

Medical University of South Carolina

MEDICA

MUSC Theses and Dissertations

2016

Patient Engagement: The Impact of Electronic Patient Portal Use on Missed Appointments in Patients with Diabetes, a Retrospective Study

Keli P. Walden

Medical University of South Carolina

Follow this and additional works at: <https://medica-musc.researchcommons.org/theses>

Recommended Citation

Walden, Keli P., "Patient Engagement: The Impact of Electronic Patient Portal Use on Missed Appointments in Patients with Diabetes, a Retrospective Study" (2016). *MUSC Theses and Dissertations*. 421.

<https://medica-musc.researchcommons.org/theses/421>

This Dissertation is brought to you for free and open access by MEDICA. It has been accepted for inclusion in MUSC Theses and Dissertations by an authorized administrator of MEDICA. For more information, please contact medica@musc.edu.

Patient Engagement: The Impact of Electronic Patient Portal Use on Missed Appointments in
Patients with Diabetes, a Retrospective Study.

BY

Keli P. Walden

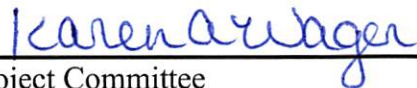



A doctoral project submitted to the faculty of the Medical University of South Carolina in partial fulfillment of the requirements for the degree of Doctor of Health Administration in the College of Health Professions.

PATIENT ENGAGEMENT:
THE IMPACT OF ELECTRONIC PATIENT PORTAL USE ON MISSED
APPOINTMENTS IN PATIENTS WITH DIABETES,
A RETROSPECTIVE STUDY.

BY

Keli P. Walden

Approved by:

		4/22/16
Chair, Project Committee	Karen Wager, DBA	Date
		4/27/16
Member, Project Committee	Robert Warren, MD, PhD	Date
		4/20/16
Member, Project Committee	Martha Sylvia, PhD	Date
		4/25/16
Dean, College of Health Professions	Lisa Saladin, PT, PhD	Date

Acknowledgements

I cannot believe I am finished! Upon completing my MBA in 2003, I longed to complete a doctorate. Thirteen years later, I am done! During the three years that I have been in the program, I have moved, endured a divorce, buried two parents, started a business, and cared for my 6 year-old son Alex through his open-heart surgery. Suffice it to say, my doctoral degree and dissertation have served as a time of tremendous learning and reflection for me both professionally and personally. As a mother to a precious boy, I knew that it took a village to raise a child. Now that my degree is complete, I know that it takes a village to complete a doctoral program as well. I would like to express the deepest appreciation to the many professors, friends, and family who made this dream possible. Without your support, I could not have completed this journey.

I would first like to thank my dissertation committee, Karen Wager, Martha Sylvia, and Robert Warren. I could not imagine having a better group of folks in my corner. I am forever indebted to you all. Jim Zoller, Sarah Logan, and Gibbs Knotts, you have all taught me more about statistics than I ever wanted to know. I thank each of you for that. Melissa Habrat and Buck Rogers, my data gurus, it would not have been possible to conduct this research without you two. Michael Madson and Erica Jones, you are both editing geniuses and I am so appreciative for your help. Teri Lynn Herbert, your guidance on how to navigate research databases made the literature review bearable (but just barely). Ha! Ashley Tennessee, my cohort colleague and friend till the end, I could not have done this without you cheering me on and assuring me that we would survive. We did it!! Each of you has been instrumental to the completion of this project and I am beyond blessed and grateful to have had the opportunity to meet and work with you all. Thank you!

Last but certainly not least, my amazing family: my parents, brothers and sisters, aunts and uncles for supporting me through this dissertation and throughout my life. To Craig, words can't describe how thankful I am to have you. You helped me with Alex, ran my errands proofread my paper, cooked and cleaned for me, and the list goes on. You supported me and were always willing to help and I will never forget that.

Finally, to Alex, I hope you can look back on this one day and find inspiration to accomplish your own educational goals. I understood the meaning of true, unconditional love the day I welcomed you into my world. Thank you for motivating me to be better and do better. I love you far more than you will ever know!

Thank you all, so very much!

Abstract

Abstract of Doctoral Project Presented to the
Executive Doctoral Program in Health Administration & Leadership
Medical University of South Carolina
In Partial Fulfillment of the Requirements for the
Degree of Doctor of Health Administration

PATIENT ENGAGEMENT: THE IMPACT OF ELECTRONIC PATIENT PORTAL USE ON
MISSED APPOINTMENTS IN PATIENTS WITH DIABETES, A RETROSPECTIVE STUDY

By

Keli Patterson Walden

Chairperson: Karen Wager, DBA

Committee: Martha Sylvia, PhD, MBA, RN; Robert Warren, MD, PhD, MPH

Background: This retrospective observational chart review evaluated the use of the MyChart[®] patient portal as a viable tool for engaging patients. Engagement was measured as fewer missed appointments (no-shows and same-day cancellations).

Objectives: To determine who uses the MyChart[®] patient portal in a chronically ill population of adult patients with diabetes and assess the association of portal use with missed appointments.

Methods: The medical records of adult patients (18-80) with a diagnosis of Type 1 and/or Type 2 Diabetes Mellitus (DM) were reviewed ($N=7,795$). The efficacy of the MyChart[®] patient portal

at reducing missed appointments was assessed by comparing patients who use the portal (evidenced by two or more log-ins during the study period) to those who do not.

Results: In this study, 43.7% of adult patients with diabetes used a portal account. Portal users were predominantly female, non-Black, married, non-smokers, and had at least one of the comorbidities often associated with diabetes (hypertension, hyperlipidemia, and/or obesity). Portal users were on average 58.8 years old. Use of the MyChart[®] patient portal was independently associated with a reduced no-show rate (4.7% for portal users compared to 12.4% for nonusers). However, when patients who activated a portal account during the study period were subjected to a within-subjects analysis, the mean missed appointment percentage was not statistically significantly different when patients had an activated portal account compared to when they did not. Thus, the portal may be a useful tool for engaging chronically ill patients but it is only one component to appointment arrivals.

Conclusion: Conclusions from this study are limited given the retrospective design.

Nonetheless, the findings suggest that the patient portal is effective at engaging chronically ill patients and thus warrants greater merit. The portal may also be a useful tool for reducing missed appointments in patients with chronic illness who would greatly benefit from appointment adherence. Future research should focus on testing the hypotheses generated in a prospective manner.

Table of Contents

Acknowledgements.....	2
Abstract.....	4
LIST OF TABLES.....	8
CHAPTER I.....	9
INTRODUCTION.....	9
Background and Need.....	9
Problem Statement.....	19
Study Objectives.....	21
Research Questions.....	21
Research Hypotheses.....	21
Population.....	22
CHAPTER II.....	23
LITERATURE REVIEW.....	23
Theoretical Framework.....	24
Review of the Literature.....	27
CHAPTER III.....	45
METHODOLOGY.....	45
Study Design.....	45
Setting.....	45

Study Population.....	46
Intervention (MyChart® Patient Portal).....	48
Outcomes	49
Data Set Description	49
Definition of Variables	49
Data Analysis Plan.....	50
Protection of Human Subjects	54
Limitations	55
CHAPTER IV	57
RESULTS	57
Who uses MyChart®?	57
The Impact of MyChart® on Missed Appointments.....	59
CHAPTER V	61
DISCUSSION.....	61
Discussion of Results.....	61
Conclusion	66
Summary.....	66
TABLES	68
REFERENCES	72

LIST OF TABLES

Table 1: Characteristics of MyChart[®] Users compared to Nonusers.

Table 2: Logistic Regression Analysis predicting MyChart[®] use for patients with diabetes

Table 3: Linear Regression Model predicting No-Show percentages

Table 4: Within-subjects comparison: Paired samples t-test comparing mean missed appointment percentage between those with and without an activated MyChart[®] account

CHAPTER I

INTRODUCTION

Background and Need

Since the turn of the 20th century, the field of medicine has been based upon a paternalistic model, where it is assumed that the doctor knows best. In the paternalistic model, the physician plays a parental role, and serves as the driver of the patient's health. A patient comes to the doctor with health concerns; the doctor uses his or her skills to determine the patient's medical condition and/or stage in the disease process, and then decides the treatment plan that is in the patient's best interest with limited patient participation (Emanuel & Emanuel, 1992). This model is in stark contrast to what is now recognized as a superior delivery model that partners patients with their care team: shared-decision making. Shared-decision making is founded upon the concept of patient-centered healthcare, which enables and encourages patients to take an active role in the management of their own health (AHRQ, n.d.).

Patient-centered healthcare has been a source of intense discussion since the Institute of Medicine (IOM) identified the concept as one of six aims necessary for a new 21st century health system (IOM, 2000). In *Crossing the Quality Chasm*, the IOM (2000) defines patient-centered healthcare as “care that is respectful of and responsive to individual patient preferences, needs, and values, and ensuring that patient values guide all clinical decisions” (para.8). Put simply, patient-centered care is grounded in a deep respect for patients as unique living beings and the obligation to care for them on their terms (Epstein & Street, 2011).

With patient-centered care prominently situated on the political agenda, the Patient Protection and Affordable Care Act (ACA) was enacted in March 2010, bringing renewed emphasis to the concept. The passing of the ACA, with its many payment and delivery system

reform provisions, has brought about a host of changes to the way care is paid for and delivered. Today's complex and ever-changing healthcare arena demands that organizations simultaneously strive to reduce costs, improve quality of care, enhance patient satisfaction, and advance the health of populations. Sadly, in many healthcare settings, the strategies designed to achieve these goals situate the patient as more of a recipient of healthcare services than an active partner with their healthcare providers and care team (Daniel, Deering & Murray, 2014). Organizations operating with this mindset would likely contend that a better managed healthcare organization leads to better outcomes. Consequently, these organizations often focus on more efficient processes and services. Nevertheless, patient-centered care is critical to improving health because a patient's actions have a significant impact on health outcomes (Daniel et al., 2014). Accordingly, health systems that focus more on efficient processes and services, rather than on the patient, are unlikely to maximize health outcomes.

The statistics associated with chronic illness provide tremendous incentive to shift the focus to patients and emphasize chronic management and preventative medicine. The Centers for Disease Control and Prevention (CDC) (2015) reports that chronic illness is the most common, costly and—perhaps most importantly— preventable of all health problems. In addition, as of 2012, about half of all adults in the United States (117 million people) reported having at least one chronic illness while one in four reported having two or more (Ward, Schiller, & Goodman, 2014). With chronic disease cited by the CDC (2015) as the cause of 7 out of 10 deaths each year, one could argue that the nation's challenges are a result of a “health” rather than a “healthcare” crisis.¹

A common thread in healthcare reform in the United States is the emphasis on effectively

¹ Health is defined as “a state of complete physical, mental, and social well-being and not merely the absence of disease or

managing the care of patients with chronic conditions (Rai, Prichard, Hodach, & Courtemanch, 2011). However, an effective healthcare organization should not focus solely on chronic disease management, but on prevention and reduction as well. Recognizing that medical care is one of many determinants of health, healthcare organizations should strive to improve patient experiences across the spectrum. Under this model, the greatest gains in delivery can be achieved by addressing poor health as the underlying problem.

Many of the important developments in policy and practice stemming from the ACA (e.g., accountable care organizations, patient-centered medical home) emphasize the patient as the key to accomplishing reform objectives and thus provide a framework for shifting to patient-centered care (Daniel et al., 2014, para.1). These developments recognize that patients are not the object of care, but rather full-fledged participants in it; and unless participation is active and informed, the impact of healthcare is severely muted (Gruman, Jeffress, Edgman-Levitan, Simmons, & Kormos, 2011). Therefore, building and sustaining an affordable, high quality, patient-centered healthcare system requires a deep commitment to patient engagement as the primary factor contributing to an optimal state of health for patients.

Patient Engagement

Patient engagement, the topic of this study, is a strategic focal point for healthcare providers, administrators, policymakers, and payers. Predictably, in May 2015, 72% of healthcare leaders, surveyed at the Health Information and Management Systems Society (HIMSS) leadership conference, viewed patient engagement as one of the most important issues impacting their organizations (Noteboom, 2015). In July 2015, the American Hospital Association (AHA) reported that patient engagement was also a top priority for the nation's hospitals based on the 2015 Most Wired survey (AHA, 2015). The literature reflects several

variations in the definition of the term “patient engagement”; however, in its simplest form, patient engagement refers to providers and patients working together to improve health (HIMSS, 2015). The Agency for Healthcare Research and Quality (AHRQ), as quoted by Irizarry, Dabbs and Curran (2015), defined patient engagement as “the involvement in their own care by individuals (and others they designate to engage on their behalf), with the goal that they make competent, well-informed decisions about their health and healthcare and take action to support those decisions” (para.1).

It is widely accepted that patients who are informed, activated, and engaged as active partners in their own care, with their physicians and care providers experience better health outcomes (Quevedo & Gold, 2010). Existing literature reveals a host of additional clinical, operational, and financial benefits resulting from greater patient engagement: increased patient satisfaction, increased staff retention, enhanced staff recruitment, reductions in the number of office visits, disease awareness, decreased length of stay, improved self-care, decreased ED return visits, fewer medication errors, reduced doctor shopping, and improved liability claims experience (Charmel & Frampton, 2008; Woods et al., 2013; Shimada et al., 2013; Neuner, Fedders, Caravella, Bradford & Schapira, 2015; Riippa, Linna, & Ronkko, 2014; Graffigna, Barello, Libreri, & Bosio, 2014). In view of these benefits, patient engagement is a crucial component to the multifaceted solution required to address the cost and quality crisis in US healthcare (Irizarry et al., 2015, para. 1).

Patient engagement is deemed particularly valuable in the drive to improve health because it supports and promotes self-management. Self-management (SM) can be defined as “strategies a person undertakes to control disease, promote health, and live well with illness. Behaviors to manage disease include taking medication, seeking health-care, or managing pain”

(Auduly, 2013, p. 2). To distinguish between the two concepts, patient engagement focuses on strategies that *providers* use to recruit patients to manage their own health and promote positive health behaviors (James, 2013). In contrast, SM consists of a range of activities or tasks *patients* do to enhance their health and well-being (Boger et al., 2015).

Past research, such as the randomized clinical trial conducted by Hibbard, Mahoney, Stock, and Tusler (2007) suggest that an increase in patient engagement is related to a positive change in a variety of SM behaviors (Hibbard et al., 2007). In multidisciplinary health research, engagement is often regarded as a determinant for patient empowerment and disease SM (Barello, Graffigna, Vegni, & Bosio, 2014). Patient engagement and SM thus work in tandem and are both essential elements to effective chronic disease improvement. For chronically ill patients who must manage their conditions on a daily basis, both patient engagement and SM is of utmost importance, and if patient engagement is increased, SM behaviors usually follow (Hibbard et al., 2007).

Patient engagement and SM have become focal points of discussion because they represent fundamental principles for patient-centered healthcare (Pulvirenti, McMillan, & Lawn, 2014). The focus is significant because “the more we can engage patients to be partners in their own care, the healthier they— and our entire healthcare system— will be” (Long, as quoted by McKinney, 2012, para.5). Greene and Hibbard (2012) added that surviving and thriving in the new payment environment would require health systems and providers to “identify effective ways to support patients so that they may be more effective partners in the care process” (p. 524). Therefore, to ease the burden of growing demand and restricted resources, healthcare providers have begun developing and implementing practices to engage the most underutilized asset of healthcare—the patient—in the care process (Riippa, Linna & Ronkko, 2014).

The Role of Health IT in Patient Engagement

Health Information Technology (HIT) is essential to the success of the ACA and has been identified as a vital tool for facilitating greater patient engagement. HIT is defined as “a broad concept that encompasses an array of technologies to store, share, and analyze health information” (HealthIT.gov, 2013). Steichen and Gregg (2015) indicated “HIT provides an opportunity to organize disparate data sources into one cohesive, patient-centered record” (para. 2). The Office of the National Coordinator for Health Information Technology has offered the following proposed vision of how HIT can support a paradigm shift to patient-centered care: “the power of each individual is developed and unleashed to be active in managing their health and partnering in their healthcare, enabled by information and technology” (Daniel et al., 2014, p. 3). The role of HIT in patient engagement is significant because the on-demand, real-time communication preferences of today’s consumers would be *virtually impossible* without a sound HIT infrastructure.

Electronic Health Record and Meaningful Use

One example of HIT is the Electronic Health Record (EHR). The EHR is an electronic system maintained by providers (such as hospitals) that stores health information. Centers for Medicare and Medicaid Services (CMS) views EHR technology as “the next step in the continued progress of healthcare that can strengthen the relationship between patients and clinicians” (CMS, 2012). Accordingly, CMS strives to increase the adoption of EHRs by both physicians and hospitals through the use of the Medicare and Medicaid EHR incentive programs (CMS, 2014). These programs enable eligible physicians and hospitals to qualify for incentive payments to offset the costs of their systems (CMS, 2014). However, simply adopting an EHR system is insufficient. To realize the EHRs full potential, and to earn payments through the CMS

programs, eligible physicians and organizations must also demonstrate that they are using certified technology in a “meaningful” way (Wager, Lee, & Glaser, 2013, pp. 180-181).

CMS also believes that the use of portal technology places healthcare providers in the best position to encourage patients to take a more active role in their care (HIMSS, 2014). Accordingly, to satisfy Stage 1 Meaningful Use requirements, providers must install a patient portal. Prerequisites for meeting Stage 2 go a step further and require at least one patient seen during the reporting period (or their authorized representatives) to use the portal to view, download, and/or transmit their health information to a third party (CMS, 2016). According to Irizarry et al. (2015), the meaningful use criteria of the CMS EHR incentive program serves as the current principal driver of patient portal development. The features mandated by MU that are directly related to patient portal functionality include providing (1) a clinical summary to the patient after each visit, (2) secure messaging between provider and patient, (3) ability to view, download, and transmit personal health record data, (4) patient specific education, (5) patient reminders for preventative services, and (6) medication reconciliation (Ahern et al., 2011, as cited by Irizarry et al., 2015). Wright, Febowitz, Samal, McCoy, and Sittig (2014) reported that 237,267 eligible providers (EPs) registered for the Medicare EHR incentive program as of May 30, 2013 and were paid a total of over \$3 billion in incentive payments by CMS.

Patient Portals

Patient portals represent “important technological means to support patient-centered care” (Rigby et al., 2015, p. 150). Portals are web-based applications that are owned and administered by healthcare institutions and serve to enhance patient-provider communication; empower patients; support cares between visits; and most importantly, improve patient outcomes (Rigby et al., 2015). Since portals represent electronic entry points into the EHR, they contain

features intended to engage patients to be more active in managing and monitoring their health (Goel et al., 2011; Kruse, Argueta, Lopez, & Nair, 2015). While SM tools can differ in each portal, the majority includes features such as clinical summaries, patient-specific education resources, secure electronic messaging with providers, and reminders for preventative and follow up care (ONC, 2013). For patients charged with self-managing their chronic conditions, the portal can be a valuable resource. Prior to patient portals, patient-specific clinical information was typically dispersed in a collection of paper records—which are often poorly organized, illegible, and difficult to retrieve—making it nearly impossible to manage chronic conditions that require frequent monitoring and ongoing patient support (IOM, 2000, p.5). In the evolution of the shared-decision making model of care, the patient portal represents an innovative strategy for facilitating patient engagement and SM.

For purposes of this study, it is important to distinguish the differences between patient portals and personal health records (PHRs). PHRs contain the same type of information as patient portals (e.g. immunizations, diagnoses, medications) but are owned, accessed, and managed by patients (ONC, 2015). Conversely, health information in a patient portal is largely created and managed by authorized providers, though some patient personalization is typically possible. Terry (2008), as cited by Nazi (2013), reiterated the key differences and benefits of a patient portal over a PHR, noting “a PHR that doesn’t connect to your doctor is like an ATM without any money in it” (p. 28). Related to patient engagement, the differences in ownership and management between the patient portal and PHR are significant, since the latter is only updated when the patient updates it (Kruse, Bolton, & Freriks, 2015; Kruse, Argueta, et al., 2015).

Self-Management using the Patient Portal

Self-management (SM) is considered crucial in chronic disease management. Since health behaviors (such as smoking, food choices, and alcohol use) are linked to the majority of chronic health problems, use of patient portals in this growing population is important. Fittingly, Kruse, Arugeta, et al. (2015) indicated that patients who used patient portals showed significant improvements in the SM of their chronic disease.

One large academic medical center in the southeastern United States implemented a new integrated EHR system, Epic[®], on July 1, 2014. Within Epic is a comprehensive patient web-portal called MyChart[®] that allows patients to engage in their care (e.g. examine test results, view upcoming and past appointments, and update medications and allergies). One helpful feature within MyChart[®] is the ability to view, modify, and cancel upcoming appointments. Once appointments are scheduled, MyChart[®] sends an email to patients, reminding them of upcoming visits. This feature has the potential to minimize missed appointments, because patients who are engaged in the SM of their conditions were shown to participate in preventative behavior, which includes adherence to medical appointments (Riippa, Linna, & Ronkko, 2014). Conversely, absent a personal or family emergency, missing appointments suggests poor SM, likely a misunderstanding of the value of the appointment or “forgetting.” In a chronically ill population, missed appointments represent a key obstacle in the quest to improve health.

A missed appointment occurs when a patient cancels within 24 hours of the scheduled appointment time (“same-day cancellation”) or fails to show up (“no-show”). Same-day cancellations and no-shows can be detrimental on several levels. First, they pose major issues for both physicians and healthcare organizations; quality of care is substantially compromised, already scarce financial resources are further drained, and productivity is dampened. Second, and

more importantly, no-shows and same-day cancellations pose major issues for patients themselves. Patient wait time is increased, and patients with chronic illnesses, such as diabetes, have more difficulty receiving regular care and follow up. More than most chronic diseases, diabetes requires a deep commitment to self-care because patients with diabetes are responsible for the vast majority of management requirements of their condition (McMahon et al., 2005).

Diabetes

Osborn, Mayberry, Wallston, Johnson, and Elasy (2013) indicated that optimal diabetes SM is multifaceted, requiring activities such as exercise, appropriate nutrition, blood glucose monitoring, and medication adherence (para.1). However, the complex nature of SM activities often necessitates frequent support and oversight from a team of medical professionals. National clinical practice guidelines recommend patients visit their primary care provider (PCP) every 3 to 6 months (Nutri et al., 2012).

When patients with diabetes miss appointments or when they cannot get timely appointments because the schedule is filled with patients who will no-show, health outcomes deteriorate (Turkcan et al., 2013). Poorer glycemic control, reduced metabolic control, sub-optimal SM practices, and significantly higher rates of subsequent acute care utilization are all associated with diabetic patients who miss scheduled appointments (Karter et. al, 2004; Nutri et al., 2012; Schectman, Schorling, & Voss, 2008). In addition, Nguyen, DeJesus, and Wieland (2011) found that when patients frequently missed appointments, they were less likely to receive necessary preventative health services, which led to poorly controlled hypertension and diabetes.

Therefore, “a vital role of the healthcare system is to provide the tools necessary for chronically ill patients to make informed decisions about their healthcare, and to solve the problems encountered daily from living with a chronic condition” (Solomon, Wagner, & Goes,

2012, para. 1). The patient portal is one such tool, and may represent a powerful instrument for engaging patients in the SM of their condition (Nijland, van Gemert-Pijnen, Kelders, Brandenburg, & Seydel, 2011). Solomon et al. (2012) agreed that web-based interventions could serve a vital role in healthcare providers' efforts to enhance SM in this growing population of chronically ill people. Portal technology has therefore become a priority for many healthcare organizations worldwide. By leveraging interventions that facilitate patient scheduling, improve attendance to provider appointments, and provide patient information to care teams, healthcare providers enable preventative services to begin (Nuti et al., 2015). Accordingly, the patient portal can potentially be a crucial first step in facilitating adherence to the American Diabetes Association (ADA) effective disease management guidelines because they engage patients by keeping them accountable for their health, making them more likely to schedule and attend their provider appointments (Nuti et al., 2015).

Problem Statement

Patient portals are recognized in the literature as a promising mechanism to encourage greater patient engagement and resulting SM (Irizarry et al., 2015). In spite of the great promise that portals have shown for helping manage, maintain, and improve patient health, their association with patient outcomes, utilization, and cost is unclear. Further, the impact of electronic patient portals on safety, effectiveness, quality of care, and patient engagement is limited and inconclusive (Rigby et al., 2015). Finally, while they are touted as a transformative technology for facilitating disease SM and patient-centered healthcare, little is known about the impact of portals on diabetes care and associated outcomes specifically (Osborn et al., 2013).

The literature suggests that web-based multidisciplinary tools—such as patient portals, that enable patients to schedule appointments or remind them of the date and time of an

appointment—can have a positive impact on clinical and behavioral outcomes (Nutti et al., 2015). Unfortunately, little research exists for the outcome parameters of no-shows and same-day cancellations in a chronically ill population, such as patients with diabetes. Horvath et al. (2011) documented the use of the patient portal to improve patient adherence, specifically reduce missed appointments. This study focused on the association between portal enrollment, with email reminders, on clinic adherence. The conclusion was that patients who registered for portal use had a significantly reduced no-show rate, thus the patient portal “may have important beneficial effects on clinic operations” (Horvath et al., 2011, p. 17). While useful, the Horvath et al. (2011) study had several limitations. Since it only studied portal enrollment, it might not reflect the activity of active portal enrollees, as patients who sign up for the portal do not necessarily use it. The study also lacked detailed information regarding the number of log-ins of active enrollees. As the authors noted, this information would have made a stronger case that active portal use is an important component of patient arrivals. Further, data on advance cancellations (same-day or otherwise) were not captured (Horvath et al., 2011).

The present study aims to improve upon prior research by addressing the aforementioned limitations. Specifically, the study will focus on:

1. Better understanding a chronically ill population of adult diabetics who may gain significant benefit from greater patient engagement and resulting SM;
2. Exploring who currently uses the portal in an adult diabetic population, as this information represents an important first step for increasing future use; and
3. Determining the relationship between the actual use (not merely enrollment) of the patient portal and missed appointments.

Adequately describing and assessing the use of the portal in facilitating patient

engagement and SM is necessary to determine how to better utilize this technology to improve health outcomes. This descriptive study will contribute to that necessary foundation.

Study Objectives

The objective of this study is to describe the demographic characteristics of patients with diabetes who use the MyChart® patient portal at a large academic medical center. Jones, Weiner, Shah, and Stewart (2015) stated that by determining which patient characteristics predict use of patient portals, organizations can develop targeted approaches to engage different segments of the population. This study contributes to previous research (especially Riippa, Linna, Ronkko, et al., 2014) by extracting predictors of portal use in a chronically ill population who would benefit considerably from appointment adherence. Most importantly, this study will demonstrate the relationship between portal use and missed appointments (i.e., no-shows and same-day cancellations) and identify whether portal use is associated with fewer missed appointments.

Research Questions

1. What are the demographic profiles of MyChart® users?
2. What demographic characteristics predict MyChart® use?
3. Does MyChart® use predict overall no-show percentage?
4. Is there a difference in patients' missed appointment percentage when they have an activated MyChart® account compared to when they do not?

Research Hypotheses

It is hypothesized that no-show rates are associated with MyChart® use among diabetic patients. Further, it is hypothesized that when patients activate a portal account before an appointment, and therefore receive email reminders of their upcoming visit, their missed appointment rate is reduced.

Population

This study included all adult patients (age 18-80) with a Diabetes Mellitus (DM) diagnosis who had a primary care provider (PCP) within the Medical University of South Carolina (MUSC) network and were seen for an appointment between 7/1/14-6/30/15. The *Diabetes Registry* was used to identify patients in the study population. Patients with diabetes that had a pregnancy due date anytime in the future were excluded to avoid the inclusion of those with gestational diabetes.

CHAPTER II

LITERATURE REVIEW

A search of published, peer-reviewed literature was conducted between September 2015 and November 2015 for articles that analyzed the use of patient portals to engage patients. The PubMed, CINAHL, and Scopus research databases were queried for both qualitative and quantitative studies published in the English language between 2010-2015. The search strategy included combinations of the following terms: *missed (or missing or fail) appointment, electronic health record, EHR, electronic medical record, patient portal, mobile app, smart phone, self-manage, self-management, diabetes, appointments & schedules, computerized patient record, and patient participation*. In addition, although previously indexed in each of the research databases, a key journal search was performed in the *Journal of Medical Internet Research*, because the periodical is deemed a high-volume publisher of innovative research in the informatics field. Official governmental websites (e.g. CMS, HealthIT.gov) were also reviewed for regulatory guidance. A MUSC librarian was consulted for assistance in selecting the databases and search terms to retrieve potential articles.

Scopus searches consisted of the title, abstract, and keyword fields; the CINAHL searches included headings and keywords; and the PubMed search utilized title, abstract, keywords, and MESH headings. Additional references were obtained by citation review in key articles. Filters were applied to exclude articles outside of the desired date range (2010-2015) as well as those that were not in the English language. The date range was selected because the enactment of the HITECH Act occurred in February 2009, placing new requirements, such as patient portal usage, on healthcare organizations striving to meet meaningful use criteria. In addition, with the current focus on patient-centered care, this topic is updated routinely. A filter

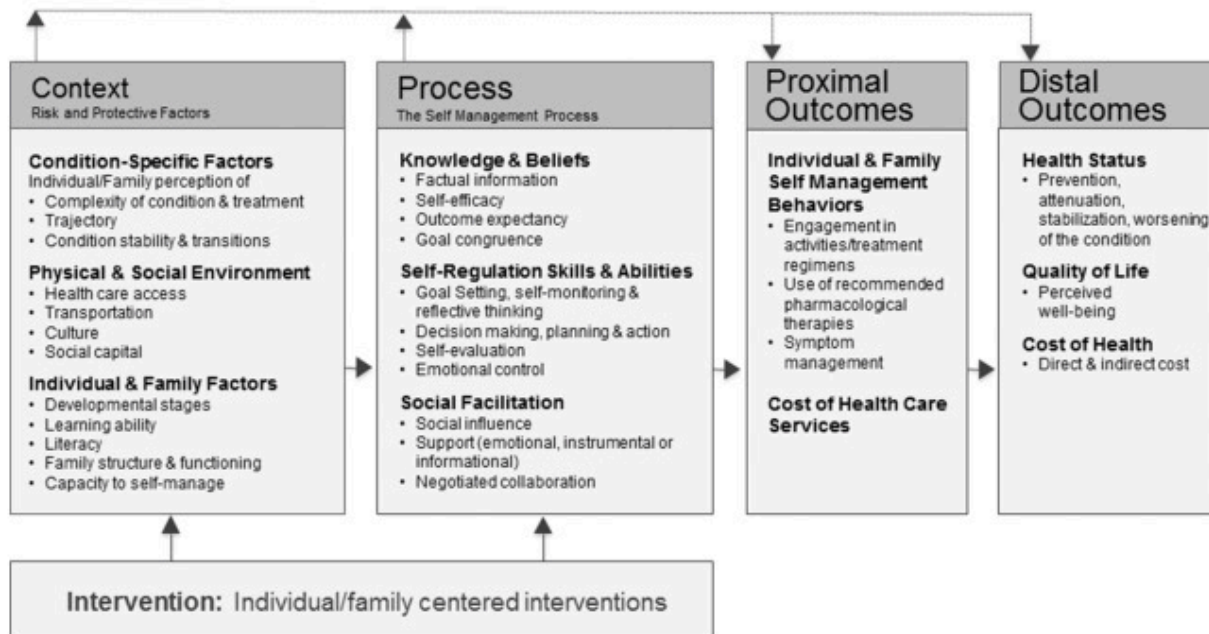
was also used to exclude the MEDLINE results from the CINAHL search, as PubMed automatically queries MEDLINE.

Many articles returned in the initial search discussed personal health records (PHRs). This study's focus is on patient engagement through the patient portals; therefore, only studies that specifically referenced patient portals were included. The exclusion process was manual, conducted by one reviewer, and involved a critical review of the title and abstract of each article. Articles were then discarded or selected based on their relevance to the current study.

Theoretical Framework

The theoretical framework utilized for this research was Ryan and Sawin's (2009) Individual and Family Self-Management Theory (IFSMT). The IFSMT is a descriptive theory that conceptualizes SM as a multidimensional, complex phenomenon that affects individuals, dyads, or families across all developmental stages (Ryan & Sawin, 2009, p. 222).

The IFSMT (see Figure 1) and the conceptual model adapted from it to fit this study, serve as the foundation for this literature review.



Ryan, P.A., & Sawin, K. J. (2014). Individual and Family Self-Management Theory [Figure]. Retrieved from www.nursing.uwm.edu/smsc

Figure 1: IFSMT Theory

The IFSMT was selected because of its emphasis on the responsibility of chronically ill individuals and their families to actively manage their conditions. This theory focuses on the risk and protective factors (defined in this study as barriers and facilitators) leading to the enhancement of SM. The IFSMT is comprised of three interrelated dimensions:

1. Context
2. Process
3. Outcomes

Factors in the context dimension consist of risk and protective influences that are categorized as condition-specific considerations, physical and social environments, and individual and family characteristics. The condition-specific characteristics associated with diabetes are the multiple comorbidities that often accompany the illness as well as the required routine follow-up and daily SM requirements. Environmental factors are either physical or social

and include factors such as transportation, access to healthcare, and transition from one healthcare provider or setting to another. Individual and family factors are associated directly with the individual or family (e.g. literacy) (Ryan & Sawin, 2009). The factors in the context dimension either enhance or present barriers to SM and affect an individual's and family's ability to engage in the next two dimensions: process and outcomes (Ryan & Sawin, 2009).

The process dimension is based on the dynamic interaction among the following: knowledge and beliefs, acquisition and use of self-regulation skills, and social facilitation and negotiation (Ryan & Sawin, 2009). That is, persons will be more likely to engage in SM behaviors if they have information about and embrace knowledge and beliefs consistent with behavior, if they develop the ability to change their behavior, and if they experience social facilitation (e.g. support) that encourages them to engage in preventative health behaviors. In this study, the process dimension is represented by the MyChart[®] patient portal. The portal is a tool that may enhance an individual and their families' SM processes and may therefore result in positive improvements in the next dimension: outcomes (Ryan & Sawin, 2009).

The outcome dimension includes proximal (i.e. short term) outcomes that lead to the attainment of distal (i.e. long term) outcomes. Proximal outcomes consist of the actual engagement in SM behaviors such as treatment regimens and the use of pharmacological therapies that are specific to a condition, risk, or transition (e.g. diabetics must perform daily finger sticks to measure their blood glucose levels). The proximal outcomes in this study are no-show and same-day cancellation rates. Distal outcomes such as improved health, improved quality of life, and improvements in both direct and indirect costs are related, in part, to the successful achievement of proximal outcomes (Ryan & Sawin, 2009).

In the past five years, the IFSMT model has been used in other studies to explain a

variety of research topics. A correlational, longitudinal design framed by the IFSMT was used to determine the relationship between patient perceptions of patient-empowering nurse behaviors and patient activation and functional health status six-weeks after discharge in patients who recently underwent a surgical procedure (Jerofke, 2013). Derman (2014) used the IFSMT to examine themes discussed by United States veterans and their significant others who used secure messaging to include the patterns of use and whether the patterns varied based on gender and age of the user. Verchota (2014) conducted a correlational, cross-sectional study to determine whether SM behavior in adolescents with type 1 diabetes mediated the relationship of IFSMT process variables on metabolic control and diabetes-specific health-related quality of life (DQOL). Most recently, Colorafi (2015) used the IFSMT to examine ways of encouraging older adults with multiple co-morbidities to engage with their plan of care. The current study will contribute to the body of knowledge surrounding this understudied mid-range theory by using it to examine another dimension of patient engagement. That is, patient engagement and SM through the patient portal in a population of adults with diabetes.

For purposes of this research, the IFSMT has been modified to focus on sensitizing concepts most relevant to this study. Sensitizing concepts offer ways of seeing, organizing, and understanding the literature and provide starting points for building analysis (Charmaz, 2003, as cited in Bowen, 2006). Sensitizing concepts are thus utilized as points of departure from the original theoretical framework and provide proper context for studying the engagement and SM of a diabetic population through a patient portal.

Review of the Literature

The potential for patient portals to improve patient engagement and health outcomes has been discussed for well over a decade. Historically, authors have tried to illuminate the subject

by highlighting the great potential patient portals show for engaging patients (Byczkowski, Munafo, & Britto, 2014; Solomon et al., 2012). Given the number of office visits, laboratory and procedure visits, and SM activities chronic illnesses necessitate, patient portals may be an especially useful tool for this patient population (Ancker et al., 2011; Byczkowski et al., 2014; Krist et al., 2014; Riippa, Linna, Ronkko, et al., 2014). Accordingly, condition-specific factors (e.g. complexity of condition and treatment) are likely to encourage portal adoption and use.

Several studies describe the value of the portal from the patient's perspective. The findings suggest that patients find portals easy to use, useful for communicating with their care provider, facilitative of participation in their own care, and therefore having great value and utility (Nagykaldi, Aspy, Chou, & Mold, 2012; Urowitz et al., 2012; Woods et al., 2013).

Recent publications reveal that in spite of the portal's great promise, and in spite of any external incentives, both patients and providers have adopted patient portals at slow rates in the United States, demonstrating that adoption and use is complex (Tulu et al., 2015). Articles summarized and synthesized in this literature review were selected based on their relevance to IFSMT conceptual dimensions. Accordingly, they address characteristics associated with portal enrollment and use in a diabetic population, as well as examine barriers to use that future studies should address.

Portal Adoption and Use. The literature cites a host of reasons for poor adoption and use of patient portals, and distinguishes among patient populations who are faced with different challenges. Several studies have concluded that there are significant demographic differences between portal users and nonusers. The most common factors discussed include health literacy, race/ethnicity, educational attainment, and age. These disparities among subgroups are often defined as the "digital divide" and represent major barriers to patient portal access (Irizarry et al.,

2015). The majority of published studies about patient portals have been conducted in the general population instead of in a population restricted to patients with diabetes (Ronda, Dijkhorst-Oei, Gorter, Beulens, & Rutten, 2013, p. 556). However, given the complex SM demands on diabetics, the studies synopsisized in this section of the literature review are limited to those relevant to SM and/or use of the patient portal in diabetic populations.

White, Wolff, Cavanaugh, & Rothman (2010) explained that patients with diabetes and limited health literacy (LHL) are more likely to have poorer disease knowledge and symptom recognition, poorer glycemic control, greater difficulty interpreting food labels and estimating portion sizes, lower self-confidence in diabetes management, fewer SM behaviors, and poorer communication with their providers (p. 1). LHL is especially prevalent in certain racial or ethnic groups, the elderly, and people with little education (AHRQ, 2004, as cited in McCleary-Jones, 2011). Therefore, it comes as no surprise that LHL, race/ethnicity, and educational attainment, represent strong predictors of portal enrollment and use.

Limited Health Literacy. LHL is consistently associated with poor SM behaviors and unfavorable health outcomes in people with diabetes, which has led to a growing body of literature that explores this relationship (Al Sayeh, Majumdar, Williams, Robertson, & Johnson, 2013; Mayberry, Rothman, & Osborn, 2014; van der Heide et al., 2014).

Al Sayeh et al. (2013) evaluated the relationships between health literacy (HL) and clinical outcomes (glycemic control, hypoglycemia, blood pressure, diabetes complications, and low-density lipoprotein (LDL)), behavioral indicators and patient-reported outcomes (diabetes knowledge, self-efficacy, self-care, self-monitoring of blood glucose and other SM), and health literacy and patient-provider interaction indicators (patient-provider communication, patient trust, information exchange and involvement in decision-making, use of computers and the

Internet, and other outcomes (e.g. Health-Related Quality of Life [HQRL]). They found that while there was a discrepancy among studies regarding the relationship between HL and several health outcomes in people with diabetes, there was sufficient evidence to support a positive relationship between HL and SM activities and HL and diabetes knowledge (Al Sayah et al., 2013).

Relatedly, van der Heide et al. (2014) found that LHL was significantly associated with reduced diabetes knowledge, higher HbA1c level, less self-control of glucose level, and less physical activity. This study supported and enhanced the previous findings from Al Sayeh et al. (2013) by demonstrating that higher HL may contribute to participation in SM activities, in some cases through diabetes knowledge. Thus, health literacy skills may be important targets for interventions promoting diabetes SM (van der Heide, et al., 2014).

Since diabetes SM occurs in the context of routine family activities, Mayberry et al. (2014) included family members as an essential source of support for SM among adults with Type 2 Diabetes Mellitus (T2DM). They therefore studied how social or family support may affect diabetes outcomes differently for adults with LHL versus those with adequate HL. They found that being non-white or Hispanic was associated with having LHL, as was having less education or a lower income. Their results suggest that adults with LHL are especially vulnerable to the harmful aspects of family involvement in their diabetes management (e.g., nagging or arguing with patients in an attempt to get them to perform SM behaviors, or tempting them with unhealthy foods). The Mayberry et al. (2014) study shows that efforts focused on increasing social support or family support for diabetes SM may not be effective unless they also decrease obstructive family behaviors, and this appears especially relevant to patients with LHL. The impact of family members' involvement should also be evaluated as a means to increase portal

use, especially among those with LHL (Mayberry et al., 2014).

Several authors described LHL as a key characteristic associated with non-use of the patient portal. For example, Mayberry, Kripalani, Rothman, and Osborn (2011) found a relationship between patients' HL and the frequency of using computers to research diabetes-specific medications or treatments. However, contrary to the authors' predictions, participants with LHL, numeracy, or computer literacy were no less likely to access patient web portals. Therefore, HL was associated with the frequency of using the portal to manage one's health but was not necessarily a prerequisite to accessing the portal. To better understand the finding, Mayberry et al. (2011) reviewed focus group transcripts to determine how participants used the patient portal regardless of their HL, numeracy, or computer literacy. In that study, family members facilitated both initial access and continued use of the portal and participants commonly learned about the medical center's patient portal through a knowledgeable family member. Accordingly, the involvement of family members in patient care might assist patients with HL limitations in accessing and using patient portals to manage their diabetes, bridging the HIT "digital divide" (Mayberry et al., 2011).

Zikmund-Fisher, Exe, and Witteman (2014) added that LHL and numeracy skills were significant barriers to basic use of laboratory test results found in most portals. Those with LHL and low numeracy skills were less than half as likely to identify hemoglobin A1C levels as out-of-range as patients with adequate HL. This finding was important because "correctly identifying hemoglobin A1C levels as out of range was the single largest predictor of both perception of blood glucose control and intention to call one's doctor in response to the elevated test results" (Zikmund-Fisher et al., 2014, p. 13).

Zarcadoolas, Vaughn, Czaja, Levy, and Rockoff (2013) argued that vulnerable

population groups are often subject to disparities in health outcomes and healthcare quality. Many of these vulnerable populations (e.g., poor, undereducated, racial and ethnic minorities, immigrants, and those lacking English proficiency) are also likely to be low literate and/or LHL, with some reading at a 5th grade level or lower. Unfortunately, the literacy level of most health information created for the general public is written at or above the 10th grade level, which complicates or hampers the effectiveness of the SM or patient-centered approach. Studies have suggested that providing access to online health information through the patient portal may help to address some of the disparities in vulnerable groups. However, there is conflicting data regarding vulnerable patients' perceptions and the use of patient portals. Therefore, Zarcadoolas et al. (2013) sought to identify vulnerable patients' responses to patient portals, how they perceived the portals utility and value, as well as their reactions to specific portal functions. Most focus group participants felt the portal's reminders for appointments, annual visits, and screenings positively impacted their health. However, participants discussed the need to have portal information presented in ways "the average person can understand" (p. 12). After being shown a sample lab test result page, one participant commented that she would use it "if I could read it and understand it...[but] I can't understand it" while another participant stated, "I just look and see numbers" (p. 18).

Each of the referenced studies reiterates the importance of designing and refining patient portals to meet the needs of those with LHL (Zarcadoolas et al., 2013). Otherwise, "patient portals will remain an unused or underutilized tool for those who could potentially benefit the most" (p. 14).

Race/Ethnicity and Educational Attainment. In addition to concerns over HL, a number of studies describe race/ethnicity as a strong predictor of portal enrollment and use (Amante,

Hogan, Pagoto, & English, 2014; Ancker et al., 2011; Goel et al., 2011; Osborn et al., 2013; Sarkar et al., 2011; Tenforde, Nowacki, Jain & Hickner, 2012). Unfortunately, previous health services research has also revealed social disparities in diabetes outcomes by race/ethnicity and education (Wilder 2003, as reported by Sarkar et al., 2011). As more health systems adopt portal functionality, minority patients are in danger of falling further behind if the disparities in adoption and use described below are not adequately addressed (Sarkar et al., 2011).

Sarkar et al. (2011) investigated use of a patient portal among 14,102 diverse adults with diabetes. Study findings revealed marked race/ethnic differences with African-Americans, Latino, and Filipino patients least likely and Asian and White participants most likely to both request a password and log on to the portal. They also observed a consistent gradient with respect to educational attainment, such that those with higher educational attainment were more likely to request a password and log on to the portal. Compared to those with a college degree, those with a lower educational attainment were more likely never to have logged on (Sarkar et al., 2011).

Ancker et al. (2011) concurred that activation was significantly more likely among older patients, non-Blacks, speakers of English or other languages compared to Spanish speakers, the privately insured, and those with more clinical visits. Repeat use was significantly more likely among Whites, English speakers, those with commercial insurance or Medicaid, and those with more chronic illnesses. Therefore, according to Ancker et al. (2011), racial and economic disparities are evident at all stages of access to the portal, activation of portal accounts, and usage of accounts.

Tenforde et al. (2012) found that compared to nonusers, users were younger, had higher incomes and educational attainment, were more likely to identify as Caucasian, and had better

unadjusted and adjusted diabetes quality measure profiles. Of the 4,036 patients who enrolled in the portal, the median number of login days during the 12-month study period was nine. This study suggested that patients are logging on too infrequently for portals to be as effective as hoped in improving outcomes in this subset of the population. Portals need to engage patients with diabetes on a more regular basis and provide tailored, action-oriented advice to improve their SM (Tenforde et al., 2012).

Osborn et al. (2013) conducted a mixed-methods study to understand who used the patient portal and discover reasons for nonuse; how portal users utilized the portal to manage their medications; and participants' ideas for improving portal functionality for medication management and adherence support. Users were more likely than nonusers to be Caucasian/White, have higher incomes, be privately insured, and be more educated than nonusers. After showing nonusers a portal demonstration video, four out of seven nonusers reported they were interested in using the portal but had either never heard about it, or had heard about it but did not know what its capabilities were. Among users, more frequent use of a portal was associated with better Hemoglobin A_{1C}. This study was limited by the participants' perceptions of the frequency of using a portal and how they use it, therefore, it may not adequately reflect actual opinions and/or behaviors (Osborn et al., 2013).

Amante, et al. (2014) found that demographic factors such as higher education level, younger age, higher income, and non-minority race were associated with higher portal utilization. The authors suggest that educating patients, family members, and providers on how best to use portals and on the benefits of portal use can increase enrollment and use (Amante et al., 2014).

Ronda et al. (2013) found that patients with T1DM requested a login more frequently

than patients with T2DM. In addition, patients with a login were strikingly differently from those without. Namely, having a login was independently associated with younger age, male gender, higher educational level, treatment by an internist, longer duration of diabetes, and more frequent use of insulin and other drugs. This study concluded that promoting the patient portal without addressing disparities in use was an exercise in futility (Ronda et al., 2013).

Nijland et al. (2011) evaluated patient portal user profiles and explored factors influencing the initial and long-term use of a Web-based application (DiabetesCoach) for supporting the self-care of patients with T2DM. Patients that enrolled to use the portal were mostly male, with a high or medium level of education, and a mean age of 61. This study was important because expanding the uptake of portal technology requires, first and foremost, a better understanding of the obstacles that prevent access (initial use) and secondly, a better understanding of the factors that influence long-term use (Nijland et al., 2011). Unfortunately, the study was limited by the incredibly small and select sample of participants (only 14% of patients invited to use the portal responded favorably). In addition, this study's setting was a primary healthcare foundation in the Netherlands, which is considerably different from primary care practices in the U.S. (Nijland et al., 2011).

By increasing convenience and access to medical record information and tools online, portals can lower barriers to engaging in SM tasks and may therefore reduce health disparities related to race/ethnicity and LHL as previously discussed (Lyles, Schillinger, & Sarkar, 2015). Lowering barriers to engagement in SM tasks can be particularly important for patients with chronic illness because they need increased assistance with complex SM activities.

Unfortunately, Lyles, Schillinger et al. (2015) believe that “portal expansion is not fully realizing this promise” (p. 2). Lyles, Schillinger et al. (2015) argue that unfortunately “portal expansion is

not fully realizing this promise” and it is not an issue of access or interest alone (p. 2). With most Americans having internet access and the vast majority having interest in internet-based communication with providers, a lack of usability, particularly for diverse groups, was described as an additional formidable barrier to achieving widespread use of the portal (p. 3). Goel et al. (2011) added to this conclusion, that 26% of all respondents they interviewed in a telephone survey in one urban general medicine clinic did not remember even discussing the patient portal with their provider. Meanwhile, approximately 63% did not attempt enrollment despite remembering a discussion with their providers and cited issues such as not having enrollment instructions, not thinking it would be useful, thinking it would be too complicated, and lack of computer skills (Goel et al., 2011). They concluded that interventions aimed at reducing racial and ethnical disparities in enrollment should also address attitudinal barriers and not focus exclusively on access (Goel et al., 2011).

Summary

These studies reiterate the most common factors related to portal adoption and use in a diabetic population and suggest that LHL, race/ethnicity, and lower educational attainment all contribute to the problem of underutilization. Unfortunately, the important determinants of patient portal use described in this section are also directly related to the disproportionate burden of chronic illness and disparities in health outcomes (Lyles & Sarkar, 2015, p. 271). Therefore, promoting patient engagement through patient portals is challenging and rapid expansion of portals could exacerbate existing healthcare disparities if only well-resourced individuals use them (Lyles & Sarkar, 2015, p. 271).

Conversely, with so many hospitals and clinics now using electronic health records and patient portals, well-designed technology may make a meaningful population impact (Lyles &

Sarkar, 2015). Tung and Peek (2015) agreed that the pervasive use of technology to address a disease such as diabetes, which is impacted by basic patient decisions from grocery shopping to stress management, provides a novel opportunity for facilitating the shift to patient-centered care. However, finding ways to overcome barriers posed by race/ethnicity, LHL, and lesser educational achievement should be an important policy goal to prevent these groups from falling further behind (Goldzweig et al., 2013; Sarkar et al., 2011).

Barriers to Use

Many of the contextual differences (factors that challenge or protect engagement in SM) in the uptake and use of portals are described above. However, after adjusting for socioeconomic status or Internet use in everyday life, differences in portal use persist, suggesting the influence of additional patient and/or provider and system-level factors (Lyles et al., 2013). Zarcadoolas et al. (2013) described that once a patient was enrolled in the patient portal, there were no disparities in use by race/ethnicity, indicating that the way portals are designed and presented to consumers may influence how they are perceived, valued, and ultimately utilized.

The current major legislative and political support for EHRs represents the greatest investment in health information technologies in US history (Menachemi & Collum, 2011). These investments (e.g. EHR Meaningful Use incentive programs) have undoubtedly provided a tremendous platform for portal development and adoption. However, despite the large amount of stimulus money available, virtually all healthcare systems are still struggling with patient portal use, and the MU program has had to grant extensions for systems to meet patient engagement goals (Lyles, Schillinger et al., 2015, p. 2). These challenges underscore the fact that significant barriers still exist for both portal enrollment and use. This section will address one of those key barriers, insufficient evidence that the portal actually improves outcomes.

Evidence of Improved Proximal and Distal Outcomes

HIT is a rapidly emerging field. Accordingly, an increasing number of studies have been published as of late that evaluates portals' ability to improve outcomes. Some authors described the portal's capacity to empower patients and improve disease awareness, which led to favorable patient-provider communication (Varsi, Gammon, Wibe, & Ruland, 2013; Wade-Vuturo, Mayberry, & Osborn, 2013; Woods et al., 2013). Other authors linked the patient portal to improvements in medication adherence and the management of chronic disease, decreases in the number of office visits, enhanced self-care, increased patient satisfaction, improved quality of care, and superior customer retention (Kruse, Bolton et al., 2015; Lyles, Sarkar et al., 2015; Varsi et al., 2013, p.2).

Further, a variety of studies have identified clinically relevant benefits associated with use of patient portals. Many found that the portal was significantly associated with improved glycemic control and patients with both T1DM and T2DM who accessed a portal were more likely to achieve target A1c levels compared to patients who did not access a portal (Lau, Campbell, Tang, Thompson & Elliott, 2014; Wade-Vuturo et al., 2013).

Related to the present study explicitly, Krist et al. (2012) argued that information systems that feature patient-centered functionality have the potential to increase preventive service delivery and thus provide important public health benefits (p. 318). Or and Tao (2014) added that the use of portal technology can lead to greater SM, higher frequency of attending health checks, greater physician activity levels, improved diet and eating behaviors, improved medication adjustment, and improved diabetes knowledge (p. 324).

While there are many studies pointing to either real or potential benefits of patient portals, unfortunately there is currently insufficient evidence that the portal or its features

actually improves health outcomes (Kruse, Bolton, & Freriks. 2015). Therefore, even though the portal has great potential to meet the intents of MU, there is not enough evidence to declare its efficacy.

Solomon et al. (2012) concurred that even though the portal has great potential as a transformative technology in the management of chronic disease, evidence is needed that interventions like portals can produce benefits for a sustained period among a diverse population. Solomon et al. (2012) suggested that clarifying the value of web-based SM tools will stimulate the investments necessary to accelerate adoption throughout all segments of the large and growing chronic disease population. One important advancement needed is greater provider endorsement; many authors have described this practice as a significant barrier/facilitator to portal adoption and use because, for most patients, healthcare providers are likely to be the ones to introduce them to the portal and interest them in using it as a tool to help manage their health (Ancker et al., 2011). If providers are not familiar with the portal and its potential benefits, or are not convinced of its potential benefits, they are less likely to endorse the portal to patients' posing a significant barrier to adoption and use (Amante et al., 2014; Ronda et al., 2013). Ryan and Sawin (2009) posit provider endorsement as social facilitation that includes social influence. Social influence is a message or dialogue in which respected persons with expert knowledge in positions of perceived authority with expert knowledge advise and encourage individuals and families to engage in specific health behaviors (Ryan & Sawin, 2009).

Patients with T1DM and T2DM studied by Ronda, Dijkhorst-Oei, and Rutten (2014) indicated that they discovered the portals' availability because their healthcare provider told them about it and lack of awareness was the main barrier to enrollment and use. When Ronda, Dijkhorst-Oei, and Rutten (2015) compared patients who requested a login but never used it or

once (“early quitters”) with patients who used it at least two times (“persistent users”) they again found that the majority of patients from both groups discovered the existence of the patient portal after being informed by their physicians. This finding reiterates the important role that the healthcare provider has in turning a patient into an active and persistent user (Ronda et al., 2015). Therefore, to increase patients’ participation in a portal, the unawareness of its existence and its possibilities need to be addressed by their healthcare professionals (Ronda et al., 2014).

With provider endorsement established as a key barrier to portal adoption and use, Irizarry et al. (2015) argued that the perceived usefulness of the portal from the providers’ perspectives cannot be underestimated. Provider endorsement is one of the most influential factors impacting patients’ initial adoption as well as its continued use as a tool for collaborative communication (Irizarry et al., 2015). Therefore, one effective way to enhance provider endorsement may be to change provider behavior (including attitudes and beliefs) related to the portal (Ancker et al., 2011). Recognizing that many negative attitudes and beliefs may be related to a lack of provider confidence in the portals benefits, additional evidence of the portals’ potential to improve proximal and distal outcomes will be needed. Provider endorsement is critical from a systemic standpoint because the workflow of individual providers and the healthcare team as a whole (including nurses, pharmacists, support staff, and physicians) must be adapted to incorporate patient portal functionality, and the patient engagement it allows, to render effective illness management processes (Irizarry et al., 2015). Evidence that the portal actually improves outcomes for patients will help mitigate some of the barriers providers have identified as leading to their dissatisfaction. These barriers include lack of usability and interoperability, onerous regulatory requirements, decreased interaction with the patient, disruption of day-to-day workflow, and reduced quality of clinical documentation (Buntin,

Burke, Hoaglin, & Blumenthal, 2011; Lyles & Sarkar, 2015; Mangalmurti, Murtagh, & Mello, 2010; Porter, 2014; Reece, 2011; Sinno, Gandhi, & Gamble, 2011; Sitting & Singh, 2012; Sockolow, Bowles, Lehmann, Abbott, & Weiner, 2012; Urowitz et al., 2012; Wylie, Baier, & Gardner, 2014). Goldzweig et al. (2013) proposed that better understanding patient portal benefits would require studies that include details about context (e.g., evidence on health outcomes, satisfaction, efficiency, and attitudes), implementation factors (e.g., how patients are educated about the portal), and costs.

Ultimately, this literature review indicates that there is a larger group of researchers who agree on the benefits and promises of portals, but that others are more critical and take the position that their benefits are still unproven and their association with patient outcomes is unclear. Low portal use represents a key challenge for all researchers and must increase before correlations between the patient portal and improved clinical outcomes can be thoroughly assessed.

Discussion

The literature published on patient engagement and SM through the patient portal has grown exponentially in recent years and this review only highlights a small portion of those studies. In spite of the volume of publications, the continually low adoption and usage rates described coupled with the rise in chronic diseases suggest that this topic has not been sufficiently addressed to date. Given the literature, it appears that portal benefits may be measured as fewer missed appointments (i.e. no-shows and or same-day cancellations). These measures may be relevant to both patients and medical care practitioners since missed appointments have long been identified as common barriers to chronic disease management (Daggy et al., 2010; Gellad, Hass, & Safran, 2011). From a patient perspective, a missed

appointment is associated with poorer outcomes and increased emergency room visits (Samuels et al., 2015). From the provider perspective, missed appointments can result in lost revenue, decreased productivity, increased costs, and disruption of the patient-physician relationship (Samuels et al., 2015). Hwang et al. (2015) argued that missed appointments, and no-shows specifically, are also an important indicator of inferior primary care outcomes and suboptimal utilization. Meanwhile, Currie et al. (2012) found that T1DM and T2DM patients who missed appointments were at an increased risk of all-cause mortality.

Factors contributing to missed appointments

Missed appointment rates for diabetic patients vary from 4 to 40% (Turkcan et al., 2013). Several authors have sought to better understand the reasons for patients' missed appointments, including: transportation issues, high healthcare costs, logistic constraints (childcare/work), feeling better, feeling too bad to leave home, a perceived lack of respect from doctors and clinic staff, anxiety about their illness, and personal and family issues (Dumontier, Rindfleisch, Pruszynski, & Frey, 2013; Vijayan, 2014). However, the most common reason cited by patients is that they simply forgot (Akhter, Dockray & Simmons, 2012; Arora et al., 2015; Kaplan-Lewis & Percac-Lima, 2013).

Diabetic patients are often no exception. For instance, Akhter et al. (2012) used a telephone survey to ask T1DM patients who frequently missed appointments how their attendance could be improved, and these patients indicated that sending appointment reminders not too far in advance would be helpful. Their findings suggest improving the administrative approach to patients' appointments', reminding them in advance and improving communication between staff and patients. (Akhter et al., 2012).

As a result, many healthcare organizations have implemented reminder practices

designed to reduce missed appointments. Some authors found mobile phone text message reminders were a cost-effective way of doing so (Brannan, Dewar, Taggerty, & Clark, 2011; Taylor, Bottrell, Lawler, & Benjamin, 2012). However, a more recent study by Kheirkhah et al. (2016) conducted at the U.S. Veterans Health Administration (VHA) found that both phone and text reminder systems have shown only modest improvements in no-show rates. Rai et al. (2011) argued that organizations must nonetheless have interventions to effectively reach out to patients with gaps in care and remind them of their appointments. Otherwise, many patients will at best delay treatment and at worst not seek treatment at all; and over time other interventions to reduce diabetes-related complications may be in vain (Nutti et al., 2015). Parker et al. (2012) therefore suggested that interventions that may address poor appointment keeping deserve special attention (p. 590). Consequently, while patient portals and the appointment reminders that stem from them may not address all of the factors associated with missed appointments, they can address one of the most important: forgetting (Horvath et al., 2011; Markowitz, Volkening, and Laffel, 2014). This potential represents a real opportunity.

Summary

Since many studies indicate that providers may hold the key to increasing patient portal adoption and use, this study may also help address some of the barriers associated with portal endorsement. Most providers can agree that regardless of their position on technology, missed appointments are a long-standing challenge in the healthcare industry (Samuels et al., 2015). Therefore, more providers may be more apt to rally around the idea of the portal and endorse it if it proves an effective way to decrease these events. This study adds to the current body of research by demonstrating which patients are more likely to use patient portals in a chronically ill population. In addition, it addresses two common issues that were described in the literature –

1) the importance of provider endorsement (Ancker et al., 2011; Irizarry et al., 2015; Ronda et al., 2015) and 2) the need to demonstrate how the portal can improve outcomes, costs, and utilization. This study is important because improving population health necessitates that we actively engage this growing population of chronically ill patients.

CHAPTER III

METHODOLOGY

Study Design

A retrospective observational chart review was used to address the following research questions:

1. What are the demographic profiles of MyChart® users?
2. What demographic characteristics predict MyChart® use?
3. Does MyChart® use predict overall no-show percentage?
4. Is there a difference in patients' missed appointment percentage when they have an activated MyChart® account compared to when they do not?

The study design was selected because it addresses the research questions and may pave the way for future research that is not possible without a randomized prospective study. For the primary and secondary research questions, the relationship between MyChart® use and missed appointments, it is hypothesized that no-show percentages are associated with MyChart® use. Further, it is hypothesized that when patients activate a portal account before an appointment, and therefore receive email reminders of their upcoming visit, their missed appointment percentage is reduced.

Setting

The study was conducted at the Medical University of South Carolina (MUSC), a large academic health science center that maintains a 700-bed medical center (MUSC Health) and hosts more than one million patient visits on an annual basis (About MUSC, n.d.). The 2010-2015 MUSC Health Strategic Plan outlined seven strategies to help MUSC become a top 25 academic medical center by 2015 (MUSC Health Strategic Plan, n.d.). One strategy related to

Health Information Technology (HIT) was integrating the outpatient and inpatient Electronic Health Record (EHR) systems, thus improving communication, collaboration, and coordination of care. Accordingly, on July 1, 2014, MUSC implemented an enterprise-wide EHR software solution, Epic®.

The primary goal of the Epic® EHR implementation was to establish a “one patient, one record” solution that assimilated the inpatient and outpatient systems, thereby accomplishing a health-IT related strategic goals. Additionally, the new Epic® EHR enabled MUSC to satisfy a “meaningful use” requirement stipulated by the Health Information Technology for Economic Clinical Health (HITECH) Act that requires EHR technology to be certified.

Study Population

This study included all MUSC adult patients with diabetes on the MUSC Diabetes Registry who a) had an appointment scheduled with one of MUSC’s in-network primary care providers (PCP’s) between July 1, 2014 and June 30, 2015 (the study period) and b) had records available in the Epic® EHR. Six inclusion criteria are established to determine whether a patient is included in the MUSC Diabetes Registry. Patients were included if they met *any* of the first three criteria and *each* of the last three criteria.

1. Patient had a diabetes diagnosis in the Epic® EHR problem list, which includes current or recent medical complaints, issues, or diagnoses recorded by a provider
2. Patient was seen for an appointment and the provider listed a diabetes diagnosis found in the diabetes grouper (i.e. a collection of diagnoses codes that relate to each other clinically) for the visit
3. An invoice was generated to the patient or a third party payer with a diagnosis found in the diabetes grouper

4. Patient was 18 or older
5. Patient's status was not deceased
6. Patient was not flagged as a test (i.e. fictitious) patient that was created and used in the Epic® EHR to allow for workflow and functionality testing.

Nuti et al. (2015) indicated that primary care practices are the main source of healthcare for most patients with diabetes. Accordingly, patient records were selected on the basis of the patient having a primary care provider (PCP) within the MUSC Network during the study period. This criterion helps minimize the risk of including participants seeking care at MUSC for reasons other than diabetic care (e.g. orthopedics).

The study population was refined by the following exclusion criteria: patients who had a pregnancy due date anytime in the future and patients over 80 years of age. The exclusion criteria were designed to remove individuals with gestational diabetes. Additionally, excluding patients over 80 years of age helps mitigate the risk of this subset of patients becoming identifiable, which can occur when specific criteria are applied to small populations.

After inclusion and exclusion criteria were employed, patients were grouped according to their MyChart® account use. Patients who activated their account and logged on two or more times during the study period were classified as *MyChart® users*, an approach consistent with recently published studies (Jones et al., 2015; Ronda et al., 2015). Patients who did not activate an account, or who activated an account but did not log on at least twice during the study period, were classified as *nonusers*. This classification is important because this study sought to define the profiles of active users, not just those who activate an account. Relatedly, since MyChart® users logged in two or more times during the study period, a stronger case may be made that use (not simply enrollment) is an important influence on patient arrivals. This classification

represents a key difference between this research and Horvath et al. (2011).

Intervention (MyChart® Patient Portal)

Within Epic® is a comprehensive patient web-portal called MyChart® (Figure 1). The portal represents the process dimension in Ryan & Sawin's IFSMT theory.

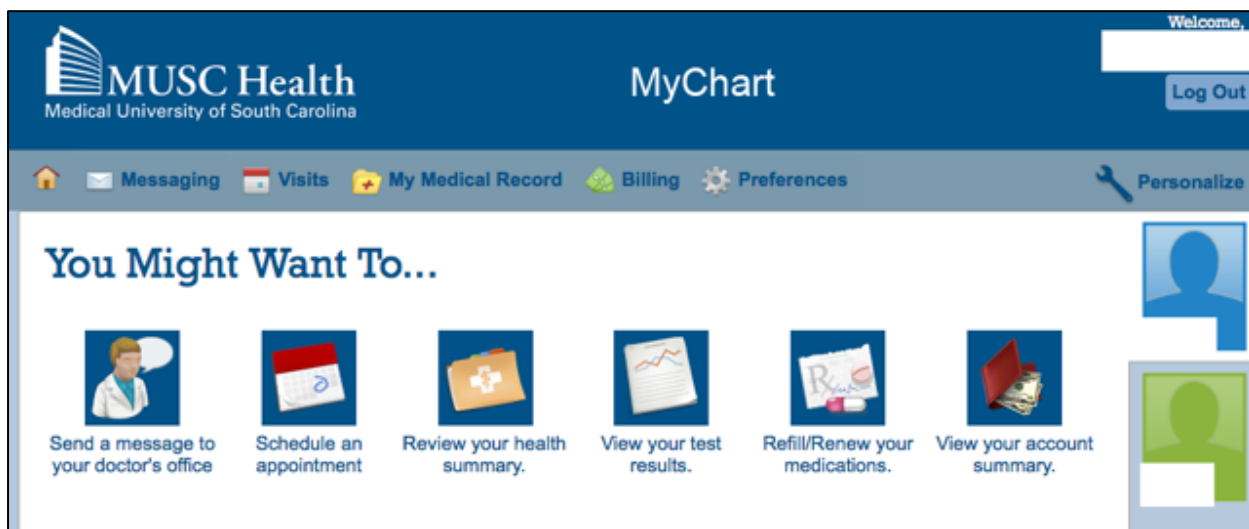


Figure 1: MyChart® patient portal

MyChart® enables patients to engage in their care (e.g. examine test results, refill and renew medications, and send a secure message to their doctor's office) voluntarily and at no cost. Access to information is controlled through secure activation codes, personal usernames, and passwords (MyChart®, 2013). Patients who wish to sign up for an account are issued an activation code during their clinic visit. Alternatively, patients can register for an account online or by calling MUSC. Once the request is processed, patients are emailed an activation code and instructions for completing the registration process. Activation codes expire after 30 days and are no longer valid after the first use (MyChart®, 2013).

A key function of MyChart® is that patients can schedule, view, and cancel appointments. All primary care clinics provide patients the option to schedule an appointment by sending a secure message to their provider. However, some clinics also allow patients to schedule

themselves through the portal. All MyChart® enrollees receive an email confirming their appointment the day it is scheduled, another reminder approximately one week prior to the appointment, and an additional reminder at approximately 48 hours prior to the appointment.

Outcomes

The outcome measures formulated for the purposes of this study are *no-shows* (primary) and *same-day cancellations* (secondary). A no-show is defined in this study as a scheduled appointment that a patient missed without providing any prior notice. A same-day cancellation is defined as an appointment that a patient cancelled within 24 hours of the scheduled time.

Data Set Description

After regulatory and ethics approval from the MUSC Institutional Review Board, a de-identified dataset was requested from the Epic® Research Team. The data was provided by MUSC's Honest Broker and comprised two datasets (one containing patient-level demographic information and the other containing appointment level information). The datasets were linked by a "dummy" (e.g. pseudo) identifier assigned by the Epic® Research Team, a protocol consistent with the requirements for an exempt study.

Definition of Variables

Patient demographics

The following demographic variables were collected for each patient: race (Black/non-Black), marital status (married/not married), gender (male/female), smoking status (smoker/non-smoker), and comorbidities (specifically, whether (yes/no) the patient had hypertension, hyperlipidemia, and/or obesity). Patient age was also collected and considered continuous. MyChart® factors obtained in the demographic dataset included whether the patient had an activated account (yes/no) as well as whether the patient "used" the account (yes/no). As

previously discussed, *use* in this study is defined as having logged on to the portal two or more times during the study period.

For demographic comparisons between groups, patients were classified into one of two categories:

(1) MyChart® nonuser (i.e. does not have an activated account or has an activated account [MyChart® enrollee] but *has not* logged on to the portal two or more times during the study period),

(2) MyChart® user (i.e. has an activated account and *has* logged on to the portal two or more times during the study period).

Patients will be categorized based on their MyChart® activation and “use” status as of 6/30/15.

Appointment demographics

Pertinent appointment data was also captured in a longitudinal dataset: the number of PCP appointments for each patient, the status of the appointment (arrived, no-showed, or cancelled), and whether the patient had an activated MyChart® account (i.e. MyChart® enrollee) at the time of each appointment (yes/no). Cancellations were further classified to identify those that occurred within 24 hours of the scheduled appointment time (i.e. same-day cancellations). As a longitudinal dataset, the MyChart® activation status was assessed at the time of each appointment throughout the one year study period (July 1, 2014 to June 30, 2015). However, “use” was not determined at the time of each appointment—only on June 30, 2015, the end of the reporting period.

Data Analysis Plan

The analysis of Epic® EHR data employed a combination of univariate, bivariate, and multivariate techniques. The study’s unit of analysis was patients. Initially, the demographic

profiles of MyChart® users, nonusers, and enrollees were compared. In addition, the characteristics of patients who use MyChart® were predicted. Subsequently, the primary and secondary research questions, the relationships between portal use and missed appointments (no-shows and same-day cancellations), were examined. All statistical analysis and data management were performed using SPSS®

The demographic profiles of MyChart® enrollees, users, and nonusers were compared using descriptive statistics. Frequency and percentage distributions were calculated on each categorical demographic variable obtained from the Epic® EHR, while the mean and standard deviation were calculated for patient age, the only continuous demographic variable. The bivariate and multivariate analyses only analyzed MyChart® users and nonusers. It is important to note that some patients who were classified as nonusers may also be MyChart® enrollees, but since they did not use the portal at least two times during the study period, they were not distinguished in this study.

To test for statistically significant relationships between MyChart use® ((dependent variable (DV)) and each categorical patient-level demographic variable (independent variables (IVs)) previously described, cross-tabulation and chi-square tests were conducted. Chi-square was selected because both the IVs and DV were categorical. To evaluate the significance of the results, the chi-square coefficient (χ^2) was compared to an expected frequency table. Any p-values less than or equal to .05 were deemed statistically significant. When the calculated χ^2 value was larger than the expected value, the null hypothesis (H_0) was rejected. Rejecting the null hypothesis resulted in accepting the alternative hypothesis (H_A), indicating that the IVs described were statistically significant to MyChart® use in an adult diabetic population. An independent t-test was conducted to determine whether a statistically significant difference

existed between the two groups (MyChart[®] users and nonusers) with respect to age. Again, the significance value was set at $p \leq .05$. The table below shows the hypotheses tested.

H ₀ 1: MyChart [®] use (DV) is not associated with race (IV) among patients with diabetes.	H _A 1: MyChart [®] use (DV) is associated with race (IV) among patients with diabetes.
H ₀ 2: MyChart [®] use (DV) is not associated with marital status (IV) among patients with diabetes.	H _A 2: MyChart [®] use (DV) is associated with marital status (IV) among patients with diabetes.
H ₀ 3: MyChart [®] use (DV) is not associated with gender (IV) among patients with diabetes.	H _A 3: MyChart [®] use (DV) is associated with gender (IV) among patients with diabetes.
H ₀ 4: MyChart [®] use (DV) is not associated with smoking status (IV) among patients with diabetes.	H _A 4: MyChart [®] use (DV) is associated with smoking status (IV) among patients with diabetes.
H ₀ 5: MyChart [®] use (DV) is not associated with hypertension (IV) among patients with diabetes.	H ₀ 5: MyChart [®] use (DV) is associated with hypertension (IV) among patients with diabetes.
H ₀ 6: MyChart [®] use (DV) is not associated with hyperlipidemia (IV) among patients with diabetes.	H ₀ 6: MyChart [®] use (DV) is associated with hyperlipidemia (IV) among patients with diabetes.
H ₀ 7: MyChart [®] use (DV) is not associated with obesity (IV) among patients with diabetes.	H ₀ 7: MyChart [®] use (DV) is associated with obesity (IV) among patients with diabetes.
H ₀ 8: There is no difference in the mean age (DV) between MyChart [®] users and nonusers (IV)	H ₀ 8: There is a statistically significant difference in the mean age (DV) between MyChart [®] users and nonusers (IV)

Binary logistic regression was then used to predict a patient's decision to enroll in MyChart[®]. The DV was coded as 1 for patients who used MyChart[®] and 0 for patients who did not. The independent variables for the regression model were coded as follows: sex (0=male, 1=female) marital status (not married=0, married=1) smoking status (non-smoker=0, smoker=1), race (non-Black=0, Black=1), whether the patient had hypertension (0=no, 1=yes), whether the patient had hyperlipidemia (0=no, 1=yes), whether the patient had obesity (0=no, 1=yes), and average age. Binary logistic regression was selected because the DV (i.e. whether the patient uses MyChart[®]) can only have one of two outcomes (yes/no). Logistic regression (logit command) was used to sort out the independent effects of each demographic variable. Significant coefficients were identified where $p \leq .05$. The odds ratio or $\text{Exp}(b)$ provides the odds of a change

in the DV that occur with a one unit increase in the predictor variable. The following hypotheses were tested:

H ₀ 9: Race (IV) does not predict MyChart [®] use (DV) among patients with diabetes.	H _A 9: Race (IV) predicts MyChart [®] use (DV) among patients with diabetes.
H ₀ 10: Marital status (IV) does not predict MyChart [®] use (DV) among patients with diabetes.	H _A 10: Marital status (IV) predicts MyChart [®] use (DV) among patients with diabetes.
H ₀ 11: Gender (IV) does not predict MyChart [®] use (DV) among patients with diabetes.	H _A 11: Gender (IV) predicts MyChart [®] use (DV) among patients with diabetes.
H ₀ 12: Smoking status (IV) does not predict MyChart [®] use (DV) among patients with diabetes.	H _A 12: Smoking status (IV) predicts MyChart [®] use (DV) among patients with diabetes.
H ₀ 13: Hypertension (IV) does not predict MyChart [®] use (DV) among patients with diabetes.	H _A 13: Hypertension (IV) predicts MyChart [®] use (DV) among patients with diabetes.
H ₀ 14: Hyperlipidemia (IV) does not predict MyChart [®] use (DV) among patients with diabetes.	H _A 14: Hyperlipidemia (IV) predicts MyChart [®] use (DV) among patients with diabetes.
H ₀ 15: Obesity (IV) does not predict MyChart [®] use among patients with diabetes.	H _A 15: Obesity (IV) predicts MyChart [®] use among patients with diabetes.
H ₀ 16: Age (IV) does not predict MyChart [®] use among patients with diabetes	H _A 16: Age (IV) predicts MyChart [®] use among patients with diabetes

By linking the appointment data to the patient demographic data, additional descriptive statistics were computed. Specifically, the mean number of appointments per patient and the average no-show and same-day cancellation percentage for each patient.

Multiple linear regression analyses were used to determine whether a patient's MyChart[®] user status significantly predicted overall no-show percentages, after controlling for all other demographic variables. Therefore, the linear regression model will illustrate which predictor variables best explain no-show percentages. Multiple linear regression was selected because the dependent variable is continuous (% no-show) and it was important to study the effect of multiple variables on the outcome, not simply MyChart[®] use. The following hypotheses were tested:

H ₀ 17: MyChart® use (IV) does not predict no-show percentages (DV) among patients with diabetes.	H _A 17: MyChart® use (IV) predicts no-show percentages (DV) among patients with diabetes.
--	--

Finally, to determine whether MyChart account activation at the time of appointment had any impact on the mean no-show and same-day cancellations (i.e. missed appointment) percentages, patients who activated a portal account during the study period were subjected to a within-subjects analysis. The number of no-shows and same-day cancellations were combined and classified as missed appointments. The percentage of missed appointments with an activated portal account and without an activated portal account was computed. Then, the differences in each patient's mean missed appointment percentage pre and post portal activation was compared using a two-sided paired-samples t-test to determine the potential impact of portal activation. The paired-samples t-test was selected because the participants in the two groups (those with an activated account and those without) are the same. In this way, individual differences were not a factor as the test measures each patient's missed appointment percentage before and after portal activation. The following hypotheses were tested:

H ₀ 18: An activated MyChart® account at the time of appointment has no impact on a patient's missed appointment percentage.	H ₀ 18: An activated MyChart® account at the time of appointment does have an impact on a patient's missed appointment percentage.
---	---

Protection of Human Subjects

The investigator successfully completed the Collaborative IRB Training (CITI) tutorial module (Group 2: Social & Behavioral Investigators & Key Personnel) prior to starting this research. To obtain approval for this study, an application was submitted electronically to the MUSC Institutional Review Board (IRB) through the organization's eIRB website. The study was evaluated and approved in the Exempt research category in accordance with 45 CFR

46.101(b)(2). Once IRB approval was obtained, Epic® data was provided by MUSC's Honest Broker. This process was facilitated by the completion of both a service request in SPARC (Services, Printing, & Application for Research Centers) and a Research Data Request form, as well as approval by the Research Team's Data Review Committee.

Limitations

This research project may provide important insights into the use of the patient portal in a chronically ill population to improve missed appointments. However, there were six key limitations in this study. The most important limitation is related to the retrospective study design. Data was derived from the pre-existing medical records of patients with diabetes, which provides an inferior level of evidence when compared to a randomized, prospective study. Therefore, this study only identified associations and did not determine causality.

The second limitation is the manner in which MyChart® use was defined. The goal was to define use by the number of log-ins as well as detailed information regarding how the patient used the portal (e.g., viewing lab results, scheduling an appointment, requesting a medication refill). Unfortunately, given time and resource constraints, a detailed review of the log files that contained this granular information was not feasible. Thus, use was defined as having logged on to the portal two or more times during the study period as previously explained.

The third limitation associated with non-research oriented administrative records is that they are frequently incomplete or inaccurate. Accordingly, some demographic records contained missing data related to the patient's comorbidities (hypertension, hyperlipidemia, and obesity). However, the number of records that contained missing data was limited to 42 records, so this issue did not pose serious problems for data analysis.

The fourth limitation stems from the cross-sectional nature of the demographic dataset.

With demographic variables captured at one point in time, the end of the reporting period, there is always a risk that they may have changed during the study period.

The fifth limitation is that the study results were drawn from primary care clinics within one academic medical center. Since the study involved a specific organization and group of chronically ill patients, it is uncertain whether the findings will generalize to other populations or settings

Finally, the sixth limitation is selection bias given that the MUSC Diabetes Registry was sampled. In some cases, patients presenting to MUSC for the first time for non-diabetes related care (e.g. cancer) could indicate that they had diabetes and, thus, may or may not be included in the Diabetes Registry. If the diabetes diagnosis was not clinically confirmed by an MUSC PCP, some patients may not belong to the population intended to be analyzed.

CHAPTER IV

RESULTS

Who uses MyChart®?

Demographic Characteristics of MyChart® Users

During the study period (July 1, 2014 to June 30, 2015), 7,297 patients with diabetes scheduled 45,022 appointments (M=6.17 appts/pt, SD=4.524) with one of MUSC's PCP's. While all patients could activate an account during the study period, only a portion of them did. Of the 7,297 patients, 3,186 (43.7%) were considered MyChart® users, and thus they had an activated portal account and logged on two or more times during the study period. MyChart® users were significantly more likely to be female (55.2%), non-Black/African American (69.6%), married (65.1%), non-smokers (93%), and have at least one of the following comorbidities: hypertension (83.5%), obesity (76.1%), and hyperlipidemia (83.9%). The average age of portal users was 58.8 years (SD 12.2). The p-value in the bivariate analysis (i.e. chi-square tests and *t*test) indicates that each demographic variable is statistically significant to MyChart® use ($p \leq .05$). Accordingly, the null hypotheses (H_{01} - H_{08}) can be rejected and the alternative hypotheses accepted (H_{a1} - H_{a8}), indicating that each demographic variable has a relationship with portal use. The overall missed appointment rate (no-shows and same-day cancellations) for both MyChart® users and nonusers combined was 17%, consisting of 9.2% (4,171/45,022) no-shows and 7.7% (3,499/45,022) same-day cancellations. The average no-show rate was significantly lower for patients who used the portal (4.7%) compared to patients who did not (12.4%) ($t(7295) = 19.949$, two-tail $p = .000$). The average same-day cancellation rate was only slightly lower, yet statistically significantly different, for portal users (5.3%) compared to nonusers (6.7%) ($t(7295) = 5.100$, two-tail $p = .000$). See Table 1 for demographic comparisons between users and nonusers.

Demographic Characteristics that Predict MyChart® use

A binomial logistic regression was conducted to determine whether the demographic characteristics have any relationship to a patient using MyChart® (DV). The number of observations was 7,295, reduced by two from the 7,297 study population to remove patients who did not have each comorbidity denoted in the Epic® EHR. The Omnibus Tests of Model Coefficients was statistically significant ($\chi^2(8)=1552.34, p \leq .000$), which indicates that adding the demographic variables to the model increased its predictive power. Including the predictor variables resulted in correctly classifying the outcome for 70.5% of cases compared to 53.3% in the constant only model. The Nagelkerke R^2 value was .257, indicating that only 25.7% of the variance in MyChart® use is explained by the variance in the demographic variables. Therefore, there are many other variables not in our model which influence whether a patient will use the portal.

The results of the logistic regression model indicate that with the exception of hypertension, which has a significance value of .152, all demographic characteristics analyzed significantly predicted MyChart® use (Table X, all $p \leq .05$). Therefore, patients who are female, married, and have comorbidities (specifically, hyperlipidemia and obesity) are significantly more likely to use MyChart®. Conversely, patients who are older, Black/African American, and smokers are significantly less likely to use the portal.

The odds ratio (i.e. $\text{Exp}(B)$) indicates the odds that a patient will use MyChart® based on a change in the predictor variable. Therefore, when the predictor variable increases by one unit, the odds that MyChart® use can be predicted increase by the $\text{Exp}(B)$ factor when all the other variables are held constant. For example, the odds ratio associated with marital status is 1.879. Accordingly, when a patient's marital status changes from not married to married, they are

almost two times as likely or 88% more likely to use MyChart®. The odds ratio was also positive for sex (1.258), hyperlipidemia (1.298), and obesity (1.192). Therefore, females are 25.8% more likely than males to use the portal and patients with hyperlipidemia and obesity are 25.8% and 19.2% more likely to use the portal.

Likewise, the odds ratio associated with smoking status is .412, indicating that patients who smoke are more than half (41.2%) as likely to use MyChart®. The odds ratio was also less than one for age (.966) and race (.184). Thus, for every one unit increase in a patient's age, the likelihood that they will use the portal is decreased slightly (by .966 times), after controlling for the other factors in the model. Conversely, being Black/African-American considerably decreases the likelihood of portal use even after controlling for other demographic variables (Table 2).

The Impact of MyChart® on Missed Appointments

Factors that Predict No-Show Percentages

A standard multiple linear regression analysis was conducted to test whether a patient's MyChart® user status significantly predicted overall no-show percentages, after controlling for all other independent demographic variables. The regression model contained nine predictor variables MyChart® user [0=no, 1=yes], sex [0=male, 1=female] marital status [not married=0, married=1] smoking status [non-smoker=0, smoker=1], race [non-Black=0, Black=1], and comorbidities [0=no, 1=yes] and average age.

Six of the predictor variables (age, marital status, smoking status, race, presence of hypertension, and MyChart® use) were significantly associated with no-show percentages ($p \leq .05$). Smoking status ($\beta=.034$, $p=.000$) and race ($\beta=.042$, $p=.000$) positively and significantly predicted no-show percentages. Therefore, patients who smoke have a 3.4% higher no-show

percentage than non-smokers while holding all other variables constant. Similarly, Black/African Americans have a 4.2% higher no-show percentage than non-Black/African Americans. Age ($\beta=-.002$, $p=.000$), marital status ($\beta=-.010$, $p=.013$), and hypertension ($\beta=-.015$, $p=.006$) were all negatively and significantly correlated with no-show percentage. The odds ratio indicates that patients who are older have a .02% lower no-show percentage, those who are married have a 1% lower no-show percentage, and those with hypertension have a 1.5% lower no-show percentage. Most importantly, MyChart[®] use ($\beta=-.062$, $p=.000$) significantly predicted no-show percentage, indicating that patients who use the portal are 6.2% less likely to no-show. Neither sex (female) nor hyperlipidemia or obesity contributed to the regression model. The linear regression model used accounts for significantly more variance than would be expected by chance (i.e. with a constant only model). However, the overall model fit was $R^2=.113$, suggesting that only 11.3% of the variance was explained by the model (Table 3).

Within-subjects Analysis for Patients who activated MyChart[®] during the study period

A paired-samples *t*test was conducted to compare the mean percent of missed appointments (i.e. no-shows and same-day cancellation) before and after MyChart[®] activation. The results specified that for the 78 patients who activated a portal account during the study period, the mean percentage of missed appointments when patients had an activated account ($M=23.12$, $SD=41.608$) was not significantly different from when they had an inactivated account ($M=37.23$, $SD=47.933$), $t(77)=-1.658$, two-tail $p=.101$). Therefore, patients' missed appointment percentage does not significantly change when they activate an account and the difference in the two population means ($M=-14.106$) is likely due to chance (Table 4).

CHAPTER V

DISCUSSION

Discussion of Results

This study described the demographic characteristics of adult patients with Type 1 and Type 2 diabetes who actively used the MyChart® patient portal at MUSC. Remarkably, portal users comprised 43.7% (3,186/7,297) of the overall study population, a percentage far greater than the mere 5 to 10 percent of American adults previously reported to use portals (Abdouch, 2015; Giardina, Modi, Parrish, & Singh, 2015) and in gross excess of Stage 2 MU requirements that require only one person seen during the reporting period to access the portal. This higher than average usage rate demonstrates that the patient portal is in fact a viable tool for engaging adult patients with diabetes in their own care. Portals may therefore provide a suitable strategy for keeping this growing population accountable and engaged in managing their health. As previously indicated, portal users were predominantly female, non-Black/African-American, non-smokers, married, and had hypertension, hyperlipidemia, and obesity. The average age of a portal user was 58.8 (SD=12.2) years and while statistically different, was rather comparable to nonusers whose average age was 61.6 (SD=12.2) years.

Predictors of Portal Use in a Chronically Ill Population

The predictors of portal enrollment and use in a chronically ill population have varied. Some studies have found that men are more likely to actively use the portal (Jones et al., 2015; Nijland et al., 2011; Ronda et al., 2015), while others have demonstrated that women are more likely (Fleming, Cullen, & Luna; 2015; Horvath et al., 2011; Kruse, Bolton, & Freriks, 2015). There have also been conflicts surrounding the age of EHR portal users, with some studies indicating that they are younger than the average population (Ronda et al., 2013; Tenforde et al.,

2012) and others describing them as older (Ancker et al., 2011; Horvath et al., 2011). Many of those contradictions can likely be attributed to differences in the geographical locations where the studies were conducted, dissimilar healthcare organizations that served as the study setting, and diverse inclusion and exclusion criteria (e.g. some examined diabetic patients while others looked at patients with other chronic conditions). Nonetheless, for this study, gender, age, race, marital status, smoking status, and the presence of comorbidities often associated with diabetes (i.e. hypertension, hyperlipidemia, and obesity) all significantly predicted portal use.

While some demographic factors are known confounders such as race and gender, the inclusion of marital status and smoking status in this study has not been widely studied in previous research. Married patients were significantly more likely to use the portal, lending credibility to previous findings indicating that family members' involvement, in this case a spouse, may be a means to increase portal use (Mayberry et al., 2011; Mayberry et al., 2014). Similarly, those with comorbidities were more likely to use the portal as they likely have greater health needs. Smoking status was examined because MU requirements dictate that it be recorded in the EHR given the tremendous health risk smoking poses to patients. Unfortunately, smokers in the study were less likely to use the MyChart® patient portal which could help make the disease more challenging to control.

Riippa, Linna et al. (2014) suggested that the “digital divide” between sociodemographic groups is narrowing as Internet access grows. However, consistent with other prior research, this study found tremendous racial disparities in portal use as only 30.3% of users were Black, compared to 69% of nonusers (Ancker et al., 2011; Goel et al., 2011; Sarkar et al., 2011). This finding is not trivial, since previous research has indicated that Blacks/African-Americans have a dramatically higher prevalence of diabetes with greater disease and mortality burdens compared

to non-Hispanic White Americans (Chow, Foster, Gonzalez, & McIver, 2012). Therefore, the same individuals who are less likely to use the patient portal are also more likely to have diabetes and suffer poor health outcomes from the disease. Accordingly, the portal may be useful in engaging chronically ill patients overall, but it is less advantageous in engaging minorities, and specifically Blacks/African-Americans. Greater understanding of the factors that influence racial minorities to engage in their care will be critical so that existing healthcare disparities are not further exacerbated.

When predicting the demographic characteristics related to portal use, only a small portion of the variance ($R^2=.257$) could be explained by the hypothesized logistic regression model. However, this finding was expected, as the literature indicates many different factors (e.g., literacy, numeracy, educational attainment) that must be considered when predicting portal use. Many of those variables were not evaluated in this study, and thus the low R^2 value was not disappointing. The low R^2 value does not change the importance of the p-values and odds ratios and thus important conclusions can still be drawn on the statistically significant predictors associated with a change in portal use.

The Impact of MyChart® on Missed Appointments

In other countries, where healthcare systems can differ significantly from the United States', the issue of missed appointments has been discussed heavily with a variety of patient populations (Hung, Fu, Lau, & Wong, 2015; Jyun-You, Chia-Fen, & Chao-Yu, 2012; Khader et al., 2014; Masding et al., 2010; Snow & Fulop, 2012; Waqar et al., 2012). In the United States, Horvath et al. (2011) documented the portal as an effective tool for engaging patients and thus potentially reducing missed appointments.

Differing from Horvath et al. (2011), the present study focused on a chronically ill

population who would likely derive the greatest benefit from greater appointment attendance. In this study, several demographic characteristics (i.e. smoking status, race, age, and marital status) were independent predictors of no-show percentages in the multiple linear regression model. Of concern was the discovery that Black/African-American patients were significantly more likely to no-show. With diabetes impacting minority populations more than Whites, Black/African-American patients would likely benefit the most from the appointments they are missing.

Most importantly, this study found that portal use was a significant predictor of no-show percentages even after controlling for each of the other demographic factors previously referenced. Therefore, the odds of no-showing were reduced by 6.2% when patients used MyChart® suggesting that the portal contributes to greater appointment adherence.

The R^2 value of the linear regression model was only .113, meaning that only 11.3% of the variance is explained by the model. With a wide variety of reasons contributing to missed appointments (e.g., transportation issues, childcare constraints, forgetting) and patients being relatively unpredictable, this finding was not surprising. Still, the p-value indicates a statistically significant relationship between the predictor variables (smoking status, race, marital status, age, and MyChart® use) and no-show percentages. The odds ratio remains the same as well, regardless of the R^2 value, and suggests how the outcome variable (no-show percentages) responds with a one unit change in each significant predictor. That is for example, when a patient uses the portal, their no-show percentage is almost two times less than if they did not use the portal.

The overall mean no-show percentage for patients who had an activated MyChart® account throughout the study period (and therefore at each PCP appointment) was significantly

lower (5.8%), when compared to those with an inactivated account (12.5%).² For patients who activated a portal account *during* the study period, the mean percentage of missed appointments pre (M=23.12, SD=41.608) and post (M=37.23, SD=47.93) MyChart® activation were compared. Then the statistical significance of the differences was assessed with a “within-subjects” analysis. Unfortunately, and contrary to expectations, the paired t-test did not show a statistically significant difference in the mean missed appointment percentage when patients had an activated account at the time of their appointment compared to when they did not. Therefore, patients’ missed appointment percentage did not significantly change when they activated an account, and the differences in the population means (M=-14.106) are likely due to chance. It is important to note that only 78 patients activated their portal account during the study period (2.4% of users), and some did not have a missed appointment (i.e. no-show or same-day cancellation) during the 12 month study period. While the p-value (.10) was very close to the significance value (.05), this finding corroborates what the previous multivariate analysis suggests: that the portal is only one component to appointment arrivals.

Thus, this study validates that the portal is not only useful in engaging chronically ill patients, but those who use it have a lower appointment no-show percentage. With missed appointments posing pivotal barriers to effective chronic disease management, this outcome is invaluable. However, the change in mean missed appointment percentage was not statistically different when tested in a small subset of the study population. Accordingly, the patient portal, like any intervention involving patients, is only one element in the multifaceted patient

² Portal user status was only assessed at the end of the reporting period on 6/30/15. Use was defined by two or more log-ins over the twelve month study period. Therefore when a patient is said to have an activated portal account at the time of their PCP appointment (assessed at each appointment), they may or may not be deemed a portal user as that information was not assessed at the time of each appointment (only whether they had an activated/inactivated account).

engagement solution.

Conclusion

The patient portal is one of many tools available to healthcare organizations striving to engage patients in their care. In this study, the portal's value for engaging chronically ill patients was demonstrated. Specifically, this study indicates that patients with diabetes who use the portal are less likely to no-show for their primary care appointments. For patients who require routine follow-up, this finding is meaningful since previous research has associated clinic nonattendance with increased mortality in patients with Type 2 diabetes (Currie et al., 2012).

As a retrospective observational study, the research was limited to the variables available for analysis. However, to effectively engage patients in the portal, thereby encouraging them to take a greater role in their health and wellbeing, healthcare organizations must thoroughly evaluate the many underlying factors that contribute to portal use. The findings in this study provide the foundational knowledge necessary to warrant further research, including randomized prospective studies. Randomized prospective studies would better assess the relationships between portal use and missed appointments and clarify causation more directly. Future studies could also expand to include other chronically ill populations (e.g. heart disease, cancer). Finally, cost was not evaluated in this study, but it is reasonable to assume that a certified EHR is not inexpensive. Hence, the benefits of portals at reducing missed appointments must be properly vetted against the cost of portal installation.

Summary

Across the United States, healthcare organizations are striving to reduce costs, enrich their quality of care, enhance patient satisfaction, and most importantly improve population health. For a country that is profoundly encumbered by chronic health issues, efforts to improve

healthcare delivery will be stifled if they do not center on reducing the burden of disease. More plainly, the United States is in the midst of a health--not healthcare--crisis and patient engagement is of utmost importance. While the patient portal is only one tool for encouraging patients to take an active role in their health, this study has highlighted that it is an important one and thus merits greater attention, particularly in a chronically ill population that desperately need engaging.

TABLES

Table 1. Characteristics of MyChart® Users compared to Nonusers (Percentages in Parentheses)

Characteristic	MyChart® Users ^a N=3,186 (43.7)	Nonusers N=4,111 (56.3)
Female	1,761 (55.2)	2,515 (61.1)
Race		
Non-Black ^b	2,220 (69.6)	1,272 (30.9)
Non-Smoker	2,965 (93)	3,540 (86.1)
Married	2,077 (65.1)	1,842 (44.8)
Comorbidities		
Hypertension	2,662 (83.5)	3,534 (85.9)
Obesity	2,426 (76.1)	2,954 (71.8)
Hyperlipidemia	2,674 (83.9)	3,360 (81.7)
Age (mean/std. dev)	58.8/12.2	61.6/12.2
Mean No-show %	4.7	12.4

^a Status as of 06/30/15

^b Non-Black includes White/Caucasian and Other (any other race except Black/African American or White/Caucasian).

Table 2: Logistic Regression Analysis predicting MyChart[®] use for patients with diabetes.

Predictor Variables ^d	B ^b	Significance ^a	Exp(B) ^c
Constant	1.827	.000	6.218
Female (1)	.229	.000	1.258
Age	-.034	.000	.966
Black/African-American (1)	-1.692	.000	.184
Married (1)	.631	.000	1.879
Smoker (1)	-.887	.000	.412
Has Hypertension (1)	.113	.152	1.120
Has Hyperlipidemia (1)	.261	.001	1.298
Is Obese (1)	.176	.006	1.192

^a The significance column indicates whether the coefficient is significantly different from 0. p-values less than or equal to .05 are deemed statistically significant. With the exception of hypertension, all predictors are significant to MyChart[®] use.

^b This column describes the amount of increase or decrease expected in the dependent variable (MyChart[®] use coded as 0=nonuser and 1=user) that would be predicted by a 1 unit increase/decrease in each predictor variable. Since the column is represented in log-odds units, it can be difficult to interpret, thus the values are converted to odds ratios in the Exp(B) column.

^c The Exp(B) (odds ratio) column describes the amount of change in the DV expected from a one unit increase/decrease in the predictor variable. For example, marital status is a categorical variable coded as (0=not married and 1=married). Therefore, when all other variables are held constant, patients who are married are 87.9% more likely to use the portal when compared to patients who are not married. The odds ratio is also positive for sex, hyperlipidemia, and obesity and negative for age, race, and smoking status.

^d With the exception of age, each of the predictor variables are categorical. The reference group is coded as 0 and the alternative is coded as 1. For example, smoking status is coded as (0=non-smoker and 1=smoker). The reference category for each of the other categorical variables is (0 = male, non-Black, not married, does not have hypertension, does not have hyperlipidemia, and is not obese).

Table 3: Linear Regression Model predicting No-show percentages

Predictor Variables	Unstandardized B Coefficients ^b	t ^a	Significance ^a
Constant	.255	20.897	0.000
Sex	-.007	-1.768	0.077
Age	-.002	-12.369	0.000
Race	.042	10.008	0.000
Marital Status	-.010	-2.496	0.013
Smoking Status	.034	5.692	0.000
Has Hypertension	-.015	-2.766	0.006
Has Hyperlipidemia	-.014	-2.581	0.010
Is Obese	.001	0.296	0.767
Uses MyChart[®]	-0.062	-15.003	0.000

^a The t and significance columns indicates whether the coefficient is significantly different from 0. p-values less than or equal to .05 were deemed statistically significant. Age, race, marital status, smoking status, has hypertension, and MyChart[®] use were all significantly associated with no-show percentages. Sex, hyperlipidemia, and obesity did not contribute to the model.

^b The unstandardized B coefficient provides the values for the regression equation for predicting the DV from the IV. The coefficient for MyChart use[®] is -.062. Thus when a patient converts from a nonuser to user, they are 6.2% less likely to no-show, when all other variables are held constant.

Table 4: Within-subjects comparison: Paired samples t-test comparing mean missed appointment percentage between those with and without an activated MyChart® account

	n	Groups			
		With MyChart®		Without MyChart®	
		M ^a	SD ^b	M	SD
Missed Appointment Percentage	78	23.12	41.608	37.23	47.933
	df ^c	M	SD	<i>t</i>	Significance ^d
Paired Differences (with/without MyChart®)	77	-14.106	75.117	-1.658	0.101

^aM=Mean

^bSD=Standard Deviation

^cdf=degrees of freedom (n-1)

^dp≤.05

REFERENCES

- Agency for Healthcare Research and Quality (AHRQ). (n.d.). *Shared decision-making*. Retrieved from www.cahps.ahrq.gov
- Akhter, K., Dockray, S., & Simmons, D. (2012). Exploring factors influencing non-attendance at the diabetes clinic and service improvement strategies from patients' perspectives. *Practical Diabetes*, 29(3), 113-116. doi:10.1002/pdi.1670
- Al Sayah, F., Majumdar, S. R., Williams, B., Robertson, S., & Johnson, J. A. (2013). Health literacy and health outcomes in diabetes: a systematic review. *J Gen Intern Med*, 28(3), 444-452. doi:10.1007/s11606-012-2241-z
- Amante, D. J., Hogan, T. P., Pagoto, S. L., & English, T. M. (2014). A systematic review of electronic portal usage among patients with diabetes. *Diabetes Technol Ther*, 16(11), 784-793. doi:10.1089/dia.2014.0078
- American Hospital Association (AHA). (2015). *Most wired hospitals focus on security and patient engagement* [Press release]. Retrieved from www.aha.org/presscenter/pressrel/2015/150709-pr-mostwired.shtml
- Ancker, J. S., Barron, Y., Rockoff, M. L., Hauser, D., Pichardo, M., Szerencsy, A., & Calman, N. (2011). Use of an electronic patient portal among disadvantaged populations. *J Gen Intern Med*, 26(10), 1117-1123. doi:10.1007/s11606-011-1749-y
- Auduly, A. (2013). The over time development of chronic illness self-management patterns: a longitudinal qualitative study. *BMC Public Health*, 13, 452. doi:10.1186/1471-2458-13-452
- Barello, S., Graffigna, G., Vegni, E., & Bosio, A. C. (2014). The challenges of conceptualizing patient engagement in health care: A lexicographic literature review. *Journal of*

Participatory Medicine, 6, e9.

- Barlow, R. D. (2015, April). EHRs: Utility vs. futility. *Health Management Technology*, 36(4), 6-9. Retrieved from <http://www.healthmgttech.com>
- Bodenheimer, T. (2005). The political divide in health care: a liberal perspective. *Health Affairs* (24)6, 1426-1435.
- Boger, E., Ellis, J., Latter, S., Foster, C., Kennedy, A., Jones, F., . . . Demain, S. (2015). Self-Management and Self-Management Support Outcomes: A Systematic Review and Mixed Research Synthesis of Stakeholder Views. *PLoS One*, 10(7), e0130990.
doi:10.1371/journal.pone.0130990
- Bowen, G. A. (2006). Grounded theory and sensitizing concepts. *International Journal of Qualitative Methods*, 5(3), 12-23. doi: 10.1177/160940690600500304
- Brannan, S. O., Dewar, C., Taggerty, L., & Clark, S. (2011). The effect of short messaging service text on non-attendance in a general ophthalmology clinic. *Scott Med J*, 56(3), 148-150. doi:10.1258/smj.2011.011112
- Buntin, M. B., Burke, M. F., Hoaglin, M. C., & Blumenthal, D. (2011). The benefits of health information technology: a review of the recent literature shows predominantly positive results. *Health Aff (Millwood)*, 30(3), 464-471. doi:10.1377/hlthaff.2011.0178
- Byczkowski, T. L., Munafo, J. K., & Britto, M. T. (2014). Family perceptions of the usability and value of chronic disease web-based patient portals. *Health Informatics Journal*, 20(2), 151-162. doi:10.1177/1460458213489054
- Centers for Disease Control and Prevention (CDC), Chronic Disease Prevention and Health Promotion. (2015). *Chronic Disease Overview*. Retrieved from <http://www.cdc.gov>

Centers for Medicare & Medicaid Services (CMS), Medicare. (2012). Electronic Health Records. Retrieved from [https://www.cms.gov/Medicare/E-](https://www.cms.gov/Medicare/E-Health/EHealthRecords/index.html?redirect=/ehealthrecords/)

[Health/EHealthRecords/index.html?redirect=/ehealthrecords/](https://www.cms.gov/Medicare/E-Health/EHealthRecords/index.html?redirect=/ehealthrecords/)

Centers for Medicare & Medicaid Services (CMS), Regulations and Guidance. (2014). *EHR incentive programs*. Retrieved from [https://www.cms.gov/Regulations-and-](https://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/index.html?redirect=/ehrincentiveprograms/)

[Guidance/Legislation/EHRIncentivePrograms/index.html?redirect=/ehrincentiveprograms/](https://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/index.html?redirect=/ehrincentiveprograms/)

Centers for Medicare & Medicaid Services (CMS), Regulations and Guidance, EHR Incentive Programs. (2016). *2015 program requirements*. Retrieved from

[https://www.cms.gov/Regulations-and-](https://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/2015ProgramRequirements.html)

[Guidance/Legislation/EHRIncentivePrograms/2015ProgramRequirements.html](https://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/2015ProgramRequirements.html)

Charmel, P. A., & Frampton, S. B. (2008). Building the business case for patient-centered care. *Healthcare Financial Management, 62*(3), 80-5.

Chow, E. A., Foster, H., Gonzalez, V., & McIver, L. (2012). The disparate impact of diabetes on racial/ethnic minority populations. *Clinical Diabetes, 30*(3), 130-133. doi:

10.2337/diaclin.30.3.130

Colorafi, K. J. (2015). *Patient-centered health information technology: Engagement with the plan of care among older adults with multi-comorbidities* (Doctoral dissertation). Arizona State University.

Currie, C. J., Peyrot, M., Morgan, C. L., Poole, C. D., Jenkins-Jones, S., Rubin, R. R., . . . Evans, M. (2012). The impact of treatment noncompliance on mortality in people with type 2

diabetes. *Diabetes Care, 35*(6), 1279-1284. doi:10.2337/dc11-1277

- Daggy, J. Lawley, M., Willis, D., Thayer, D., Suelzer, C., DeLaurentis, P., Turkcan, A., ... Sands, L. (2010). Using no-show modeling to improve clinic performance. *Health Informatics Journal*, 16(4), 246-259.
- Daniel, J., Deering, M. J., & Murray, M. Office of the National Coordinator. (2014). *Issue brief: Using health IT to put the person at the center of their health and care by 2020*. Retrieved from https://www.healthit.gov/sites/default/files/person_at_thecenterissuebrief.pdf
- Derman, C. S. (2014). Use of secure messaging by united states veterans and significant others (Doctoral dissertation). Retrieved from University of Wisconsin Milwaukee (UWM) Digital Commons. (623)
- DuMontier, C., Rindfleisch, K., Pruszynski, J., & Frey, J. J., 3rd. (2013). A multi-method intervention to reduce no-shows in an urban residency clinic. *Fam Med*, 45(9), 634-641. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/24136694>
- Emanuel, E. J., & Emanuel, L. L. (1992). Four models of the physician-patient relationship. *JAMA*, 267(16), 2221-2226. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/1556799>
- Epstein, R. M., & Street, R. L., Jr. (2011). The values and value of patient-centered care. *Ann Fam Med*, 9(2), 100-103. doi:10.1370/afm.1239
- Fleming, N. L., Cullen, D., & Luna, G. (2015). An evaluation of patient web portal engagement: An exploratory study of patients with hypertension and diabetes. *Online Journal of Nursing Informatics (OJNI)*, 19(3). Retrived from <http://www.himss.org/ojni/>
- Gellad, W. F., Hass, J. S., & Safran, D. G. (2011). Race/ethnicity and nonadherence to prescription medications among seniors: Results of a national survey. *Journal of General Internal Medicine*, 26(2), 1572-1578.

- Giardina, T., Modi, V., Parrish, D., & Singh, H. (2015). The patient portal and abnormal test results: An exploratory study of patient experiences. *Patient Experience Journal*, 2(1). Retrieved from <http://pxjournal.org/journal/vol2/iss1/20>
- Goel, M. S., Brown, T. L., Williams, A., Cooper, A. J., Hasnain-Wynia, R., & Baker, D. W. (2011). Patient reported barriers to enrolling in a patient portal. *J Am Med Inform Assoc*, 18 Suppl 1, i8-12. doi:10.1136/amiajnl-2011-000473
- Goldzweig, C. L., Orshansky, G., Paige, N. M., Towfigh, A. A., Haggstrom, D. A., Miake-Lye, I., . . . Shekelle, P. G. (2013). Electronic patient portals: evidence on health outcomes, satisfaction, efficiency, and attitudes: a systematic review. *Ann Intern Med*, 159(10), 677-687. doi:10.7326/0003-4819-159-10-201311190-00006
- Graffigna, G., Barelo, S., Libreri, C., & Bosio, C. A. (2014). How to engage type-2 diabetic patients in their own health management: implications for clinical practice. *BMC Public Health*, 14, 648. doi:10.1186/1471-2458-14-648
- Greene, J. & Hibbard, J. H. (2012). Why does patient activation matter? An examination of the relationship between patient activation and health-related outcomes. *Journal of General Internal Medicine*, 27(5), 520-526.
- Gruman, J., Jeffress, D., Edgman-Levitan, S., Simmons, L. H., & Kormos, W. A. (2011). *Supporting patient engagement in the patient-centered medical home* [White paper]. Retrieved from www.cfah.org/file/CFAH_PACT_WhitePaper_current.pdf
- Hibbard, J. H., Mahoney, E. R., Stock, R., & Tusler, M. (2007). Do increases in patient activation result in improved self-management behaviors? *Health Serv Res*, 42(4), 1443-1463. doi:10.1111/j.1475-6773.2006.00669.x

- Healthcare Information and Management Systems Society (HIMSS) (2014). *Using patient portals to achieve meaningful use*. Retrieved from <http://www.himss.org/ResourceLibrary/genResourceDetailPDF.aspx?ItemNumber=35966>
- Healthcare Information and Management Systems Society (HIMSS) (2015). *Patient engagement: What is patient engagement?* Retrieved from <http://www.himss.org>
- Horvath, M., Levy, J., L'Engle, P., Carlson, B., Ahmad, A., & Ferranti, J. (2011). Impact of Health Portal Enrollment With Email Reminders on Adherence to Clinic Appointments: A Pilot Study. *Journal of Medical Internet Research*, 13(2), e41. doi:10.2196/jmir.1702
- Hwang, A. S., Atlas, S. J., Cronin, P., Ashburner, J. M., Shah, S. J., He, W., & Hong, C. S. (2015). Appointment “no-shows” are an independent predictor of subsequent quality of care and resource utilization outcomes. *Journal of General Internal Medicine*. doi:10.1007/s11606-015-3252-3.
- Institute of Medicine (IOM). (2000). *Crossing the quality chasm: A new health system for the 21st century*. Retrieved from <https://iom.nationalacademies.org/~media/Files/Report%20Files/2001/Crossing-the-QualityChasm/Quality%20Chasm%202001%20%20report%20brief.pdf>
- Irizarry, T., Dabbs, A. D., & Curran, C. R. (2015). Patient Portals and Patient Engagement: A State of the Science Review. *J Med Internet Res*, 17(6), e148. doi:10.2196/jmir.4255
- James, J. (2013). Health policy briefs: Patient engagement. *Health Affairs*, 35(1).
- Jerofke, T. A. (2013). *Patient perceptions of patient-empowering nurse behaviors, patient activation, and functional health status after surgery* (Doctoral dissertation). Retrieved from http://epublications.marquette.edu/dissertations_mu/272

- Jones, J. B., Weiner, J. P., Shah, N. R., & Stewart, W. F. (2015). The wired patient: Patterns of electronic patient portal use among patients with cardiac disease or diabetes. *Journal of Medical Internet Research (JMIR)*, *17*(2). doi:10.2196/jmir.3157
- Kaplan-Lewis, E., & Percac-Lima, S. (2013). No-show to primary care appointments: why patients do not come. *J Prim Care Community Health*, *4*(4), 251-255.
doi:10.1177/2150131913498513
- Karter, A. J., Parker, M. M., Moffet, H. H., Ahmed, A. T., Ferrara, A., Liu, J. Y., & Selby, J. V. (2004). Missed appointments and poor glycemic control: an opportunity to identify high-risk diabetic patients. *Med Care*, *42*(2), 110-115. doi:10.1097/01.mlr.0000109023.64650.73
- Krist, A. H., Woolf, S. H., Rothemich, S. F., Johnson, R. E., Peele, J. E., Cunningham, T. D., . . . Matzke, G. R. (2012). Interactive preventive health record to enhance delivery of recommended care: a randomized trial. *Ann Fam Med*, *10*(4), 312-319.
doi:10.1370/afm.1383
- Krist, A. H., Woolf, S. H., Bello, G. A., Sabo, R. T., Longo, D. R., Kashiri, P., . . . Cohn, J. (2014). Engaging primary care patients to use a patient-centered personal health record. *Ann Fam Med*, *12*(5), 418-426. doi:10.1370/afm.1691
- Kruse, C. S., Argueta, D. A., Lopez, L., & Nair, A. (2015). Patient and provider attitudes toward the use of patient portals for the management of chronic disease: a systematic review. *J Med Internet Res*, *17*(2), e40. doi:10.2196/jmir.3703
- Kruse, C. S., Bolton, K., & Freriks, G. (2015). The effect of patient portals on quality outcomes and its implications to meaningful use: a systematic review. *J Med Internet Res*, *17*(2), e44.
doi:10.2196/jmir.3171

- Lau, M., Campbell, H., Tang, T., Thompson, D. J., & Elliott, T. (2014). Impact of patient use of an online patient portal on diabetes outcomes. *Can J Diabetes*, 38(1), 17-21.
doi:10.1016/j.jcjd.2013.10.005
- Lyles, C. R., Sarkar, U., Ralston, J. D., Adler, N., Schillinger, D., Moffet, H. H., . . . Karter, A. J. (2013). Patient-provider communication and trust in relation to use of an online patient portal among diabetes patients: The Diabetes and Aging Study. *J Am Med Inform Assoc*, 20(6), 1128-1131. doi:10.1136/amiajnl-2012-001567
- Lyles, C. R., & Sarkar, U. (2015). Health literacy, vulnerable patients, and health information technology use: Where do we go from here? *J Gen Intern Med*, 30(3), 271-272.
doi:10.1007/s11606-014-3166-5
- Lyles, C., Schillinger, D., & Sarkar, U. (2015). Connecting the Dots: Health Information Technology Expansion and Health Disparities. *PLoS Med*, 12(7), e1001852.
doi:10.1371/journal.pmed.1001852
- Lyles, C. R., Sarkar, U., Schillinger, D., Ralston, J. D., Allen, J. Y., Nguyen, R., & Karter, A. J. (2015). Refilling medications through an online patient portal: consistent improvements in adherence across racial/ethnic groups. *J Am Med Inform Assoc*. doi:10.1093/jamia/ocv126
- Mangalmurti, S. S., Murtagh, L., & Mello, M. M. (2010). Medical malpractice liability in the age of electronic health records. *The New England Journal of Medicine*, 363, 2060-2067. doi: 10.1056/NEJMhle1005210
- Markowitz, J. T., Volkening, L. K., & Laffel, L. M. (2014). Care utilization in a pediatric diabetes clinic: cancellations, parental attendance, and mental health appointments. *J Pediatr*, 164(6), 1384-1389. doi:10.1016/j.jpeds.2014.01.045

- Mayberry, L. S., Kripalani, S., Rothman, R. L., & Osborn, C. Y. (2011). Bridging the digital divide in diabetes: family support and implications for health literacy. *Diabetes Technol Ther*, 13(10), 1005-1012. doi:10.1089/dia.2011.0055
- Mayberry, L. S., Rothman, R. L., & Osborn, C. Y. (2014). Family members' obstructive behaviors appear to be more harmful among adults with type 2 diabetes and limited health literacy. *J Health Commun*, 19 Suppl 2, 132-143. doi:10.1080/10810730.2014.938840
- McCleary-Jones, V. (2011). Health literacy and its association with diabetes knowledge, self-efficacy and disease self-management among african americans with diabetes mellitus. *Association of Black Nursing Faculty (ABNF)*, 22(2), 25-32.
- McMahon, G. T., Gomes, H. E., Hickson Hohne, S., Hu, T. M., Levine, B. A., & Conlin, P. R. (2005). Web-based care management in patients with poorly controlled diabetes. *Diabetes Care*, 28(7), 1624-1629. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/15983311>
- McKinney, M. (2012, September). Well-informed patients take more active role, survey finds. *Modern Healthcare*. Retrieved from <http://www.modernhealthcare.com/article/20120910/NEWS/309109965>
- Menachemi, N., & Collum, T. H. (2011). Benefits and drawbacks of electronic health record systems. *Risk Management and Healthcare Policy*, 4, 47-55. doi: <http://dx.doi.org/10.2147/RMHP.S12985>
- Medical University of South Carolina (MUSC), MUSC Health. (n.d.). *About Us*. Retrieved from www.muschealth.com/about_us/index.htm
- Medical University of South Carolina (MUSC), MUSC Health Strategic Plan. (n.d.). *Driving strategies*. Retrieved from www.muschealth.com/strategic-plan/strategies/

- Murphy-Abdouch, K. (2015). Patient access to personal health information: Regulation vs. reality. *Perspectives in Health Information Management, Winter 2015*, 1-10.
- MyChart (2013). MyChart. Retrieved from www.mychart.muschealth.com
- Nagykaldi, Z., Aspy, C.B., Chou, A., & Mold, J. W. (2012). Impact of a wellness portal on the delivery of patient-centered preventative care. *Journal of the American Board of Family Medicine (JABFM)*, 25(2), 158-167. doi: 10.3122/jabfm.2012.02.110130
- Nazi, K. M. (2013). The personal health record paradox: Health care professionals' perspectives and the information ecology of personal health record systems in organizational and clinical settings. *Journal of Medical Internet Research*, 15(4). doi:10.2196/jmir.2443
- Neuner, J., Fedders, M., Caravella, M., Bradford, L., & Schapira, M. (2015). Meaningful use and the patient portal: patient enrollment, use, and satisfaction with patient portals at a later-adopting center. *Am J Med Qual*, 30(2), 105-113. doi:10.1177/1062860614523488
- Nguyen, D. L., Dejesus, R. S., & Wieland, M. L. (2011). Missed appointments in resident continuity clinic: patient characteristics and health care outcomes. *J Grad Med Educ*, 3(3), 350-355. doi:10.4300/JGME-D-10-00199.1
- Nijland, N., van Gemert-Pijnen, J. E., Kelders, S. M., Brandenburg, B. J., & Seydel, E. R. (2011). Factors influencing the use of a Web-based application for supporting the self-care of patients with type 2 diabetes: a longitudinal study. *J Med Internet Res*, 13(3), e71. doi:10.2196/jmir.1603
- Noteboom, M. R. (2015, May). What does 'patient engagement' really mean? *Healthcare IT News*. Retrieved from <http://www.healthcareitnews.com>

- Nuti, L. A., Lawley, M., Turkcan, A., Tian, Z., Zhang, L., Chang, K., . . . Sands, L. P. (2012). No-shows to primary care appointments: subsequent acute care utilization among diabetic patients. *BMC Health Serv Res, 12*, 304. doi:10.1186/1472-6963-12-304
- Nuti, L., Turkcan, A., Lawley, M. A., Zhang, L., Sands, L., & McComb, S. (2015). The impact of interventions on appointment and clinical outcomes for individuals with diabetes: a systematic review. *BMC Health Serv Res, 15*, 355. doi:10.1186/s12913-015-0938-5
- Osborn, C. Y., Mayberry, L. S., Wallston, K. A., Johnson, K. B., & Elasy, T. A. (2013). Understanding patient portal use: implications for medication management. *J Med Internet Res, 15*(7), e133. doi:10.2196/jmir.2589
- Or, C. K., & Tao, D. (2014). Does the use of consumer health information technology improve outcomes in the patient self-management of diabetes? A meta-analysis and narrative review of randomized controlled trials. *International Journal of Medical Informatics, 83*(5). doi: 10.1016/j.ijmedinf.2014.01.009
- Parker, M. M., Moffet, H. H., Schillinger, D., Adler, N., Fernandez, A., Ciechanowski, P., & Karter, A. J. (2012). Ethnic differences in appointment-keeping and implications for the patient-centered medical home--findings from the Diabetes Study of Northern California (DISTANCE). *Health Serv Res, 47*(2), 572-593. doi:10.1111/j.1475-6773.2011.01337.x
- Porter, S. (2014, December). *What factors influence physician EHR adoption?* American Academy of Family Physicians. Retrieved from <http://www.aafp.org>
- Pulvirenti, M., McMillan, J., & Lawn, S. (2014). Empowerment, patient centered care and self-management. *Health Expectations, 17*(3), 303-310. doi:10.1111/j.1369-7625.2011.00757.x

- Quevedo, S. & Gold, A. (2010). *Meaningful use and patient engagement*. In Transforming patient engagement: Health IT in the patient-centered medical home. Retrieved from <http://www.integration.samhsa.gov>
- Rai, A., Prichard, P., Hodach, R., & Courtemanche, T. (2011). Using physician-led automated communications to improve patient health. *Popul Health Manag*, 14(4), 175-180. doi:10.1089/pop.2010.0033
- Reece, R. (2011, September). Why doctors don't like electronic health records. *MIT Technology Review*. Retrieved from <http://www.technologyreview.com>
- Rigby, M., Georgiou, A., Hypponen, H., Ammenwerth, E., de Keizer, N., Magrabi, F., & Scott, P. (2015). Patient Portals as a Means of Information and Communication Technology Support to Patient- Centric Care Coordination - the Missing Evidence and the Challenges of Evaluation. A joint contribution of IMIA WG EVAL and EFMI WG EVAL. *Yearb Med Inform*, 10(1), 148-159. doi:10.15265/IY-2015-007
- Riippa, I., Linna, M., & Ronkko, I. (2014). The effect of a patient portal with electronic messaging on patient activation among chronically ill patients: controlled before-and-after study. *J Med Internet Res*, 16(11), e257. doi:10.2196/jmir.3462
- Riippa, I., Linna, M., Ronkko, I., & Kroger, V. (2014). Use of an electronic patient portal among the chronically ill: an observational study. *J Med Internet Res*, 16(12), e275. doi:10.2196/jmir.3722
- Ronda, M. C., Dijkhorst-Oei, L. T., Gorter, K. J., Beulens, J. W., & Rutten, G. E. (2013). Differences between diabetes patients who are interested or not in the use of a patient Web portal. *Diabetes Technol Ther*, 15(7), 556-563. doi:10.1089/dia.2013.0023

- Ronda, M. C., Dijkhorst-Oei, L. T., & Rutten, G. E. (2014). Reasons and barriers for using a patient portal: survey among patients with diabetes mellitus. *J Med Internet Res*, *16*(11), e263. doi:10.2196/jmir.3457
- Ronda, M. C., Dijkhorst-Oei, L. T., & Rutten, G. E. (2015). Patients' Experiences with and Attitudes towards a Diabetes Patient Web Portal. *PLoS One*, *10*(6), e0129403. doi:10.1371/journal.pone.0129403
- Ryan, P., & Sawin, K. J. (2009). The Individual and Family Self-Management Theory: background and perspectives on context, process, and outcomes. *Nurs Outlook*, *57*(4), 217-225 e216. doi:10.1016/j.outlook.2008.10.004
- Samuels, R. C. Ward, V. L., Melvin, P., Macht-Greenberg, M. Wenren, L. M., Yi, J.,...Cox, J. E. (2015). Missed appointments: Factors contributing to high no-show rates in an urban pediatrics primary care clinic. *Clinical Pediatrics*, 1-7. doi:10.1177/0009922815570613
- Sarkar, U., Karter, A. J., Liu, J. Y., Adler, N. E., Nguyen, R., Lopez, A., & Schillinger, D. (2011). Social disparities in internet patient portal use in diabetes: evidence that the digital divide extends beyond access. *J Am Med Inform Assoc*, *18*(3), 318-321. doi:10.1136/jamia.2010.006015
- Schectman, J. M., Schorling, J. B., & Voss, J. D. (2008). Appointment adherence and disparities in outcomes among patients with diabetes. *J Gen Intern Med*, *23*(10), 1685-1687. doi:10.1007/s11606-008-0747-1
- Shi, L. (2008). *Health Services Research Methods*. Clifton Park, NY: Delmar Cengage Learning.
- Shimada, S. L., Hogan, T. P., Rao, S. R., Allison, J. J., Quill, A. L., Feng, H., . . . Houston, T. K. (2013). Patient-provider secure messaging in VA: variations in adoption and association

with urgent care utilization. *Med Care*, 51(3 Suppl 1), S21-28.

doi:10.1097/MLR.0b013e3182780917

Sinno, M., Gandhi, S., & Gamble, M. (2011). 8 problems surrounding meaningful use. *Becker's Health IT and CIO Review*. Retrived from <http://www.beckershospitalreview.com>

Sitting, D., F., & Singh, H. (2012). Electronic health records and national patient-safety goals. *The New England Journal of Medicine*, 367(19), 1854-1860.

Sockolow, P. S., Bowles, K. H., Lehmann, H. P., Abbott, P. A., & Weiner, J. P. (2012).

Community-based, interdisciplinary geriatric care team satisfaction with an electronic health record: a multimethod study. *Computers, Informatics, Nursing*, 30(6), 300-311. doi: 10.1097/NCN.0b013e31823eb561

Solomon, M., Wagner, S. L., & Goes, J. (2012). Effects of a Web-based intervention for adults with chronic conditions on patient activation: online randomized controlled trial. *J Med Internet Res*, 14(1), e32. doi:10.2196/jmir.1924

Steichen, O., & Gregg, W. (2015). Health Information Technology Coordination to Support Patient-centered Care Coordination. *Yearb Med Inform*, 10(1), 34-37. doi:10.15265/IY-2015-027

Taylor, N. F., Bottrell, J., Lawler, K., & Benjamin, D. (2012). Mobile telephone short message service reminders can reduce nonattendance in physical therapy outpatient clinics: a randomized controlled trial. *Arch Phys Med Rehabil*, 93(1), 21-26. doi:10.1016/j.apmr.2011.08.007

Tenforde, M., Nowacki, A., Jain, A., & Hickner, J. (2012). The association between personal health record use and diabetes quality measures. *J Gen Intern Med*, 27(4), 420-424. doi:10.1007/s11606-011-1889-0

- Tulu, B., Trudel, J., Strong, D. M., Johnson, S. A., Sundaresan, D., & Garber, L. (2015). Patient Portals: An Underutilized Resource for Improving Patient Engagement. *Chest*. doi:10.1378/chest.14-2559
- Tung, E. L., & Peek, M. E. (2015). Linking community resources in diabetes care: a role for technology? *Curr Diab Rep*, 15(7), 45. doi:10.1007/s11892-015-0614-5
- Turkcan, A., Nuti, L., DeLaurentis, P., Tian, Z., Daggy, J., Lingsong, Z., ... Sands, L. (2013). No-show modeling for adult ambulatory clinics. In B. T. Denton (Ed.), *Handbook of healthcare operations management: Methods and applications* (pp. 251-288). New York: Springer Science + Business Media.
- Urowitz, S., Wiljer, D., Dupak, K., Kuehner, Z., Leonard, K., Lovrics, E., . . . Cafazzo, J. (2012). Improving diabetes management with a patient portal: a qualitative study of diabetes self-management portal. *J Med Internet Res*, 14(6), e158. doi:10.2196/jmir.2265
- U.S. Department of Health & Human Services. Office of the National Coordinator (ONC). (2013). *How to optimize patient portals for patient engagement and meet meaningful use requirements*. Retrieved from https://www.healthit.gov/sites/default/files/nlc_how_to_optimizepatientportals_for_patientengagement.pdf
- U.S. Department of Health & Human Services. Office of the National Coordinator (ONC). (2015). *What are the differences between electronic medical records, electronic health records, and personal health records?* Retrieved from <https://www.healthit.gov/providers-professionals/faqs/what-are-differences-between-electronic-medical-records-electronic>
- van der Heide, I., Uiters, E., Rademakers, J., Struijs, J. N., Schuit, A. J., & Baan, C. A. (2014). Associations among health literacy, diabetes knowledge, and self-management behavior in

- adults with diabetes: results of a dutch cross-sectional study. *J Health Commun, 19 Suppl 2*, 115-131. doi:10.1080/10810730.2014.936989
- Varsi, C., Gammon, D., Wibe, T., & Ruland, C. M. (2013). Patients' reported reasons for non-use of an internet-based patient-provider communication service: qualitative interview study. *J Med Internet Res, 15*(11), e246. doi:10.2196/jmir.2683
- Verchota, G. M. (2014). *Testing components of a self-management theory in adolescents with type 1 diabetes mellitus* (Doctoral dissertation). Retrieved from University of Wisconsin Milwaukee (UWM) Digital Commons. (776)
- Wade-Vuturo, A. E., Mayberry, L. S., & Osborn, C. Y. (2013). Secure messaging and diabetes management: experiences and perspectives of patient portal users. *J Am Med Inform Assoc, 20*(3), 519-525. doi:10.1136/amiajnl-2012-001253
- Wager, K. A., Lee, F. W., & Glaser, J. P. (Third Ed.). (2013). *Health Care Information Systems: A practical approach for health care management*. San Francisco, CA: Jossey-Bass.
- Ward, B. W., Schiller, J. S., & Goodman, R. A. (2014). Multiple Chronic Conditions Among US Adults: A 2012 Update. *Preventing Chronic Disease, 11*, E62. doi:10.5888/pcd11.130389
- White, R. O., Wolff, K., Cavanaugh, K. L., & Rothman, R. (2010). Addressing Health Literacy and Numeracy to Improve Diabetes Education and Care. *Diabetes Spectr, 23*(4), 238-243. doi:10.2337/diaspect.23.4.238
- World Health Organization (2003). WHO definition of health. Retrieved from <http://www.who.int/about/definition/en/print.html>
- Woods, S. S., Schwartz, E., Tuepker, A., Press, N. A., Nazi, K. M., Turvey, C. L., & Nichol, W. P. (2013). Patient experiences with full electronic access to health records and clinical notes

- through the My HealthVet Personal Health Record Pilot: qualitative study. *J Med Internet Res*, 15(3), e65. doi:10.2196/jmir.2356
- Wright, A., Feblowitz, J., Samal, L., McCoy, A. B., & Sittig, D. F. (2014). The Medicare Electronic Health Record Incentive Program: provider performance on core and menu measures. *Health Serv Res*, 49(1 Pt 2), 325-346. doi:10.1111/1475-6773.12134
- Wylie, M. C., Baier, R. R., & Gardner, R. L. (2014). Perceptions of electronic health record implementation: A statewide survey of physicians in Rhode Island. *The American Journal of Medicine*, 127(10), 1010.e21-1010.e27. doi: 10.1016/j.amjmed.2014.06.011
- Zarcadoolas, C., Vaughn, W. L., Czaja, S. J., Levy, J., & Rockoff, M. L. (2013). Consumers' perceptions of patient-accessible electronic medical records. *J Med Internet Res*, 15(8), e168. doi:10.2196/jmir.2507
- Zikmund-Fisher, B. J., Exe, N. L., & Witteman, H. O. (2014). Numeracy and literacy independently predict patients' ability to identify out-of-range test results. *J Med Internet Res*, 16(8), e187. doi:10.2196/jmir.3241