon only once per message.

We defined clinic non-response as a message thread that included only patient-generated messages and no messages from clinic staff. For the purposes of analysis, non-response is handled the same as message taxa.

Our study examines each taxon, and clinic non-response, as unique independent variables. In prior research, we identified a strong correlation between the number of threads initiated and taxon occurrence (see Chapter 6). Our independent variables were therefore estimated as a prevalence value for each taxon: the numerator is the number of times the patient sent (patient-generated taxa) or received (clinician-generated taxa) a selected taxon and the denominator is the total of all patient- or clinician-generated taxa, respectively. We similarly estimated non-response prevalence using a denominator of all threads initiated by the patient.

Covariates. We included several patient demographic and health status characteristics as covariates based on our understanding of these factors' contributions to healthcare utilization, health status, and taxa use. We included patient sex, race (white, black, other), and insurance type (public, private, uninsured, other), rural home location as determined through 2010 Rural Urban Community Area codes (United States Department of Agriculture Economic Research Service, 2019), and health condition (diabetes, hypertension, or both conditions) as categorical variables. Our continuous covariates included patient age, number of threads initiated in 2017, and number of diagnoses selected from the most commonly occurring ICD-10-DM diagnosis codes within our population (diabetes, hypertension, lipoprotein metabolism and other lipidemia disorders, overweight and obesity, joint disorders, gastro-esophageal reflux disease, back or spine pain, soft tissue disorders like rheumatism or fibromyalgia, and sleep disorders). We also included the number of outpatient visits as a covariate in analyses where outpatient visits were not the dependent variable. In analyses that only included patients who initiated threads, we added a continuous variable representing the distance between patients' home addresses and the clinics to which they corresponded, calculated as the distance between zip code centroids. We used an average of distances if the patient corresponded with multiple clinics. We coded the variable as missing for all address-based covariates if the patient's address was located outside of Virginia.

We included patients' baseline systolic and diastolic blood pressures as a proxy for illness severity in analyses that explored hypertension medication adherence. If more than one blood pressure was obtained on that day, we averaged the available blood pressure values. Due to high rates of missing data for baseline glycemic values for our patients with diabetes (see Chapter 8), we did not include a comparable covariate for the diabetes medication adherence analyses.

Analysis. We conducted regression analyses based on the type of dependent variable. For the dependent variables measuring visit counts, we applied Poisson regression with robust variance estimation (Hilbe, 2014) to estimate incident rate ratios. For the two adherence variables, we conducted logistic regression analyses and estimated the likelihood that patients were adherent to their medications using odds ratios.

For each dependent-independent variable combination, we conducted two regression analyses: one with the population who initiated threads (SM users) and a second that included the full population. For full population analyses, we included all patients who did not initiate a thread in 2017 (non-SM users) and patients who sent or received a message coded with the selected taxon (patients who sent messages not coded with the selected taxon were excluded from these analyses). All analyses were conducted using SAS v9.4.

7.4 Results

Our patient sample included 2111 patients with diabetes and/or hypertension. Thirty-eight percent of patients had only diabetes and 37 percent had only hypertension. Forty-nine percent of the sample initiated at least one thread in 2017, for a total of 7346 threads that included 10163 patient-generated messages and 8146 staff-generated messages.

Table 7-1 presents the mean prevalence of each taxon among patients who initiated threads. The two most prevalent non-grouping level patient-generated taxa were Prescription refills and renewals and Appointment reschedule requests; least prevalent were Social communication taxa. On average, patients initiated 2.11 [1.88, 2.36] threads that received no response from clinic staff. Approximately 39 percent [37.24, 40.45] of the content patients received from clinicians included Information sharing.

Visit Counts. Table 7-2 presents the average number of visits by type and whether patients initiated threads. Patients who initiated threads had more outpatient visits than those who did not

Table 7-1.

Mean Taxon Prevalence Among Patients Who Initiated a Message Thread in 2017

Generated by	Taxa	Mean Taxon Prevalence [95% CI][1]
Patient	Information seeking	20.93 [19.51, 22.35]
	Logistics	7.31 [6.48, 8.13]
	Medical guidance	14.34 [13.09, 15.59]
	Information sharing	23.61 [22.17, 25.05]
	Clinical update	10.43 [9.38, 11.47]
	Response to clinician's message	10.73 [9.91, 11.56]
	Self-reporting	2.45 [1.82, 3.08]
	Task-oriented requests not reflective of uncertainty	41.38 [39.31, 43.46]
	Prescription refills and renewals	14.97 [13.45, 16.49]
	Other administrative	5.00 [4.22, 5.78]
	Appointment cancellation	4.70 [3.77, 5.64]
	Follow-up appointment	4.26 [3.48, 5.05]
	Appointment for preventive care or physical exam	1.47 [1.00, 1.94]
	Appointment reschedule	10.98 [9.60, 12.37]
	Other task-oriented requests	10.67 [9.58, 11.76]
	Referral	1.35 [0.93, 1.77]
	New or change prescription	4.09 [3.47, 4.71]
	Laboratory test or diagnostic procedure	1.74 [1.34, 2.13]
	Appointment for new condition/symptom	3.50 [2.77, 4.23]
	Social communication	2.63 [2.18, 3.09]
	Appreciation or praise	0.67 [0.43, 0.91]
	Complaints	0.79 [0.57, 1.00]
	Life issues	1.23 [0.90, 1.56]
Clinic staff	No response to patient-initiated thread[2]	28.07 [26.26, 29.88]
	Action responses	30.38 [28.63, 32.12]
	Acknowledge	3.82 [3.12, 4.52]
	Fulfills request	22.58 [20.93, 24.23]
	Partially fulfills request	3.98 [3.37, 4.59]
	Recommendation to schedule an appointment	1.75 [1.40, 2.09]
	Information seeking	12.02 [11.04, 13.00]
	Defer/Deny	11.56 [10.55, 12.57]
	Deferred information sharing	10.46 [9.48, 11.44]
	Denies request	1.10 [0.79, 1.41]
	Information sharing	38.84 [37.24, 40.45]
	Medical guidance	13.11 [11.92, 14.30]
	Orientation to procedures, treatments, or preventive behaviors	22.45 [21.15, 23.76]
	Social communication: Appreciation or praise	0.88 [0.59, 1.17]

[1]For patient-generated taxa, the denominator is the total number of patient-generated taxa. The denominator for the clinician-generated taxa is the total number of taxa assigned to clinician-generated messages sent to the patient.
[2]Denominator is the number of threads initiated by patient.

Table 7-2.

Mean Number [95% Confidence Interval] of Office, Emergency Department, and Inpatient Visits

Patients Initiated Threads	Outpatient visits	Emergency department visits	Inpatient visits
Yes	15.89 [15.10, 16.67]	0.34 [0.28, 0.40]	0.39 [0.32, 0.46]
No	11.16 [10.51, 11.81]	0.42 [0.35, 0.49]	0.32 [0.26, 0.38]
p-value	<0.0001	0.08	0.13

(p<0.001). The average numbers of emergency department and inpatient visits skewed to zero across both groups. Patients who did not initiate threads visited the emergency department slightly more than those who initiated threads, but that difference was borderline significant (p=0.08). We found no statistical difference in the average number of inpatient visits.

Table 7-3 presents the results from the Poisson regressions models that included only patients who initiated threads. We found a small positive association between clinic non-response and outpatient visits. We observed a negative association between outpatient visits and the taxa for appointment requests for preventive care, requests for new or changed condition, and the grouped variable for clinician-generated action responses. We found two taxa positively associated with emergency department visits: follow-up appointment requests and clinic staffs' denials of patient requests. Across most taxa associated with inpatient visits, we observed an inverse association with taxon prevalence excepting the grouping variable for task-oriented requests not reflective of uncertainty, which demonstrated a positive association with inpatient visits.

Appendix Table 7-1 includes the results from the regression analyses that used the full population. We observed positive associations between outpatient visits and taxon prevalence for most patient-generated and clinician-generated taxa. Similar to analyses using the population who initiated threads, the full population regressions identified negative associations between taxon prevalence and emergency departments with one exception: follow-up appointment requests (IRR=1.11; 95% CI: 1.03, 1.20). We observed negative associations between inpatient visits and the Other task-oriented requests grouping taxon and several of its child taxa.

Table 7-3.

Association between Taxa and Office, Emergency Department, and Inpatient Visits

Generated by	Taxa	IRR[1] [95% Confidence Interval] Among Patients who Initiated Threads		
		Outpatient Visits	Emergency Department Visits	Inpatient Visits
Patient[2]	Information sharing: Response to clinician's message	--	--	0.87 [0.75, 1.00]
	Task-oriented requests not reflective of uncertainty	--	--	1.07 [1.02, 1.13]
	Follow-up appointment	--	1.14 [1.07, 1.23]	--
	Appointment for preventive care or physical exam	0.92 [0.86, 0.98]	--	--
	Other task-oriented requests	--	--	0.73 [0.63, 0.86]
	Referral	--	--	0.64 [0.44, 0.95]
	New or change prescription	--	--	0.74 [0.60, 0.92]
	Appointment for a new condition/symptom	0.95 [0.92, 0.99]	--	0.63 [0.43, 0.93]
Clinic Staff[3]	No response to patient-initiated thread[4]	1.02 [1.00, 1.03]	--	--
	Action responses	0.98 [0.97, 1.00]	--	--
	Information seeking	--	--	0.84 [0.73, 0.96]
	Defer/Deny: Denies request	--	1.17 [1.02, 1.34]	--

[1]Represents an incident rate ratio associated with a 10-percentage point increased prevalence of the selected taxon. Each cell represents a separate regression model where the independent variable is the row header and the dependent variable is the column header. Taxa not presented in the table were not statistically significant at $p<0.05$.
[2]Independent variable numerator is the number of times the patient generated messages coded with the selected taxon and the denominator is the total of all taxa coded to messages the patient generated.
[3]Independent variable numerator is the number of times the patient received messages coded with the selected clinician-generated taxon and the denominator is the total of all taxa coded to messages the patient received from clinic staff.
[4]Independent variable is the percentage of threads that did not receive a clinical response.
--=not statistically significant at $p<0.05$.

Medication Adherence. Almost half (45 percent) of patients with diabetes had no non-insulin diabetes medications listed, compared to 23 percent of patients with hypertension. Among patients with at least one medication listed in the system, three percent [2.03, 3.86] of patients with diabetes had at least one diabetes-related medication with missing data (e.g., dosing, quantity). We observed a similar missing rate among patients with hypertension (3.00 percent; 95% CI: 2.07, 3.93).

Table 7-4 displays the average MPRs and adherence rates. We detected a statistical difference between the mean MPRs of patients with hypertension ($p=0.04$) with patients who initiated threads having a higher MPR than those who did not initiate threads. Similarly, we observed a statistical difference ($p<0.01$) in medication adherence among patients with hypertension. We detected no statistical

Table 7-4.

Mean Medication Possession Ratios and Medication Adherence Rates

Health condition	Initiated Threads	Total Patients	Patients with MPRs (%)	Mean [95% CI] MPR	Percent [95% CI] Adherent[1]
Diabetes[2]	Yes	638	58.00	0.85 [0.83, 0.87]	72.16 [67.57, 76.75]
	No	686	51.46	0.85 [0.83, 0.87]	69.12 [64.28, 73.96]
	p-value	--	--	0.77	0.37
Hypertension[3]	Yes	634	80.60	0.89 [0.88, 0.90]	82.78 [79.49, 86.06]
	No	666	74.17	0.87 [0.85, 0.88]	75.10 [71.27, 78.93]
	p-value	--	--	0.04	<0.01

MPR=Medication Possession Rate.
[1]Adherent is defined as an MPR greater than 0.8.
[2]MPR for patients with diabetes is an average of all non-insulin diabetes-related medications.
[3]MPR for patients with hypertension is the average of all hypertension-related medications.

differences among patients with diabetes for either the MPR or adherence rates.

Table 7-5 displays the results from the logistic regression analyses of hypertension-related medication adherence. No taxa were associated with diabetes medication adherence. Among the hypertension medication adherence models, several based on the full population did not converge (clinician-generated taxa for Praise and Request denials; and patient-generated taxa for Laboratory requests, Life issues, Praise or Appreciation, Self-reporting of biometrics, Other administrative requests, and Appointment requests for preventive care).

Among patients who initiated message threads, we identified only one taxon—Appointment reschedule requests—associated with hypertension medication adherence: as patients' requests to reschedule appointments increased, their adherence decreased. Among the full population (comparing patients who initiated threads and those who did not), we identified only positive associations between taxon prevalence and adherence. The largest magnitude association among these was for clinicians' recommendations to schedule appointments (OR=1.93, 95% CI: 1.01, 3.69). The odds for adherence also increased as the prevalence of thread non-response increased (OR=1.12; 95% CI: 1.06, 1.21).

7.5 Discussion

We report on the first analyses to examine associations between message content and healthcare

Table 7-5.

Association between Taxon Prevalence and Hypertension Medication Possession Ratios

Generated by	Taxa	Odds Ratio [95% CI] Among Secure Message Thread Initiators	Odds Ratio [95% CI] Among Full Population[1]
Patient[2]	Information seeking	--	1.11 [1.01-1.22]
	Medical guidance	--	1.19 [1.04-1.36]
	Information sharing	--	1.12 [1.01-1.24]
	Response to clinician's message	--	1.28 [1.05-1.55]
	Task-oriented request: Appointment reschedule	0.87 [0.79-0.96]	--
	Other task-oriented request: New or change prescription	--	1.52 [1.06-2.18]
Clinic Staff[3]	No response to patient-initiated thread[4]	--	1.12 [1.03-1.21]
	Action response: Partially fulfills request	--	1.49 [1.05-2.11]
	Information sharing	--	1.08 [1.00-1.16]
	Medical guidance	--	1.17 [1.02-1.34]
	Recommendation to schedule appointment	--	1.93 [1.01-3.69]

[1]Includes all patients who sent message(s) with selected taxon (SM users) and all patients who did not initiate a message thread in 2017 (non-SM users).
[2]Independent variable numerator is the number of times the patient generated messages coded with the selected taxon and the denominator is the total of all taxa coded to messages the patient generated.
[3]Independent variable numerator is the number of times the patient received messages coded with the selected clinician-generated taxon and the denominator is the total of all taxa coded to messages the patient received from clinic staff.
[4]Independent Variable is the percentage of threads that did not receive a clinical response.
--=Not statistically significant at $p<0.05$.

visits and medication adherence. Our analyses found that patients who initiated message threads had more outpatient visits, fewer emergency department visits, and better hypertension medication adherence. We confirmed our hypotheses that clinic non-response would be associated with more outpatient visits and that task-oriented requests would be associated with fewer visits; however, we confirmed the latter only with inpatient and outpatient visits for selected task-oriented request sub-taxa. We also verified a positive association between emergency department visits and clinic staff denials of patient requests. Counter to our hypotheses, we observed: (1) a positive association between emergency department visits and follow-up appointment requests; (2) an inverse association between adherence and task-oriented requests; and (3) positive associations between outpatient visits and taxa in full population analyses.

We believe this is the first study that explores the association between medication adherence and secure messaging, and in particular, medication adherence and message content. Overall, patients with hypertension who initiated message threads had higher adherence rates than patients who did not initiate message threads. We identified a negative association between patients' requests to reschedule appointments and hypertension medication adherence; that is, as the prevalence of reschedule requests increased, the odds for medication adherence decreased. We expected the opposite to occur, considering such task-oriented requests to be indicative of self-care. If, however, frequent invocations of this taxon instead are considered an indicator that the patient is unable to follow-through on medical care responsibilities, we might expect the observed result.

It is also possible that patients' habits changed during the year and their medication adherence adjusted accordingly. The adherence measure is an average over the calendar year. Our research does not include any temporal aspects and this association may be an example of why incorporating temporality into the analyses may be helpful to understand the results. One way to assess this is to compare taxa use and adherence in smaller temporal bands, such as quarterly. Harris et al. (2013) detected larger effects when measuring outcomes relative to the preceding quarter of secure messaging use compared to the prior year. Our study measured content and outcomes simultaneously. Further exploration of how content influences future healthcare utilization, as well as the reverse—what utilization influences future message content—would improve understanding of how clinic staff and patients might use secure messaging to influence medication adherence and other patient outcomes.

Temporal information would also be helpful to better understand the association between emergency department visits and follow-up appointment requests. It is common practice for patients to receive guidance to follow-up with their primary care providers after discharge. The positive association we reported here may be evidence of patients following that guidance. Without the temporal context for when these requests were made relative to emergency department visits, we cannot be certain if this explains the association.

We identified a positive association between outpatient visits and clinic non-response: as the prevalence of non-responses increased, so did the number of outpatient visits. This association was only significant with outpatient visits; we did not observe similar associations with emergency department and inpatient visits. The average number of emergency department and inpatient visits our population experienced in 2017 was low, making association detection challenging. It is important to consider, however, that if a patient requested information or that a task be completed with no secure message response, then the patient likely needed to find another avenue to obtain the answer or complete the task. Lanham et al. (2018) found that half of their messages lacking an electronic message response were responded to through another modality (e.g., phone, in-person visit).

On average, almost three in ten of our patients' threads did not receive a message response. This may have significant impact on the trust between patient and clinic staff, as well as decrease patients' ability to manage their care if information-seeking about health conditions or task-oriented requests related to self-management are not addressed. During a series of focus groups, patients noted that the quality and content of a clinician's responses could alter their relationship with that clinician; for example, frustration increased when questions were left unanswered (Alpert et al., 2019). Many organizations utilize a triage system when responding to patients' messages, although the complexity of such triage systems have been reported by some clinicians as a barrier to use (Wooldridge et al., 2016). Such complexity could lead to messages being overlooked. Administrators may want to examine ways to simplify or streamline triage workflows to ensure non-response is avoided whenever feasible.

Consistent with our hypothesis, patients who received denial responses from their clinical team visited the emergency department more frequently. At one percent prevalence among patients who initiated messages, clinic denials were not a common occurrence. While this is an interesting result, it is important to remember that our findings make no indication of causality nor do we have context for the denial. Our analyses were based on individual taxa assigned to messages and do not consider the full conversation within the message thread. A denial accompanied by clinic staff seeking additional information or making a recommendation to schedule an appointment may have a different impact on patient outcomes relative to a denial without information or context. Similarly, denials to certain types of message content may have more impact on outcomes than others. Future research should analyze the impact of the full call-and-response context of the thread to try to tease out these nuances.

In addition to the limitations noted above, there are several others we feel are important to call out. As noted in Chapter 6, there is a strong association between thread volume and each taxon. The variety of taxa sent by a patient increases as the number of threads initiated by the patient increases. To count for this, we represented our independent variables as a prevalence value. The use of prevalence allowed us to account for the number of taxa sent or received by the patient while not losing the taxon volume. It does, however, make interpretation of the results somewhat challenging.

We have five concerns associated with our estimates and use of the adherence measure. First, our populations' average hypertension non-adherence rates were lower than most published literature of between 34 and 61 percent (Schulz et al., 2016), which may limit generalizability. Our second concern is based on our determination of adherence. The premise of the MPR calculation is that there are at least two prescription fills for a given medication. If a patient discontinues a medication counter to medical guidance, it would not be detectable through the MPR estimate. Approximately one-quarter of patients with hypertension, for example, never fill prescriptions and approximately one in eight discontinue medications within one month of discharge (Ho et al., 2009). Future studies exploring the association between adherence and message content may wish to consider alternate approaches to measuring adherence. Thirdly, we applied the standard threshold for assessing good adherence (>80 percent) but the average MPR for our patients with hypertension was 7 to 9 percentage points above this threshold. Our sample may therefore have been insufficient to detect statistically significant associations for many taxa. Fourthly, while Surescripts includes the vast majority of pharmacies in the country, it does not provide universal coverage. It is possible, therefore, that some patients filled prescriptions that were not accounted for in our data. Finally, only about half of the patients with diabetes had medications available to calculate MPRs, resulting in a large portion of that population excluded from those analyses.

Our comparisons using the full population found statistically significant associations between outpatient visits and many taxa. It is possible that these associations reflect patient activation and engagement represented through secure messaging use rather than associations with specific taxa. One of the final stages of patient activation is taking action to improve or maintain health (Hibbard, Stockard, Mahoney, & Tusler, 2004), and it could be argued that patients who make requests of their clinical team between outpatient visits are taking that action. In fact, one study found a positive association between patients' between-visits communications and activation rates (Alexander, Hearld, Mittler, & Harvey, 2012). If use of secure messaging is a proxy for activation, then results that compare secure message users and non-users may only be interpreted through the lens of patient activation and differences in taxon use may not be reliable. Our analyses using only the population who initiated threads may remove most of the effect from the activation confounder since this may represent a largely activated population. Our findings are consistent with this hypothesis: many of the differences we detected by taxon in the full population analyses did not persist in models that only included patients who initiated threads.

Similar to other research that examined patient healthcare utilization through a count of outpatient visits, we hypothesized a general positive or negative association between taxa and visit count. Measuring utilization in this way, however, may be too blunt a metric to be effective. The ultimate goal in improving patient outcomes should not be reducing visits but rather reducing inappropriate or unnecessary care. It may be that an average of 15 visits per patient is what our population needed to achieve good outcomes. More appropriate metrics to consider for future research might be around whether patients received appropriate guidance-based care, such as appropriate preventive care, laboratory tests, and screenings.

Finally, we reported elsewhere (see Chapter 6) the limitations in the messages coding reliability. The interrater reliability for some sub-taxa demonstrated moderate or poor correlation, indicating a need for taxa definition refinement. We suspect this to be a potential source of misclassification bias within the study and it reflects a lack of precision in identifying appropriate taxa within messages. Ultimately, lower interrater reliability may represent a threat to internal study validity and interpretation of our results should take this into consideration. Future applications of our taxonomy would benefit from a more robust multi-coder process and clearer taxa definitions.

7.6 Conclusion

Through the application of a theory-based taxonomy, this work explores one step in Street, Makoul, et al. (2009) pathway that demonstrates the link between communication functions applicable to secure messaging and patients' health outcomes. Our dependent variables are proxies for Street's intermediate outcomes of healthcare access and self-management. A recent study conducted by Alpert et al. (2019) found that patients felt that effective communication delivered via secure messaging prevented unnecessary appointments. Application of our taxonomy to message content and analyzing the associations between the taxa and patient outcomes is the first step to better understanding what types of content might be leveraged to improve that communication and achieve the goals of improving appropriate healthcare utilization.

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7.8 Appendix

Appendix Table 7-1

Associations Between Taxa and Office, Emergency Department, and Inpatient Visits Among Full Population[1]

Generated by	Taxa	IRR[2] [95% Confidence Interval] Among Full Population[1]		
		Outpatient visits	Emergency Department Visits	Inpatient Visits
Patient[3]	Information seeking	1.03 [1.02, 1.05]	0.92 [0.86, 0.99]	--
	Logistics	1.04 [1.02, 1.07]	0.81 [0.71, 0.93]	--
	Medical guidance	1.03 [1.01, 1.05]	--	--
	Information sharing	1.03 [1.02, 1.05]	0.92 [0.86, 0.98]	--
	Clinical update	1.04 [1.01, 1.06]	--	--
	Response to clinician's message	1.05 [1.02, 1.08]	0.87 [0.78, 0.97]	--
	Task-oriented requests not reflective of uncertainty	1.02 [1.01, 1.03]	--	--
	Prescription refills and renewals	1.02 [1.01, 1.04]	--	--
	Other administrative	1.05 [1.02, 1.07]	--	--
	Appointment cancellation	1.05 [1.03, 1.08]	--	--
	Follow-up appointment	--	1.11 [1.03, 1.20]	--
	Appointment for preventive care or physical exam	--	0.79 [0.64, 0.97]	--
	Appointment reschedule	1.02 [1.00, 1.03]	--	--
	Other task-oriented requests	1.02 [1.00, 1.04]	0.86 [0.77, 0.97]	0.76 [0.66, 0.87]
	Referral	1.09 [1.03, 1.15]	--	0.73 [0.55, 0.98]
	New or change prescription	1.04 [1.00, 1.07]	0.75 [0.62, 0.91]	0.74 [0.60, 0.91]
	Appointment for new condition/symptom	--	0.82 [0.68, 0.99]	0.67 [0.49, 0.90]
	Social communication	1.08 [1.03, 1.13]	--	--
	Complaints	1.19 [1.05, 1.34]	--	--
	Life issues	1.06 [1.02, 1.10]	--	--
Clinic Staff[4]	No response to patient-initiated thread[5]	1.03 [1.02, 1.05]	--	--
	Action responses	1.01 [1.00, 1.03]	--	--
	Acknowledgement	1.03 [1.00, 1.06]	0.71 [0.54, 0.94]	--
	Information sharing	1.03 [1.02, 1.04]	0.94 [0.89, 0.99]	--
	Orientation to processes or procedures	1.04 [1.02, 1.05]	0.89 [0.83, 0.96]	--
	Medical guidance	1.03 [1.01, 1.05]	--	--
	Information seeking	1.06 [1.03, 1.09]	0.90 [0.83, 0.99]	--
	Recommendation to schedule appointment	1.07 [1.00, 1.14]	--	--
	Defer/deny request	1.05 [1.03, 1.08]	--	--
	Defers information sharing	1.06 [1.03, 1.08]	--	--

[1]Includes all patients who sent/received message(s) with selected taxon and all patients who did not initiate a message thread in 2017. [2]Represents a visits rate ratio change associated with a 10-percentage point increase of the selected taxon among the total patient- or clinician-generated taxa. Each cell represents a separate regression model where the independent variable is the row header and the dependent variable is the column header. Taxa not included in the table were not statistically significant at $p<0.05$.
[3]Independent variable numerator is the number of times the patient generated messages coded with the selected taxon and the denominator is the total of all taxa coded to messages the patient generated.
[4]Independent variable numerator is the number of times the patient received messages coded with the selected clinician-generated taxon and the denominator is the total of all taxa coded to messages the patient received from clinic staff. [5]Independent Variable is the percentage of threads that did not receive a clinical response.
--=Not statistically significant at $p<0.05$.

8. What's in a Message: Associations Between Secure Message Content and Patient Health Outcomes

Dawn Heisey-Grove, Ph.D. (c), M.P.H.
Ph.D. candidate, Virginia Commonwealth University

Jonathan DeShazo, Ph.D., M.P.H.
Associate Professor and Blick Scholar, Virginia Commonwealth University

Laura McClelland, Ph.D.
Associate Professor, Virginia Commonwealth University

Leonard Friedman, Ph.D. M.P.H., FACHE
Professor, The George Washington University

Kevin Jackson, Ph.D., RRT
Assistant Professor, Norfolk State University

Alexander Tartaglia, D. Min.
Senior Associate Dean and Katherine I. Lantz Professor, Virginia Commonwealth University

8.1 Abstract

Background

The number of electronic messages securely exchanged between clinic staff and patients has risen dramatically over the last decade. A variety of studies explored whether the volume of messages sent by patients was associated with outcomes. None of these studies, however, examined whether message content itself was associated with outcomes. Since a secure message thread is considered most like an in-person clinic encounter, it is critical to evaluate the context of the communication to best understand its impact on patient health outcomes.

Methods

We applied a theory-based taxonomy to 18309 patient- and staff-generated messages derived from message threads initiated by patients between January 1 and December 31, 2017. The study population included 2111 patients with diabetes, hypertension, or both conditions; 1031 of those patients initiated at least one thread. We conducted linear regression analyses to determine whether selected message codes, or code groupings, were associated with our patient health outcomes of interest, which included changes in glycemic levels (A1C) in patients with diabetes and changes in systolic (SBP) and diastolic (DBP) blood pressure in patients with hypertension. Each regression analysis was performed twice: once with the full population of patients and once among only those patients who initiated threads.

Results

We found that patients who initiated threads had larger declines in A1Cs ($p=0.01$) compared to patients who did not initiate threads. Patients who sent information seeking messages experienced decreases in A1C between baseline and endpoint ($\beta=-0.07$; 95% CI: -0.13, -0.00) while patients who sent information sharing messages had increased A1C ($\beta=0.08$; 95% CI: 0.01, 0.15). Clinic non-response was associated with decreased SBP ($\beta=-0.30$; 95% CI: -0.56, -0.04), as were staffs' action responses (acknowledgments and fulfillments) ($\beta=-0.30$; 95% CI: -0.58, -0.02). Increased DBP, SBP, and A1C were

associated with patient- and clinician-generated appreciation and praise messages with effect sizes ranging from 0.4 (A1C) to 5.69 (SBP), while large improvements in SBP were associated with patients' complaints (β=-4.03; 95% CI: -7.94, -0.12). Deferred information sharing by clinic staff was associated with increased SBP (β=1.29; 95% CI: 0.4-2.19).

Conclusion

This is the first research to find associations between a set of theory-based taxa developed for secure message content and patients' health outcomes. Our findings indicate mixed impacts to patients' health based on message content they send and receive. Further research is needed to understand the implications of this work; in the meantime, healthcare providers should be aware that their message content may influence patient health outcomes.

8.2 Introduction

The use of secure messaging—email messages exchanged between patients and clinical staff through a secure platform—has increased significantly over the last two decades as patients' access to the functionality increased (Cronin, Davis, et al., 2015; Heisey-Grove et al., 2015; Henry et al., 2016; Shimada et al., 2013; Tarver et al., 2018). Patients reported that secure messaging offered convenience, with the added benefit of documenting the conversation so that it could be referenced later (Haun et al., 2017; Nazi, 2013; Rief et al., 2017; Wade-Vuturo et al., 2013). Although clinicians cited challenging workflows as the biggest barrier to use (Hoonakker et al., 2017), they noted that secure messaging improved communication between visits and boosted patient engagement, satisfaction, and trust (Nazi, 2013; Wade-Vuturo et al., 2013).

Communication between patients and clinicians should include information exchange, uncertainty management, relationship development and fostering, and activities that enable decision making and health self-management (Street, Makoul, et al., 2009). According to Street, Makoul, et al. (2009), these communication functions lead to proximal and intermediate outcomes that eventually result in improved patient health outcomes. Message threads, inclusive of an initiating message and all subsequent replies, are considered to be most comparable to in-office visits. If threads include the communication functions identified by Street, Makoul, et al. (2009), they should be associated with better health outcomes.

Researchers have explored whether the number of secure messages exchanged between patients and clinicians was associated with outcomes for a variety of conditions; the most commonly studied conditions were hypertension and diabetes. An equal number of studies found secure message use associated with improvements in blood pressure control (Price-Haywood et al., 2018; Ralston et al., 2014; Zhou et al., 2010) and no association between the two (Harris et al., 2009; Price-Haywood et al., 2018; Shimada et al., 2016). In addition, a number of studies identified positive associations between secure message use and controlled glycemic levels (Chung et al., 2017; Harris et al., 2009; Harris et al., 2013; Shimada et al., 2016; Zhou et al., 2010); two studies identified no association (Greenwood et al., 2014;

Harris et al., 2013); and one found inconsistent associations (Price-Haywood et al., 2018). These studies did not explore whether what was said in the messages had an impact on patient outcomes, yet if we want to know whether messages supply the communication functions highlighted by Street, Makoul, et al. (2009), we must move beyond counting messages and begin to classify and quantify the message content itself.

Our research leverages a theory-based taxonomy developed explicitly for secure messaging (Chapter 6). Our taxonomy provides taxa (i.e., codes) for patient- and clinic staff-generated content, and includes categories intended to identify patient uncertainty and self-management; clinic staff information sharing and request fulfillment status; information seeking and response from both patients and staff; and social communication that may be related to fostering relationships and trust. We applied this taxonomy to a large sample of patient- and clinician-generated messages and explored whether certain types of message content were associated with changes in glycemic levels among patients with diabetes and changes in blood pressure among patients with hypertension.

8.3 Methods

Study population. Our study population included adult patients from the Virginia Commonwealth University Health System (VCUHS) who registered with the VCUHS patient portal and had at least two outpatient or one inpatient visit with VCUHS in 2016 with ICD-10-DM diagnosis codes for either diabetes (E11) or hypertension (I10). Patients also had to have at least one VCUHS visit in 2018. We stratified the sample based on health condition (diabetes only, hypertension only, or both conditions) and whether patients initiated a message thread between January 1 and December 31, 2017, and then randomly selected samples from each stratum.

Dependent variables. We created one dependent variable for patients with diabetes and two for patients with hypertension. For patients with diabetes, we measured the change between the endpoint and baseline measures of glycemic control (A1C). For patients with hypertension, we included dependent variables that measured changes between endpoint and baseline measures for systolic blood pressure

(SBP) and diastolic blood pressure (DBP). We used the most recently measured value in 2016 as the baseline measure and the earliest measured value obtained between January and June 2018 as the endpoint measure. If multiple blood pressures were taken on the same day, we averaged available values. Patients without baseline or endpoint values were excluded from regression analyses.

Independent variables. The taxonomy applied to messages is explained in more detail elsewhere (Chapter 6), but briefly: we created taxa, or codes, to distinguish between different types of patient-generated and clinic staff-generated content. The patient-generated taxa identify content relevant to information seeking (medical guidance or logistical), information sharing (self-reported biometrics, clinical updates, or responses to clinicians' messages), task-oriented requests (scheduling, other administrative, or prescription), and social communication (appreciation or praise, complaints, or life issues). Taxa associated with clinic staff-generated content include information sharing (medical guidance or orientation to procedures or treatments), information seeking, recommendations to schedule appointments, action responses to patients' task-oriented requests (acknowledgement, partial and complete fulfillment), request denials, information sharing deferrals (e.g., cannot provide a response until test results are in), and social communication.

We assigned taxa to all messages—those generated by patients and clinic staff—that were saved to the patient's chart and part of patient-initiated threads created and completed between January 1 and December 31, 2017. We included only patient-initiated threads because we felt these were the best markers of patient uncertainty and self-management. The message coding process is described elsewhere (Chapter 6). In brief, a given message was assigned as many taxa as there were concepts in the message; however, we limited the number of times a given taxon (i.e., a single code) could be counted for each message to one per message.

In addition to the individual taxa, we generated taxa groupings: patient information seeking; patient information sharing; patient social communication; patient task-oriented requests reflective of self-management; other patient task-oriented requests; staff information sharing; and staff action responses. We also created an independent variable that measured clinic non-response, defined as a thread that included no messages sent from clinic staff.

We based our independent variables on counts of taxa either sent or received by patients between January 1 and December 31, 2017. We demonstrated in prior research (Chapter 6) a strong correlation between the likelihood of sending or receiving a taxon based on patients' thread volume, so our independent variables measure taxa as a function of volume: each taxon is represented as a proportion of the total patient-generated or clinic staff-generated taxa they sent or received. Non-response is measured as a proportion of the total threads initiated by the patient.

Covariates. We included several patient characteristics as covariates. These included patient age as of January 1, 2017; patient sex; race (black, white, and other); payer type (public, private, uninsured, or other); rural home location as a bivariate derived from Rural-Urban Commuting Area codes (United States Department of Agriculture Economic Research Service, 2019); health condition (diabetes only, hypertension only, or both conditions); the number of outpatient and inpatient visits during 2017; and the number of threads initiated during 2017. We also included baseline A1C and blood pressure values in models measuring change in glycemic control and blood pressure, respectively. For models that included only patients who initiated message threads ("secure message-only population"), we included the distance from patients' homes to the clinics to which they sent messages. We estimated distance based on the difference between the zip code centroids of patients' homes and clinics. When patients sent messages to more than one clinic, we averaged across the distances. We considered patients' home locations missing when zip codes were located outside Virginia.

Analysis. We executed two regression analyses for each combination of taxon and dependent variable: one model used the full population and the second used the secure message-only population. The comparison in the full population models included all patients who did not initiate a message thread and those patients who sent or received messages with the selected taxon. Models that included the secure message-only population compared patients who sent or received messages coded with the selected taxon to those who sent or received other types of messages. All analyses were conducted using SAS v9.4. This research was approved by the VCU Institutional Review Board under an expedited category 5 review.

8.4 Results

Our study sample consisted of 2111 patients, of whom 49 percent initiated at least one message thread. We included patients with diabetes only (n=811), hypertension only (n=787), and both conditions (n=513). We coded 7346 message threads initiated by these patients, which included 10163 patient-generated messages and 8146 messages generated by clinic staff. Each patient initiated, on average, seven threads (median=4).

Table 8-1 presents a comparison of the baseline, endpoint, and difference values for A1C and blood pressures between patients who initiated threads and those who did not. The two populations had similar baseline A1C and DBP values. The patients who initiated threads had a lower average baseline SBP compared to patients who did not initiate threads ($p<0.01$). Patients with diabetes who initiated threads had a larger average difference between endpoint and baseline A1C (-0.56) compared to those who did not initiate a thread (-0.21). The mean differences in SBP and DBP were not statistically significant between the two populations. A significant number of patients with diabetes were missing baseline or endpoint measures.

Change in A1C among patients with diabetes. Among patients who initiated threads, we observed a statistically significant decrease ($p<0.001$) in A1C values between 2016 and 2018. The same was not true among patients who did not initiate threads ($p=0.20$). Table 8-2 displays associations between taxa and A1C changes for the taxa groupings. Taxa not represented in the table were not associated with A1C changes at $p<0.05$. As the proportion of information seeking increased, patients experienced greater declines in their A1C values—this was true when comparing patients who sought information to patients who did not initiate threads, as well as to those who sent other types of messages.

Table 8-1.

Mean Baseline and Endpoint Values

Baseline and endpoint values		Patients who initiated threads		Patients who did not initiate threads		P-value difference in means
		Number (%) of Patients with Missing Data	Mean [95% CI]	Number (%) of Patients with Missing Data	Mean (95% CI)	
A1C (%)	Baseline	174 (27.32)	7.56 [7.40, 7.74]	266 (38.72)	7.56 [7.38, 7.74]	0.92
	Endpoint	297 (46.62)	7.09 [6.92, 7.26]	394 (57.35)	7.37 [7.14, 7.59]	0.05
	Difference	348 (54.63)	-0.56 [-0.75, -0.36]	446 (64.92)	-0.21 [-0.39, -0.02]	0.01
SBP (mm Hg)	Baseline	1 (0.16)	132.90 [131.50, 134.30]	6 (0.90)	135.80 [134.30, 137.20]	<0.01
	Endpoint	12 (1.90)	136.20 [134.60, 137.90]	33 (4.94)	138.40 [136.80, 139.90]	0.06
	Difference	13 (2.05)	3.41 [1.67, 5.15]	38 (5.70)	2.45 [0.76, 4.13]	0.43
DBP (mm Hg)	Baseline	1 (0.16)	78.16 [77.32, 79.01]	6 (0.90)	78.94 [78.07, 79.81]	0.21
	Endpoint	12 (1.90)	79.80 [78.96, 80.64]	33 (4.94)	80.79 [79.95, 81.62]	0.10
	Difference	13 (2.05)	1.71 [0.78, 2.64]	38 (5.70)	1.67 [0.79, 2.55]	0.95

Notes: A1C=glycemic value; DBP=diastolic blood pressure; Hg=mercury; SBP=systolic blood pressure.

Table 8-2.

Changes in Glycemic Levels Associated with Message Taxa

Taxon	Beta estimate [95% Confidence Interval]	
	Comparison of Populations 1 and 2	Comparison of Populations 2 and 3
Patient-generated (messages sent by patients to clinic staff)		
Information seeking	-0.08 [-0.14, -0.02]	-0.07 [-0.13, -0.00]
Logistics	-0.11 [-0.21, -0.01]	--
Information sharing	--	0.08 [0.01, 0.15]
Staff-generated (messages received by patients from clinic staff)		
Information sharing: Orientation to procedures or treatments	-0.07 [-0.13, -0.01]	--
Social communication: Appreciation or praise	0.40 [0.09, 0.70]	0.50 [0.10, 0.89]

Notes: Population 1=Patients who did not initiate message threads. Population 2=Patients who sent messages with the selected taxon. Population 3=Patients who initiated message threads but did not send messages with the selected taxon. -- Parameter estimate not significant in model at p<0.05. Our results are structured to detect an association between a one percentage point change in A1C associated with a 10-percentage point change in taxon prevalence.

We identified a similar association with the sub-taxon, Information seeking: Logistics, when comparing to those who did not initiate threads. Conversely, patients who shared information with their clinic staff experienced A1C increases, compared to those who sent other types of messages to clinic staff.

Two clinician-generated sub-taxa were associated with A1C changes among patients: patients who received orientation to procedures and treatments had declines in A1C compared to patients who did not initiate threads; and patients who received appreciation or praise from clinic staff experienced increased A1C values between 2016 and 2018.

Change in SBP among patients with hypertension. Overall, we observed an average increase in SBP between 2016 and 2018 among patients who initiated threads ($p<0.01$) and patients who did not initiate threads ($p=0.02$). Table 8.3 presents the five taxa associated with SBP changes among these populations. Two patient-generated taxa (biometrics self-reporting and appreciation or praise), and two clinician-generated taxa (the grouped taxon for request denials and information deferrals, and the sub-taxon for deferred information sharing) were associated with increased SBP. This was true in both population comparisons. In contrast, we observed decreased SBP among patients who sent complaints, compared to patients who did not initiate threads.

Change in DBP among patients with hypertension. Among both populations (patients who initiated threads and those who did not), we found statistically significant increases in DBP between 2016 and 2018 ($p<0.01$ for both). Table 8-4 presents the associations between taxa and changes in DBP that were statistically significant at $p<0.05$. Three patient-generated taxa were associated with increased DBP (requests to reschedule appointments or to schedule appointments for new symptoms or conditions; and appreciation or praise). Similar effect sizes were observed across the two models for each taxon.

We also observed that as non-response prevalence increased, patients experienced greater declines in DBP. Similarly, patients who received proportionally more action response-related content (including acknowledgements, request fulfillment, and partial request fulfillment) had greater DBP

Table 8-3.

Changes in Systolic Blood Pressure Associated with Message Taxa

Taxon	Beta estimate [95% Confidence Interval]	
	Comparison of Populations 1 and 2	Comparison of Populations 2 and 3
Patient-generated (messages sent by patients to clinic staff)		
Information sharing: Self-reporting of biometrics	1.61 [0.07, 3.15]	1.73 [0.19, 3.28]
Social communication: Appreciation or praise	4.57 [0.73, 8.42]	5.69 [0.67, 10.72]
Social communication: Complaints	-4.03 [-7.94, -0.12]	--
Staff-generated (messages received by patients from clinic staff)		
Deny or defer grouped taxon	0.84 [0.03, 1.64]	1.21 [0.34, 2.09]
Deferred information sharing	0.92 [0.09, 1.75]	1.29 [0.40, 2.19]

Notes: Population 1=Patients who did not initiate message threads. Population 2=Patients who sent messages with the selected taxon. Population 3=Patients who initiated message threads but did not send messages with the selected taxon. -- Parameter estimate not significant in model at $p<0.05$. Our results are structured to detect an association between a one-unit change in SBP associated with a 10-percentage point change in taxon prevalence.

Table 8-4.

Changes in Diastolic Blood Pressure Associated with Message Taxa

Taxon	Beta estimate (95% Confidence Interval)	
	Comparison of Populations 1 and 2	Comparison of Populations 2 and 3
Patient-generated (messages sent by patients to clinic staff)		
Appointment reschedule request	0.33 (0.02, 0.63)	0.44 (0.10, 0.78)
Appointment request for new symptom or condition	0.62 (0.01, 1.23)	0.68 (0.03, 1.33)
Social communication: Appreciation or praise	2.53 (0.62, 4.44)	3.12 (0.62, 5.62)
Staff-generated (messages received by patients from clinic staff)		
No response to patient-initiated thread	--	-0.30 (-0.56, -0.04)
Action response grouped taxon	-0.22 (-0.44, -0.01)	-0.30 (-0.58, -0.02)
Information sharing: Orientation to procedures or treatments	--	0.45 (0.08, 0.83)

Notes: Population 1=Patients who did not initiate message threads. Population 2=Patients who sent messages with the selected taxon. Population 3=Patients who initiated message threads but did not send messages with the selected taxon. The Action responses taxon groups the Acknowledge, Fulfills request, and Partially fulfills request taxa.
-- Parameter estimate not significant in model at $p<0.05$. Our results are structured to detect an association between a one-unit change in DBP associated with a 10-percentage point change in taxon prevalence.

decreases. Patients who received orientation to procedures or treatments had correspondingly increased DBP, compared to patients who did not receive those kinds of messages from clinic staff.

8.5 Discussion

We present here the first findings exploring associations between message content and patient health outcomes. Our research found associations between selected message content and changes in patients' glycemic levels and blood pressures. Consistent with our hypotheses, patients who sent information seeking messages, or who received orientation-related information sharing messages from clinic staff, experienced greater decreases in A1C. Consistent with other research, we found an overall association between secure messaging use and improved A1C. Also as expected, we observed DBP decreases among patients who received confirmation of action, and SBP increases in response to request denials or deferrals.

Counter to our hypotheses, however, we found that A1C increased among patients who shared information with clinic staff and among patients who received praise from clinic staff; the latter was also true for SBP. We also observed DBP increases associated with certain types of scheduling requests and information sharing by clinic staff. Finally, we observed an inverse association between DBP and clinic non-response: patients' DBP decreased as non-response prevalence increased.

We know from our research that patients with a non-response typically have more than one thread lacking a clinic response (Chapters 6 and 7). To our knowledge, only one other study quantified clinic non-response to patients' messages; our study is the first to quantify non-response with a large number of messages and to link non-response to patient outcomes. The Lanham et al. (2018) study conducted chart reviews to determine if response occurred through other modalities and found that half of their 11 unanswered messages were resolved through other mechanisms. Extrapolating the Lanham et al. (2018) findings to our work implies that at least half of the threads lacking a message response might have received a response not accounted for in our research (e.g., phone, discussion during appointment). To better understand our study findings, it will be important to account for these other response types in future studies. It may be that for certain types of message requests, responses via the same modality are not an ideal forum and alternative communication modalities yield better responses. It is also possible that certain types of patient-initiated threads do not require a clinic response: for example, when a prescription refill request is completed, patients may receive a notification from their pharmacy that the prescription is ready, negating the need for the clinic to notify the patient.

It is also possible that thread initiation may be an indication of patient activation and engagement and clinic non-response may not inhibit patients' activation. Patient activation follows four stages: belief in the importance of engagement in the care processes, knowledge in what is needed to improve health, taking action to improve or maintain health, and finally, maintaining or persisting in those actions even when stressed (Hibbard et al., 2004). Patients at higher stages of activation generally experience better outcomes, have lower health care costs, and higher rates of health screening and prevention activities (Greene & Hibbard, 2012; Greene, Hibbard, Sacks, Overton, & Parrotta, 2015; Rask et al., 2009; Skolasky et al., 2011). Alexander et al. (2012) found that patients who communicated outside of office visits had higher patient activation rates. Consistent with their research, we found that patients who initiated threads experienced A1C improvements compared to patients who did not initiate threads.

In previous research (Chapter 6), we observed few differences in patients' use of taxa by health condition. Our current research, however, identified different effects on health outcomes associated with staff sharing orientation-related messages: patients with diabetes who received these messages had lower A1Cs in 2018 but patients with hypertension experienced increased DBP. It will be important to apply this taxonomy to other conditions to determine if other differences between outcomes and communication content exist by condition, to better improve communication between patients and clinic staff in ways that advance patients' health.

It is also important to remember that these codes were taken in isolation; that is, a taxon is one component of the overall electronic conversation represented in each thread. From this research, we do not know what patient-generated messages preceded the staff response, so we cannot determine if the orientation-related content answered patients' questions or was even an appropriate response. Analyses that explore the call-and-response nature of the message thread—that consider the initiating request, final response, and the pathway to get to that final response—should yield more insight into these results. For example, patients who requested an appointment but received an orientation response may have poorer outcomes than patients whose request was partially or completely fulfilled. It may also be that the number of clinic staff involved in responding to a thread, or the time taken to respond, has an impact on patient outcomes by increasing uncertainty or reducing patients' trust (Mishel, 1988). Examining these factors might help explain why some of our findings do not align with our study hypotheses.

An important consideration for this research is that it demonstrates correlations and not causation. We hypothesized that biometrics self-reporting and appreciation and praise would be associated with improved outcomes but we found the opposite: poorer DBP and A1C values in 2018 were associated with the Appreciation and praise taxon and patients who self-reported biometrics experienced increased SBP between the two years. Our outcomes were based on measurements obtained before and after the message collection period. If instead we obtained measurements in parallel to the secure messaging period, it is possible that we might have different results. For example, effects observed in 2018 may have less relevance to messages sent earlier in the calendar year (e.g., patients only sent messages in the first quarter or half of the year). Another avenue of future study would include adding in more frequent measurements and exploring ways to identify any long-term impacts associated with certain taxa.

Our regression analyses based on patients with diabetes included fewer than half the original population because of missing baseline or endpoint measures. It is not known how these missing data would impact the final outcomes or the associations; with so many missing data it is difficult to make any conclusions. It will therefore be important to repeat these analyses with a larger sample of patients with diabetes and perhaps different outcome measures that do not have such high rates of missing-ness. The Street, Makoul, et al. (2009) framework highlights intermediate outcomes on the pathway between communication functions and health outcomes: a proxy for the access to care construct, for example, might be overall healthcare utilization (Chapter 7) or whether the patients follow routine guidelines for care (diabetic eye and foot exams, or routine follow-up or preventive care appointments). Other constructs that could be measured with existing secondary data include self-care which might include the appropriate medication refill rates (Chapter 7). These proximal outcomes also align to ones known to be associated with patient activation (Greene & Hibbard, 2012; Rask et al., 2009), further reinforcing the benefit to conducting these analyses.

Our dependent variables for patients with hypertension did not have such high rates of missing data. In the analyses that used only patients who initiated message threads, we found that as the prevalence of appointment reschedule requests increased, so did patients' DBP. We interpreted a reschedule request as a manifestation of self-care, following Mishel's Uncertainty in Illness theory (Mishel, 1988, 1999), because the patient is taking charge of their healthcare visits by rescheduling to a time more convenient to them, thereby leading to less stress. Our findings indicate this is not the case. Instead, the poorer outcomes associated with reschedule requests may be a manifestation of stress in patients' lives that required rescheduling medical appointments. If these patients were not managing their stress and not maintaining their levels of self-care, their health outcomes might suffer as their patient activation threshold declined (Greene et al., 2015; Hibbard & Greene, 2013; Hibbard et al., 2004). Consistent with this, we observed similar poor outcomes—with slightly larger effect sizes—associated with appointment requests for new conditions or symptoms.

Consistent with our hypotheses, deferrals and denials were associated with increased SBP among patients with hypertension. The Deny taxon, as well as the patient-generated logistical information seeking taxon, had poor inter-rater reliability (Chapter 6), although they had fair and good intra-rater reliability, respectively. Given that, these results should be viewed with caution. Future studies that apply this taxonomy should work to improve the specificity of our taxa definitions.

Finally, we must note one additional limitation. We used only messages saved to patients' charts. If clinic staff did not opt to save a message to the chart, it would not be captured in this study. We expect, therefore, that the numbers presented in this paper underestimate the number of messages sent and received by patients. We also expect that the number of non-responses was underrepresented since it seems likely that if clinic staff did not respond to a message, they would be less likely to save the message as well. It is also possible that messages we classified as non-response had a response that was not saved to patients' charts. If we assume that our sample underestimated the number of messages sent and received by patients, we would expect a bias towards the null and our results should therefore be viewed as conservative estimates of effect.

8.6 Conclusion

This is the first study to explore associations between message content and patient health outcomes. We identified associations between certain patient- and clinic staff-generated taxa and changes in patients' glycemic levels and blood pressure. We also found that staff non-response was associated with improvements in patients' DBP, although the reasoning behind this association is unclear. There is significantly more research needed to better understand what we observed in our study. In the meantime, healthcare staff should be aware that message content is associated with patients' health outcomes when corresponding with patients through this medium.

8.7 References

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9. Conclusion

In Chapters 6, 7, and 8, we presented peer-review-ready manuscripts that offered the first explorations of the associations between secure message content and patient and clinician characteristics, patients' healthcare utilization, and patient health outcomes. This research is relevant and timely because although secure messaging is an increasingly common form of communication between patients and clinicians, no research has been conducted that evaluates the links between what is being said in that communication with improvements in patient health outcomes, as other patient-centered communication has been shown to do. Our research is the first to explore these associations, and our findings emphasize the importance of this communication modality to patients' health. In this concluding chapter, we tie the three papers together and describe avenues for future research.

9.1 Connecting the dots (or papers)

For this research, we applied a theory-based taxonomy to a large sample of patient- and clinician-generated messages. We based our analyses on two health conditions, diabetes and hypertension, to demonstrate that the taxonomy was applicable across different conditions and highlight, based on health condition, how patients and clinicians used the taxonomy while exploring the associations between taxa and health outcomes. In our first paper, we presented the first known application of this taxonomy to a large sample of patient-initiated threads. We presented statistics on interrater and intrarater reliability that indicated a need for taxa definition refinement; however, most taxa had kappa estimates that ranked fair or above based on Cicchetti (1994). We also highlighted associations between patients' characteristics and the taxa they exchanged with clinic staff.

Epstein and Street (2007) highlighted intrinsic and extrinsic factors that moderate relationships between communication and health outcomes. In Paper 1, we explored the association between intrinsic stable characteristics (patients' age, sex, race) associated with patients' use of taxa, as well as how those characteristics were associated with the types of messages received by patients from clinic staff. This is important because the latter may be associated with a mutable intrinsic factor—clinician attitudes—which might be modified through education or training.

Our findings in Paper 1 (Chapter 6) are therefore relevant because patients' use, or lack thereof, of taxa associated with improved outcomes may create—or further exacerbate—disparities in care and health outcomes. Further, differences in how clinic staff apply taxa may result in differential treatment through secure messaging that further expands existing care disparities or exacerbates disparities influenced by patients' intrinsic stable characteristics. Papers 2 and 3 (Chapters 7 and 8, respectively) identified areas where improved intermediate and health outcomes were associated with taxa for which patients' age, sex, or race was associated with what they sent. We also identified intermediate and health outcomes associated with clinician-generated taxa sent differentially to patients based on patients' age, sex, health condition, and payer type. These findings highlight areas where differential communication between patient and clinic staff could be mitigated through staff awareness and training, similar to existing trainings about the appropriate delivery of face-to-face communication.

Our results that examined clinic staff characteristics associated with the messages they exchanged with patients appeared to be consistent with messaging triage systems employed at VCUHS and many other healthcare organizations. We observed, however, that a significant portion of our patient population initiated at least one thread to which no clinic staff responded, with slightly more than one-quarter of all threads lacking a response. This may be an artifact of the triaging system, where, for example, messages might be lost due to complex workflows or responses occurred through other modalities (e.g., in-person or phone). In Paper 1's adjusted analyses, we demonstrated that the only characteristic associated with non-response was the number of threads initiated by the patient. In Papers 2 and 3, counter to our hypotheses, we found non-response prevalence was positively associated with medication adherence and negatively associated with changed DBP.

9.2 Limitations

Our research was not without its limitations, which were presented in more detail across the three papers. We had poor interrater reliability for some taxa, although the intrarater reliability was primarily good and excellent (Cicchetti, 1994). This indicates the need to improve taxa definition specificity. We also had a significant number of patients with diabetes missing A1C baseline or endpoint measurements, which limited our ability to generalize the findings. We did not include important factors that likely contributed to intermediate and health outcomes and taxa use, such as temporal indicators (e.g., how long it took to respond, or when messages were exchanged in relation to the measured outcomes), and patients' education and health literacy levels. It is likely that our message sample underrepresented the true burden of threads initiated and messages exchanged because we relied only on messages saved to patients' charts. Finally, and perhaps most significantly, our research did not examine taxa pairings associated with characteristics and outcomes. These analyses would allow us to better understand the relevance of clinic responses to patient messages, and vice versa. This context will be important to develop appropriate education and training materials for staff and to understand how to appropriately target and improve patients' use of secure messaging in ways that improve their outcomes.

9.3 Next steps

Across the three papers we highlighted a number of avenues for future research. First is the need to explore the pairings of message taxa to better understand which types of patient-generated content elicit which types of responses, and to put clinician- and patient-generated responses into context. Also important is the need to enhance the taxonomy's reliability by improving the specificity of taxa definitions and conducting the content analysis through a more rigorous process. That process might include coders who are independent of the taxonomy creators and who undergo robust training, and the incorporation of an objective third party to adjudicate coding discrepancies (Krippendorff, 2019). There is also a need to validate the taxonomy with patients and clinic staff to determine if they feel the taxa represent the types of content they exchange (i.e., face validity). This could be conducted through a Delphi panel for clinic staff and perhaps focus groups with patients or patient advocates.

Future analyses should also explore different proximal and intermediate outcomes measures, selected either based on the Street, Makoul, et al. (2009) framework or by incorporating measures for patient activation to assess the relationship between taxa and activation, which we hypothesized in Papers 2 and 3 to be associated with secure messaging and possibly taxa use. In addition, other intrinsic stable or mutable characteristics should be included, such as patients' income, education level, ethnicity, and health literacy level (Street, Makoul, et al., 2009); prior research demonstrated associations between many of these factors and use of secure messaging. Research has also shown the importance of clinician race and age on communication (Del Piccolo et al., 2015; Street & Haidet, 2011; Street et al., 2008). Inclusion of a more robust marker for overall illness severity is also warranted, as Mishel (1988) highlighted that this could impact patients' cognitive abilities.

Other components of the messages themselves deserve more attention within the context of content. Assessing the reading level of messages similar to Mirsky et al. (2016b), may help elucidate why some clinic responses are less effective than others or why some patient-generated messages lack a message response. Similarly, there is a need to explore associations between taxa use and message timings, as well as other factors that might influence patients' responses to messages and the level of trust they have with clinic staff, such as who is responding and the number of messages or staff it took to achieve a final response.

The research presented in our three papers is the first of its kind and as such, generates many new hypotheses and highlights how much work still needs to be done in this area. It is our hope that this research can be employed to improve messaging communication between patients and clinic staff with a goal of reducing communication disparities that may lead to disparate outcomes.

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