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The Factors That Impact Patient Portal Utilization

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The Factors That Impact Patient Portal Utilization

by

William C. Reed

A dissertation submitted in partial fulfillment of the requirements

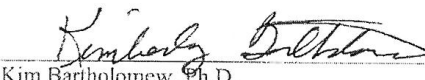for the degree of Doctor of Philosophy

in

Information Systems

College of Computing and Engineering
Nova Southeastern University

2019

We hereby certify that this dissertation, submitted by William Reed, conforms to acceptable standards and is fully adequate in scope and quality to fulfill the dissertation requirements for the degree of Doctor of Philosophy.

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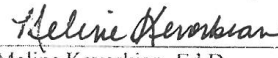
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2019

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An Abstract of a Dissertation Submitted to Nova Southeastern University
in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

The Factors That Impact Patient Portal Utilization

by
William C. Reed
December 2019

Spawned by legislative mandates, such as the American Recovery and Reinvestment Act of 2009's Health Information Technology for Economic and Clinical Health Act, and individuals desiring to have more personal accountability for their health and healthcare, the introduction and use of electronic personal health information (ePHI) has grown substantially. Given that most ePHI is maintained within the healthcare delivery system, an information portal is required for individuals to have access to the ePHI. As a result, the legislation required the introduction and use of patient portals to grant such access.

Despite substantial financial incentives and disincentives for healthcare organizations to provide and promote the use of patient portals, actual utilization of patient portals has fallen significantly short of expectations and desires. It has been posited that limited patient portal utilization may have been related to multiple factors, with no definitive set of factors empirically established as the root cause. While patient age and gender exhibit some relation to patient portal utilization, those factors are not able to be modified, thereby limiting any potential to change utilization. Therefore, there is an interest to identify other variables that can be modified to have an impact on patient portal utilization.

The study sought to contribute to the body of knowledge concerning factors that impact the utilization of patient portals, specifically, how patient literacies, i.e., computer/Internet, health, and numeracy impact patient portal utilization. These literacies for 400 University of Maryland Medical System patients were assessed via self-administered surveys, with the results compared to their actual patient portal utilization. The goal was to identify related correlations between literacy scores and utilization, using the correlations to construct a portal use index capable of accurately predicting utilization based on these literacies. However, Kendall tau-b correlation coefficients indicated an absence of significant correlations between patient literacies and patient portal use.

Acknowledgements

I want to thank the 400 UMMS patients who participated in this study. Without their participation, this research could not have been completed. Their willingness to perform self-assessments of their health and numeracy literacies will provide insights how these factors may impact patient portal utilization.

Vernon M. Chinchilli, Ph.D., Distinguished Professor and Chair, Department of Public Health Sciences, Penn State College of Medicine, assisted me with the analysis of the study data. His recommendations and direction enabled me to recognize the value of the findings, despite their not supporting my original hypotheses.

This research would not have been possible without the permission, direction, and assistance from the University of Maryland. Recognition specifically goes to the Clinical and Transitional Research Informatics Center (CTRIC) at the University of Maryland, Baltimore (UMB), especially Zachary Dezman, M.D., for providing the *My*Portfolio data extracts, as well as the University of Maryland Medical System's (UMMS') Joel Klein, M.D., and Vince Russamano, for assisting in my understanding of the *My*Portfolio structure and content. Thanks also goes to J. Kathleen Tracy, Ph.D., Associate Professor, Epidemiology & Public Health for the University of Maryland, Baltimore School of Medicine, for serving as my affiliate student sponsor and navigating me through the UMB IRB process. And, very special appreciation is given to Jon Burns, Senior Vice President and Chief Performance Officer, for only through his sponsorship was I able to conduct my research at UMMS.

Obviously, the genesis of my doctoral pursuit, as well my research, was at Nova Southeastern University (NSU). My doctoral education was achieved through knowledge imparted to me by the NSU professors with whom I had classes, especially Dr. Yair Levy who introduced me how to conduct quality literature research, and Dr. Timothy Ellis, who honed my ability to synthesize such research into meaningful presentations.

A special note of appreciation goes to Valerie Monick who served as my paper reviewer *extraordinaire*. She read my paper so many times that I believe she now knows as much about patient portals as I do. I will miss our debates regarding APA nuances.

To the members of my dissertation committee, my deepest appreciation for guiding and mentoring me through a challenging process, including obtaining approval from two IRBs. Their astute direction enabled me to complete my dissertation with a minimal amount of rework. My thanks to Dr. Ling Wang for not only direction during my dissertation process but also assisting with my multiple IRB applications. Thanks also to Dr. Kim Bartholomew whose healthcare knowledge, especially regarding patient portals, aided in honing my research. And mostly to Dr. Trudy Abramson, chair of my dissertation committee, who, though in the final stages of her distinguished career at NSU, graciously accepted navigating me through my dissertation. Her calm guidance, constructive review, and encouragement made a long and arduous process able to reach a positive conclusion.

Thanks also two my two sons – Matthew who assisted in coding the script to facilitate emailing subjects with the literacy questionnaires, and Justin who provided constant encouragement for me to complete my research.

And finally, and most importantly, undying appreciation and gratitude to my wife, Joan, who provided the impetus for me to finally undertake this journey, her constant support during the journey, and her willingness to make personal sacrifices so that I could compete the journey; without her at my side, I would never have achieved this success. Thank you!

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Chapter 1

Introduction

Context

The depth and breadth of electronic personal health information (ePHI) have expanded as electronic health records (EHRs) have been increasingly adopted by healthcare organizations. In both acute and ambulatory care settings, the presence of EHRs has grown in recent years (Hsiao, Hing, & Ashman, 2014; Stephenson, Gorusch, Hersh, & Gold, 2014). Use of EHRs in physician practices has increased from 34.8% in 2007 to 71.8% in 2012 (Hsiao et al., 2014), with hospitals experiencing a similar change in EHR use, growing from 9.4% in 2008 to 44.4% in 2012 (Stephenson et al., 2014).

Research has indicated "that the use of a personal health record or self-management platform can promote an informed or activated patient" (Talboom-Kamp et al., 2017, para. 40). Following such a premise, that effective health self-management is predicated on the availability of and access to robust and accurate health information, in 2010, the University of Maryland Medical System (UMMS) provided patients with such availability and access to their health information via a patient portal (PP), *My*Portfolio. *My*Portfolio is anchored by MyChart technology from Epic, a leading vendor of EHR software, being used to manage health information for 190 million patients worldwide (Epic, n.d.).

Created in 1984, UMMS is a preeminent healthcare provider for Baltimore, MD., and the surrounding region. Serving nearly four million patients annually, UMMS provides healthcare through a variety of venues including 12 inpatient hospitals, numerous ambulatory clinics, and

home health services. UMMS is known for its high-quality healthcare including its R Adams Cowley Shock Trauma Center, specializing in the life-saving treatment of more than 8,000 critically ill and injured patients annually. UMMS' provision of *My*Portfolio is a further extension of its drive to provide high-quality healthcare to its patients.

Problem Statement

Direct patient access to ePHI, whether via an EHR or individual-based personal health records (PHRs), has been increasingly provided by PPs (Amante, Hogan, Pagoto, & English, 2014; Otte-Trojel, de Bont, Rundall, & van de Klundert, 2014). As of 2012, it was estimated that more than 70 million patients in the United States had access to PPs (Bates & Wells, 2012). Access has grown since 2012, with 42% of individuals nationwide having access by 2015, and continuing to expand to 52% by 2018 (Patel & Johnson, 2018). In fact, as a result of the fragmentation in the healthcare delivery system, patients are frequently forced to interact with multiple PPs, e.g., those of hospitals and multiple physicians, to obtain a comprehensive view of their ePHI. It therefore follows that access to ePHI by patients is at least partially predicated on the effective implementation and use of PPs. However, the use of PPs has proven to be challenging with "utilization of portals…hindered by several barriers" (Amante et al., 2014, p. 784).

Given PP's less than anticipated adoption and use, it is conjectured that factors such as patient literacies affect PP use. van der Vaart, Drossaert, Taal, Drossaers-Bakker, Vonkeman, and van de Larr (2014) noted "health literacy and all Internet-related characteristics were significantly related to portal usage" (p.4). As a result of the review of the literature, it appears evident that "there is a dearth of research on methods for identifying and ameliorating health

literacy issues in consumer health information systems" (Monkman & Kushniruk, 2013, p.180), thereby warranting further research. The need for such additional research is supported in the literature (Alpert, Desens, Krist, Aycock, & Kreps, 2017; Apter, 2014; Coughlin, Stewart, Young, Heboyan, & DeLeo, 2018); Goel et al., 2011a; Goel et al., 2011b; Goldzweig et al., 2013; Irizarry et al., 2017); Levy, Janke, & Langa, 2014; Neuner, Fedders, Caravella, Bradford, & Schapira, 2015).

Dissertation Goal

The goal was to define and validate a portal use index (PUI) that could be used to facilitate PP use across diverse patient populations. PUIs for existing UMMS' patients would be developed based on patients' specific literacies, i.e., computer/Internet, health, and numeracy. The PUIs would then be compared to actual *My*Portfolio use by UMMS' patients. PUIs would also be developed for new UMMS' patients. These PUIs would be used to identify and provide remediation targeted at increasing patients' PP use.

Research Questions

To examine the potential development of a PUI, the following research questions were posed:

1. How do specific patient literacies, i.e., computer/Internet, health, and numeracy, affect PP use?

2. What tools can be effectively used to evaluate patients' literacies?

3. What is the construct for a PUI that can accurately predict a patient's PP use based upon their literacies?

Relevance and Significance

While advances in healthcare delivery have consistently evolved, there have been ongoing concerns relative to the associated healthcare quality and cost. Recognizing it would be advantageous to effectively balance these dimensions, healthcare visionaries posited approaches such as the Triple Aim as innovations that had the potential to enhance access and quality of healthcare while simultaneously reducing related costs (Mery, Majumder, Brown, & Dobrow, 2017). Such approaches promote a patient-centered focus that involves increased patient engagement (Greenberg et al, 2017), including patients' increased access to the ePHI.

Patient access to ePHI has been facilitated through capabilities provided by PPs (Amante et al., 2014; Otte-Trojel et al., 2014). However, the lack of PP adoption and utilization inhibits both a patient's access to ePHI and associated self-management of his/her health care. Additionally, sub-optimal PP use places financial strain on healthcare organizations as, in addition to the implementation and perpetuation costs for PPs, they face being penalized for not meeting PP use requirements, i.e., Meaningful Use (MU) (Payment adj hardship, n.d.).

UMMS *My*Portfolio adoption experience, 18% through the first quarter of 2018 (Epic Quarterly Update, 2018), is not dissimilar to PP adoption in the healthcare industry, 15-30% (Heath, 2017). The implementation of *My*Portfolio was an important initiative that has seen patient adoption (18%) less than desired and in Epic's lowest performance measurement tier (0-50%). It is anticipated that this study may provide UMMS with insights into why *My*Portfolio is being underutilized and possible remediation initiatives.

Scope of the Study

This study sought to identify correlations between a patient's specific literacies, e.g. computer/Internet, health, and numeracy and their PP usage. These literacies were assessed through self-administered surveys delivered via email to patients that had enrolled with the UMMS' PP, *My*Portfolio. The literacies scores were then compared to actual PP utilization to determine associated correlations.

The study did not attempt to examine possible reasons, e.g. lack of awareness or enrollment problems, for the total absence of portal utilization. Nor was consideration given to PP utilization barriers resulting from patient demographic issues such as age, gender, or race/ethnicity. There also was no exploration as to the usability of *My*Portfolio's design.

There are potential limitations to the study. First, while the literacy surveys were designed to be minimally onerous, the response rate needed to be adequate. Response rates of 20% to email surveys are common (Shih & Fan, 2009). To ensure an adequate number of survey responses were received, this study utilized a conservative response rate expectation of 10%. Second, previous research indicated PP utilization may be impacted by a patient's health state, e.g. the presence or absence of a chronic disease and/or comorbid conditions (Baird, 2014; Krist, 2014; Neuner et al., 2015). This study did not incorporate consideration of the health state of the responding patients.

The major delimitation of the study involves the literacy survey instrument. The design needed to adequately address all three literacy dimensions – computer/Internet, health, and numeracy. However, as noted by Kim and Xie (2017), "no standardized measurement captures the full spectrum of skills and knowledge associated with health literacy and technology use" (p. 1078). The study utilized two frequently used survey instruments, eHEALS and SNS, which will be further described in the methodology section (Huang, Shiyanbola, Smith, & Chan, 2018;

Norman & Skinner, 2006; Shealy, & Threatt, 2016). An additional delimitation concerns the subject population, i.e., exclusively University of Maryland Medical System patients. While this is an organizationally and geographically confined population, the random selection of subjects should make them generally applicable to other United States patient populations. Further study would be necessary to assess applicability to other international patient populations.

Definitions and Acronyms

ARRA: American Recovery and Reinvestment Act of 2009 – "an economic stimulus package enacted by the 111th United States Congress and signed into law by President Barack Obama on February 17, 2009." (http://www.hitechanswers.net/about/about-arra/).

AT: Attitude Towards using a technology - A construct in TRA used to predict acceptance of new technology (Davis, 1989).

BI: Behavioral Intent to use a technology - A construct in TRA used to predict acceptance of new technology (Davis, 1989).

CMS: Centers for Medicare and Medicaid Services – "The HHS agency responsible for Medicare and parts of Medicaid." (https://www.cms.gov/apps/glossary/default.asp?Letter=ALL).

EH: Eligible Hospital – "Medicare eligible hospitals - "Subsection (d) hospitals" in the 50 states or DC that are paid under the Inpatient Prospective Payment System (IPPS), Critical Access Hospitals (CAHs), and Medicare Advantage (MA-Affiliated) Hospitals" and "Medicaid eligible hospitals - Acute care hospitals (including CAHs and cancer hospitals) with at least 10% Medicaid patient volume, and Children's hospitals (no Medicaid patient volume requirements)."

(https://www.cms.gov/regulations-and-

guidance/legislation/ehrincentiveprograms/eligible_hospital_information.html).

eHEALS: eHealth Literacy Scale – an 8-item or 10-item, self-assessment instrument

developed by Norman and Skinner to evaluate an individual's eHealth literacy

(Norman & Skinner, 2006).

EHR: Electronic Health Record – "An electronic health record is a digital version of a

patient's paper chart. EHRs are real-time, patient-centered records that make

information available instantly and securely to authorized users. While an EHR

does contain the medical and treatment histories of patients, an EHR system is

built to go beyond standard clinical data collected in a provider's office and can

be inclusive of a broader view of a patient's care. EHRs can: contain a patient's

medical history, diagnoses, medications, treatment plans, immunization dates,

allergies, radiology images, and laboratory and test results; allow access to

evidence-based tools that providers can use to make decisions about a patient's

care; and automate and streamline provider workflow."

(https://www.healthit.gov/providers-professionals/faqs/what-electronic-health-

record-ehr).

EP: Eligible Professional – "Eligible professionals under the Medicare EHR Incentive

Program include Doctors of medicine or osteopathy, Doctors of dental surgery or

dental medicine, Doctors of podiatry, Doctors of optometry, and Chiropractors."

(http://www.emrsoap.com/definitions/eligible-professional/).

ePHI: Electronic Personal Health Information – "Electronic protected health information (ePHI) is any protected health information (PHI) that is created, stored, transmitted, or received electronically." (https://kb.iu.edu/d/ayyz).

Epic: Located in Verona, WI, "Epic develops software to help people get well, help people stay well, and help future generations be healthier." (http://www.epic.com/About/).

HIPAA: Health Insurance Portability and Accountability Act – "…a US law designed to provide privacy standards to protect patients' medical records and other health information provided to health plans, doctors, hospitals and other health care providers" (https://www.medicinenet.com/script/main/art.asp?articlekey=31785).

HIT: Health Information Technology – "… a broad concept that encompasses an array of technologies to store, share, and analyze health information." (https://www.healthit.gov/patients-families/basics-health-it).

HITECH Act: "The Health Information Technology for Economic and Clinical Health (HITECH) Act, enacted as part of the American Recovery and Reinvestment Act of 2009, was signed into law on February 17, 2009, to promote the adoption and meaningful use of health information technology." (http://www.hhs.gov/hipaa/for-professionals/special-topics/HITECH-act-enforcement-interim-final-rule/index.html).

MU: Meaningful Use - "Meaningful use is using certified electronic health record (EHR) technology to improve quality, safety, efficiency, and reduce health disparities; engage patients and family; improve care coordination, and population and public health; and maintain privacy and security of patient health information."

(https://www.healthit.gov/providers-professionals/meaningful-use-definition-objectives).

*My*Portfolio: University of Maryland Medical System's Internet-based EHR provided via Epic's MyChart patient portal.

NVS: Newest Vital Sign – A 6-question instrument, developed by Pfizer, used to evaluate a patient's health literacy based upon interpretation of nutrition information found on an ice cream container (https://www.pfizer.com/files/health/nvs_flipbook_english_final.pdf).

PEOU: Perceived Ease Of Usefulness of technology – A construct in TAM used to predict acceptance of new technology (Davis, 1989).

PHR: Personal Health Record – An electronic application used by patients to maintain and manage their health information in a private, secure, and confidential environment. PHRs are managed by patients; can include information from a variety of sources, including health care providers and patients themselves; can help patients securely and confidentially store and monitor health information, such as diet plans or data from home monitoring systems, as well as patient contact information, diagnosis lists, medication lists, allergy lists, immunization histories, and much more; are separate from, and do not replace, the legal record of any health care provider; and are distinct from portals that simply allow patients to view provider information or communicate with providers." (https://www.healthit.gov/providers-professionals/faqs/what-personal-health-record).

PP: Patient Portal – "A patient portal is a secure online website that gives patients

convenient 24-hour access to personal health information from anywhere with an

Internet connection. Using a secure username and password, patients can view

health information such as recent doctor visits, discharge summaries, medications,

immunizations, allergies, and lab results." (https://www.healthit.gov/providers-

professionals/faqs/what-patient-portal).

PU: Perceived Usefulness of technology – A construct in TAM used to predict

acceptance of new technology (Davis, 1989).

PUI: Portal Use Index – A proposed metric construct that can accurately predict a

patient's likely PP utilization based upon his/her computer/Internet, health, and

numeracy literacies.

SNS: Subjective Numeracy Scale – Developed by Fagerlin et al., is a self-assessment for

measuring a person's numeracy literacy (Fagerlin et al., 2017).

TAM: Technology Acceptance Model – Proposed by Davis in 1989, TAM is used to

predict acceptance of new technology based on two characteristics – the user's

perceived usefulness of the technology and the user's perceived usability of the

technology (Davis, 1989).

TOFHLA: Test of Functional Health Literacy in Adults – Established by Parker, Baker,

Williams, and Nurss in 1995, the 67-question instrument evaluates a patient's

ability to read and understand common health information (Parker, Baker,

Williams, & Nurss, 1995).

TRA: Theory of Reasoned Action – Proposed by Fishbein and Ajzen, TRA is intended to

examine the influence external variables have on AT, BI, and U (Davis, 1989).

U: Use of technology – A construct in TRA used to predict acceptance of new technology (Davis, 1989).

UMMS: University of Maryland Medical System - Created in 1984, the University of Maryland Medical System (UMMS) is a preeminent healthcare provider for Baltimore, MD., and the surrounding region. Serving nearly four million patients annually, UMMS provides healthcare through a variety of venues including 12 inpatient hospitals, numerous ambulatory clinics, and home health services.

UTAUT: Unified Theory of Acceptance and Use of Technology – Evolved by Venkatesh, Morris, Davis, and Davis in 2003, introduced four new constructs to evolve TAM to more accurately predict acceptance of new technology (Venkatesh et al., 2003).

Organization of the Study

The study is presented in five chapters. The first chapter, Introduction, presents the context of the study, i.e., the proliferation of ePHI and EHRs, and associated PPs. UMMS is also introduced as a healthcare organization using a PP. A problem statement follows identifying that PP adoption and use are less than desired. The dissertation goal is then identified as attempting to define and validate a PUI, which is supported by the three research questions for consideration. The relevance and significance of the study is then related to concerns regarding patient health care self-management and financial stress on healthcare organizations. Finally, the scope of the study identifies associated limitations and delimitations.

Chapter 2 explores literature pertinent to the problem statement. The bulk of the chapter explores prior research concerning PP use, focusing on patient literacy factors impacting PP use,

as well as tools to assess such literacies. Additionally, literature is discussed regarding the underlying theories to be employed to evaluate PP use.

Specifics of the quantitative research methodology used are presented in Chapter 3. The sampling approach is described, along with the data collection and analysis methods. Special attention is dedicated to the survey instrument as it needs to address the three literacy dimensions – computer/Internet, health, and numeracy.

Chapter 4 presents results of the study. Subjects' response rate is identified, along with the demographic and descriptive statistics. The literacy scores and PP utilization statistics of the subjects are noted, as well as the Kendall tau-b correlation coefficients.
Conclusions from the study are given in Chapter 5. Findings related to the three research questions are presented. The chapter closes with a presentation of study limitations, along with associated implications and recommendations.

Chapter 2

Review of the Literature

Examining how use factors may affect PP adoption and use involves the convergence of multiple domains, including the PP environment, methods for assessing PP adoption, and barriers to PP use. A review of literature establishes the framework for analyzing how specific patient literacies affect PP utilization by examining research from multiple areas, specifically PP use. First, the PP environment is explored, including its intended purpose, proposed functionality, and expected adoption. Information is presented describing research concerning actual PP adoption. Drawing on the well-researched and published technology acceptance model (TAM), information concerning perceived PP usefulness and usability is presented, after an introduction of general TAM, and its successor, the Unified Theory of Acceptance and Use of Technology (UTAUT). Finally, literature is proffered that identifies various barriers to PP utilization, with a focus on three specific patient literacy barriers – computer/Internet, health, and numeracy. The review of the literature concludes with a summarization of the salient points presented.

Patient Portal Environment

A portal has been generally defined as a "door, entrance: especially a grand or imposing one" (Merriam-Webster, 2014), with a more modern secondary definition of "a site serving as a guide or point of entry to the World Wide Web and usually including a search engine or a collection of links to other sites arranged especially by topic." More specifically, the Office of

the National Coordinator for Health Information Technology defined a patient portal (PP) as "a secure online website that gives patients convenient 24-hour access to personal health information from anywhere with an Internet connection" (Office of the National Coordinator for Health Information Technology, 2014e, para. 1).

The pace of EHR and associated ePHI expansion has been accelerated by several factors. EHR implementations have been spawned by the financial incentives provided by the Health Information Technology for Economic and Clinical Health Act as part of the American Recovery and Reinvestment Act of 2009 "to accelerate the adoption of health information technology (HIT) by the health care industry" (Office of the National Coordinator for Health Information Technology, 2014a). Financial disincentives, i.e., penalties, were stipulated by the Centers for Medicare and Medicaid Services in the form of MU requirements targeted at "the use of EHRs to achieve health and efficiency goals" (Blumenthal, 2010, p. 382). The EHR MU requirements included direct online access to ePHI by patients.

The transition from implementation of EHR access capability to actual use of EHR information via PPs is seen in the progression of PP requirements as stipulated in MU Stages 1 and 2 (EHR incentive programs, n.d.). In MU Stage 1, healthcare organizations were required to implement PPs with the capability to retrieve, print and download ePHI. This requirement, commonly referred to as the Blue Button (About Blue Button, n.d.), was aimed at implementing the capability to access a PP as measured by the eligible provider (EP)/eligible hospital (EH) making the EHR information available to more than 50% of their patients within four days of the EP/EH having the information (Electronic copy of health information, n.d.). In MU Stage 2, the associated PP requirement was elevated to require the use of the Blue Button by at least 5% of the EP's/EH's patients (Use secure electronic messaging, n.d.).

While the future of MU is in question due to the transition to the Merit-Based Incentive Payment System, and its component Medicare Access and CHIP Reauthorization Act of 2015, the evolution of requirements for PPs continued with MU Stage 3. In this stage, EPs and EHs are required to provide Blue Button capabilities to at least 80% of their respective patients, and electronic access to specific patient education material to at least 35% of their respective patients (Stage2 EP Core 7 patient electronic access, 2016). Additionally, in MU Stage 3, EPs and EHs need to provide patients access to their ePHI via an application program interface, i.e., API (EHR incentive programs, 2016). The PP relevance of these MU Stage 3 2018 requirements is that, from a positive perspective they foster increased electronic patient engagement, due to the higher participation thresholds, but simultaneously detract from PP use through the introduction of APIs which negate the need for PPs to provide equivalent functionality.

Concurrent with government initiatives to provide patient access to EHRs, patients have had increased expectations for more personal control over their ePHI and healthcare (Meslin et al., 2013). With more than 86% of the United States' population estimated as having access to the Internet (Internet Live Stats, 2014), the Internet provides an attractive platform for patients to access their ePHI. Thus, a key to the expanded access to EHRs and ePHI by patients is through Internet services such as PPs.

PPs, developed and made available to patients, have provided a broad range of functionality. Most common PP functions include clinical uses, administrative uses, educational uses, and personal health uses. Although PPs have also been used for diagnostic and treatment purposes, i.e., telehealth, examination of PP use in support of telehealth is beyond the scope of this study and, therefore, not addressed within this review of the literature.

A common clinical use found in PPs is the presentation of clinical, e.g., laboratory, test results (Klein, 2007). In the most basic form, such results are presented in numeric/graphic format, at times augmented by text annotations (Taha, Sharit, & Czaja, 2014). Organizations may place embargos on certain clinical results based upon type of result, e.g., drug screen or pregnancy test, and/or content of result, e.g., identification of a tumor (Bourgeois, Taylor, Emans, Nigrin, & Mandl, 2008).

Some PPs provide additional clinical information in the form of discharge/visit summaries and summarized clinical notes (Emani et al., 2016, Nazi, Turvey, Klein, Hogan, & Woods, 2014). In 2010, a demonstration project, termed OpenNotes, was undertaken by three healthcare organizations located in Boston, MA, Danville, PA, and Seattle, WA (Bell et al., 2017, Esch et al., 2016, Nazi et al., 2014, Wright et al., 2015). OpenNotes provided patients with access to full clinical encounter notes via their PPs. Although met with initial incredulity, the OpenNotes demonstration project, involving 105 primary care physicians and 19,000 patients, proved successful with 99% of participating patients expressing desire for OpenNotes to continue and none of the 105 participating physicians electing to discontinue (Esch et al., 2015).

Facing similar initial skepticism, a PP function that has gained prominence is secure messaging between patients and providers (Byrne, Elliott, & Firek, 2009). Historically communication between patient and provider has been infrequent, in-person, and while facilitated via phone, still was fraught with delays. Secure messaging functionality, via PPs, offers the capability for patients and providers to engage in efficient and effective communication in an asynchronous, secure, and private manner. Providers were concerned that secure messaging would negatively impact their clinical efficiency and potentially erode the patient-physician relationship (Byrne et al., 2009). Some PP implementations have proffered a

different perspective (Miller, Latulipe, Melius, Quandt, & Arcury, 2016). A North et al. (2014) study of 2,357 primary care patients at the Mayo Clinic, in Rochester, MN, found secure messaging "did not significantly change their frequency of face-to-face visits" (North et al., 2014, p. 195).

Administratively, PPs provide assorted functions ranging from managing clinical appointments to resolving a patient's outstanding financial balance (Bush, Connelly, Fuller, & Perez, 2016, Jones, Weiner, Shah, & Stewart, 2015). These functions may be constrained to merely having access to what appointments are scheduled and limited to obtaining a patient's balance, or robust by enabling self-scheduling of an appointment and making a payment on that balance. PPs also offer hybrid functionality that integrates clinical and administrative functions. Prescription refills, which is a time-consuming activity for both patients and clinical staff, are greatly facilitated by that functionality being provided via the PP (Bush et al., 2016, Jones et al., 2015).

Improved health status of a patient is affected by patient's ability to be compliant with treatment directives issued by their providers. However, treatment directives are often inadequately understood by a patient, or specific discharge instructions are lost once the patient leaves the healthcare facility. PP functionality addresses these issues by providing patient education material that enables the patient to gain a greater understanding of the treatment instructions that had been provided (Gordon & Hornbrook, 2018, Groen, Kuijpers, Oldenburg, Wouters, & Aaronson, 2017). PP accessibility to discharge instructions enables the patient to retrieve key treatment information once back in their personal environment. Finally, as consumerism in healthcare expands, the collection, storage, and integration of personal health information become critical PP capabilities. Increased use of clinical monitoring devices, e.g.,

glucose monitors and personal health devices, e.g., Fitbits, are expanding the requirement for patients to have easy access to PPs to integrate and store their ePHI (Alpert, Krist, Aycock, & Kreps, 2017, Guendelman, Broderick, Mlo, Gemmill, & Lindeman, 2017).

Assessing Patient Portal Adoption

Promoted by federal requirements and incentives provided by the American Recovery and Reinvestment Act of 2009, advocates of the act anticipated that PP utilization would naturally increase. However, realized utilization of PPs has fallen woefully short of industry expectations and desires. The less than anticipated adoption of PPs has been documented in various studies (Bartholomew, 2017; Dixon, 2010; Lazard et al., 2015). The adoption of technology, in general, has historically been a challenge to predict (Davis, 1989; Venkatesh & Davis, 2000). However, there are empirically proven and accepted approaches, such as Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT), that predict technology acceptance. Recognizing that PPs are a technology, the constructs of TAM and UTAUT are explored as potential lenses for assessing the PP adoption phenomenon.

Technology Acceptance Model (TAM and TAM2). In seminal work, Davis (1989) introduced TAM, positing that a user's acceptance of technology was predicated on two principal constructs – perceived usefulness of the technology (PU) and perceived ease of use of the technology (PEOU), with PEOU also having the ability to affect PU. Davis' fundamental basis for TAM emanated from an adaptation of Fishbein's and Ajzen's theory of reasoned action (TRA). TRA examines the influence external variables have on attitude towards using a technology (AT) and behavioral intention to use a technology (BI), resulting in actual technology

use (U). Building on the TRA construct, TAM focused on its two specific variables, PU and PEOU, as influencing AT, its impact on BI, and BI's impact on U, discounting the impact on BI by all other external variables as negligible. He explored the impact of PU and PEOU on BI in an empirical analysis of two groups, 120 experienced users of PROFS, an electronic mail system, and XEDIT, a file editor, with TAM explaining some of the variability in BI.

Reassessing his original TAM position that other external variables have a negligible impact on BI, Davis and Venkatesh (2000) published an extended TAM that incorporated determinants of PU, resulting in TAM2. TAM2 added two new sets of theoretical constructs. Drawing on social influence processes, TAM2 considered the impact of subjective norm, voluntariness, and image on BI. Job relevance, output quality, and result demonstrability, all cognitive instrumental processes, were also taken into account. Subjective norm relates to a person "choosing to perform a behavior, even if they are not themselves favorable towards the behavior or its consequences, if they believe one or more important referents think they should, and they are sufficiently motivated to comply with the referents" (Venkatesh & Davis, 2000, p. 187). Voluntariness is a more elementary construct in that if use of a technology is mandatory, it affects subjective norm and, therefore, BI more so than if use is purely voluntary. The third social influence, image, is "the degree to which use of an innovation is perceived to enhance one's…status in one's social system" (Moore & Benbasat, 1991, p. 195).

In summary, a technology whose use will be viewed positively by a user's referents, subjective norm, is more mandatory than voluntary, voluntariness, and is likely to enhance the user's social status, image, will more likely be adopted by the user. Concerning the cognitive process dimension, Venkatesh and Davis (2000) defined job relevance "as an individual's perception regarding the degree to which the target system is applicable to his or her job"

(Venkatesh & Davis, 2000, p. 191). Output quality is derived from "how well the system performs those tasks" which the user requires (Venkatesh & Davis, 2000, p. 191). Finally, result demonstrability concerns the ability of the user to draw a direct correlation between the technology and a desired result, i.e., "individuals can be expected to form more positive perceptions of usefulness of a system if the covariation between usage and positive results is readily discernable" (Venkatesh & Davis, 2000, p. 192). Thus, in instances where use of a technology is applicable to the user's job, job relevance, performs task well, output quality, and demonstrates a clear line of sight from use to positive result, result demonstrability, adoption of the technology is likely to be higher. Using the expanded model incorporating social influence processes and cognitive instrumental processes, they analyzed system usage at four organizations representing manufacturing, financial services, accounting services, and investment banking, finding that TAM2 accounted for up to 52% of the variability in BI.

 Unified Theory of Acceptance and Use of Technology (UTAUT and UTAUT2). Venkatesh et al. (2003) closely examined eight models and theories of individual acceptance, including TAM/TAM2. The work evolved a new technology adoption theory, UTAUT. UTAUT replaced TAM's PU and PEOU by introducing four new constructs - performance expectancy, effort expectancy, social influence, and facilitating conditions. Performance expectancy, "the degree to which an individual believes that using the system will help him or her to attain gains in job performance" (Venkatesh et al., 2003, p. 447); effort expectancy, "the degree of ease associated with the system" (Venkatesh et al., 2003, p. 450); and social influence, "the extent to which consumers perceive that important others believe he or she should use the new system" (Venkatesh et al., 2003, p. 451); were all found to be direct determinants of BI. Facilitating conditions, "degree to which an individual believes that an organizational and technical

infrastructure exists to support use of the system" (Venkatesh et al., 2003, p. 453), was found to be a direct determinant of U. UTAUT also identified four moderating variables: gender, that moderates performance expectancy, effort expectancy, and social influence; age, that moderates all four direct variables; experience, that moderates effort expectancy, social influence, and facilitating conditions; and voluntariness, which moderates social influence. When UTAUT was applied to the data from the four organizations in the original TAM2 study, 69% of the BI variation was explained, versus 53% explained by TAM. UTAUT was further validated when data from two additional organizations were analyzed with the results able to explain 70% of the associated BI variance.

Venkatesh, Thong, and Xu (2012) modified UTAUT, producing UTAUT2, adding three new constructs that took consumer use into account. Added to UTAUT2 were hedonic motivation, defined as "the fun or pleasure derived from using a technology" (Venkatesh et al., 2012, p. 164); price value, "consumers' cognitive tradeoff between the perceived benefits of the applications and the monetary cost for using them" (Venkatesh et al., 2012, p. 165); and habit, "the extent to which an individual believes the behavior is automatic" (Venkatesh et al., 2012, p. 165). As with UTAUT, UTAUT2 included the moderating variables of age, gender, and experience, but dropped voluntariness based on the belief that from a consumer use perspective, "most consumer behaviors are totally voluntary" (Venkatesh et al., 2012, p. 162). The UTAUT2 model was empirically analyzed through a two-stage online survey of mobile Internet customers in Hong Kong. Based on the results from 1,512 respondents, UTAUT2 improved the explanation of variance of BI, as high as 74%.

Although not without opposing viewpoints, since their inception, TAM and UTAUT have been routinely used to explain the variation in BI related to the adoption of technology, with the

original work of TAM cited more than 4,000 times, the introduction of TAM2 cited in more than 11,000 articles, and the seminal works concerning UTAUT/UTAUT2 referenced nearly 19,000 times. Thus, TAM has been considered a "gold standard" (Holden & Karsh, 2010, p. 159) for predicting adoption of technology, with similar acceptance for UTAUT. Yet, TAM and UTAUT application in healthcare lagged.

Application of TAM/TAM2 in Healthcare. Approximately a decade after its introduction, TAM was first applied to healthcare by Hu, Chau, Sheng, and Tam in 1999 (Holden & Karsh, 2010). At the time, Hu et al., considered TAM "to be the most promising" (Hu, Chau, Sheng, & Tam, 1999, p. 93) of the models addressing technology acceptance, noting its "advantages in parsimony, IT specificity, string theoretical basis, and ample empirical support" (Hu et al., 1999, p. 93). There was concern that TAM had mostly been validated with subjects who were not professionals in the field where the technology was being used. Pursuing this concern, Hue et al. exercised TAM in a study of the adoption of telemedicine technology by 408 Hong Kong physicians. Using self-assessed and reported questionnaires, the results validated TAM's performance with professionals within their own professional context. Further, the results confirmed TAM's postulate that PU was a strong predictor of BI. However, the results were contrary to the expectation that TAM's PEOU would also influence BI.

Wilson and Lankton (2004) analyzed an integrated model that combined TAM with a motivational model that included constructs on intrinsic and extrinsic motivation. Their intent was to test the ability of all three models to predict patients' acceptance of e-health services. Additionally, the study was designed to assess if five specific antecedents, i.e., satisfaction with medical care, healthcare knowledge, information-seeking preference, healthcare need, and Internet dependence, impact adoption of e-health services. Online questionnaires were completed

by 163 patients measuring the constructs of TAM, the motivational model, and the integrated model, as well as the five antecedents. The results of the study validated both TAM and the motivational model and found that the integrated model was not superior to the other two models in accounting for the variance in BI. Concerning the antecedents tested, all but healthcare need demonstrated association with the models' constructs. Of those four antecedents, all but healthcare knowledge were predictors of e-health acceptance. And, when combined, the results "suggest that the antecedents will have good predictive power across the three acceptance models" (Wilson & Lankton, 2004, p. 244).

A study by Klein (2007), concerning the extension of TAM into healthcare, also considered the impact of self-efficacy on PU, PEOU, and BI, examining acceptance related to PPs. In addition to computer self-efficacy, Klein included personal innovativeness, i.e., "the willingness of an individual to try out any new information technology" (Agarwal & Prasad, 1998, p. 206), as an antecedent of PU, PEOU, and BI. Klein also subdivided BI into BI-communications, moderated by healthcare need, and BI-patient information, moderated by type of care, i.e., primary versus specialty. From a population of 1,473 PP-eligible patients, 294 responded, "sourced from 231 individual providers within 151 different practices across 17 medical specialties" (Klein, 2007, p. 755), to a questionnaire regarding their PU, PEOU, computer self-efficacy, personal innovativeness, BI- computer self-efficacy communications, BI-patient information, healthcare need, and type of care. Results indicated that computer self-efficacy had a meaningful effect on PEOU and personal innovativeness, but not on any other variable. Personal innovativeness had a meaningful effect on all other variables. PEOU had a significant impact on PU, but not on either BI, while PU had a meaningful impact on both BIs. Primary care type of care had an impact on BI-communication, but not BI-patient information.

Of particular note, results showed healthcare need had a significant impact on BI-patient information, which is contrary to Wilson and Lankton's 2004 findings that, using TAM, healthcare need exhibited no significant effect on BI.

Yarbrough and Smith (2007) performed a systematic literature review concerning the use of TAM in evaluating acceptance of information technology by physicians. Despite noting TAM had "been developed largely outside of health care" (Yarbrough & Smith, 2007, p. 654) and that "a limitation of the TAM is its inability to consider the influence of external variables and barriers to technology acceptance" (Yarbrough & Smith, 2007, p. 653), the extant literature, at that time, portrayed that "TAM is a good predictor of physician behavioral intent to accept technology" (Yarbrough & Smith, 2007, p. 662). Additionally, they indicated that although PEOU appeared not to be a strong predictor of physician acceptance, it should not be excluded from TAM.

Holden and Karsh (2010) also reviewed studies where TAM had been considered to assess technology adoption in healthcare. While many of these studies supported the use of TAM for healthcare, they noted "in its generic form, TAM may not capture – or indeed may contradict – some of the unique contextual features of computerized healthcare delivery" (Holden & Karsh, 2010, p. 159). They specifically referenced a study of Hong Kong physicians' use of telemedicine, where TAM was found to suggest "…both the limitations of the parsimonious model and the need for incorporating additional factors…" (Hu et al., 1999, p. 92).

One extension of TAM, presented by Egea and González (2011), included the impact of trust on PU, PEOU, AT, and BI. They further posited that trust is affected by the antecedent's perceived risk and information integrity. Perceived risk is described as the "perceived uncertainty in a given situation" (Egea & González, 2011, p. 323) and information integrity as

"the need to ensure that digitally stored or transmitted patient data 'are not created, intercepted, modified, or deleted illicitly'" (Egea & González, 2011, p. 324). Utilizing systematic sampling, an initial frame of 6,260 physicians was pruned to a sample of 1,500, of which 254 responded to mailed questionnaires concerning EHRs and their associated PU, PEOU, AT, BI, trust, perceived risk, and information integrity. Results of their study indicated that trust, perceived risk, and information integrity were all "strongly predictive of physician's acceptance" of EHRs (Egea & González, 2011, p. 328).

Research published by Moores (2012) also used TAM as its foundation, but sought to understand how antecedents of PU and PEOU might affect AT and U. He hypothesized that information quality, comprised of accuracy, content, format, and timeliness, as well as enabling factors consisting of computing support and self-efficacy, influence PU and PEOU. Approximately 900 clinic staff were provided surveys and asked to respond to 10 questions using a 5-point Likert scale, plus one additional detailed question concerning actual system use. Useable surveys from 346 respondents indicated that information quality and enabling factors had a significant influence on PU and PEOU.

The impact of antecedents on TAM was again considered by Lazard, Watkins, Mackert, Xie, Stephens, and Shalev (2015). However, this study evaluated how aesthetic aspects of a PP might impact acceptance by patients. The Visual Aesthetics of Website Inventory, consisting of simplicity, a user's perception that the PP's presentation is orderly, balanced, and clear; diversity, defined as how complex, visually rich, and dynamic the PP is; colorfulness, the PP's use and placement of colors; and craftsmanship, how well the user perceives the PP is crafted. A 7-point Likert scale of both TAM variables and the Visual Aesthetics of Website Inventory

aspects was completed by 333 PP users from a regional healthcare clinic. Results indicated that simplicity was an antecedent to TAM, but diversity, colorfulness, and craftsmanship were not.

Application of UTAUT/UTAUT2 in Healthcare. Similar to the expanded use of TAM, UTAUT and UTAUT2 have also been introduced in predicting the adoption of healthcare technology, Vanneste, Vermeulen, and Declercq (2013) used UTAUT to assess physicians' acceptance of BelRAI, the Belgium version of the Resident Assessment Instrument, an automated assessment tool of the health and welfare of the elderly. This study reintroduced three additional determinants, anxiety, self-efficacy, and attitude towards using technology, excluded from the work of Venkatesh et al. (2003). Flemish caregivers were issued structured questionnaires, with 282 usable responses collected. Results indicated that facilitating conditions and self-efficacy had significant influence on BI, while performance expectancy, effort expectancy, social influence, anxiety, and attitude towards using technology did not.

While many of the studies concerning the application of adoption models in healthcare focused on clinicians as the users, Yuan, Kanthawala, and Peng (2015) used UTAUT2 to explore healthcare technology adoption by consumers. A self-reported questionnaire was administered to 317 students from a Midwestern university in the United States. Using a 7-point Likert scale, questions were targeted at the UTAUT2 variables in relation to health and fitness applications. Results from analyzing the responses validated that performance expectancy had a significant impact on BI, but that effort expectancy, social influence, and facilitating conditions did not. The three specific constructs of hedonic motivation, price value, and habit, especially hedonic motivation, were all found to have a significant effect on healthcare technology acceptance.

Tavares and Oliveira (2016) used UTAUT2 specifically targeted at PP adoption. Their version of UTAUT2 incorporated a new construct, self-perception, i.e., that a consumer's health-

related actions are motivated based on "the perceived, rather than the real, severity of the complaint" (Tavares & Oliveira, 2016, p. 7). A moderator, chronic disability, was also added. Valid responses to a survey measuring the UTAUT2 variables, via 7-point Likert scales, were received from 360 consumers at three Portuguese educational institutions. Of the respondents, 14.4% (52) noted they had a chronic illness or disability. Analyzing the UTAUT2 results indicated performance expectancy, effort expectancy, habit, and self-perception all had significant impact on BI, while chronic disability did not. Results also showed hedonic motivation had no significant impact on BI, which is logical given that PPs are not intended nor designed to impart enjoyment to the user.

Monkman and Kushniruk (2015) proposed an adaption of TAM to incorporate consumer aspects, but thus far have not empirically validated the model. The model considers that healthcare technology "users (i.e., consumers or laypeople) often have limited or no healthcare experience and/or knowledge" (Monkman & Kushniruk, 2015, p. 27). They noted that, relative to healthcare, eHealth literacy needs to be incorporated into TAM, as a user's eHealth literacy level and the eHealth literacy demands of the technology will affect both PU and PEOU.

It is evident that as TAM/TAM2/UTAUT/UTAUT2 constructs have evolved, they have been increasingly used to assess the adoption of technology in healthcare. For example, TAM has been applied to understand the impact of literacies on BI to use PP technology. And, while Klein focused solely on computer self-efficacy, the application of TAM to PP adoption extended beyond computer literacy (Sharit et al., 2014). However, the application of these constructs did not produce a metric, i.e., PUI, capable of readily predicting, with a degree of accuracy, how specific patient literacies could impact PP utilization.

Barriers to Patient Portal Utilization

The use of PPs has proven to be challenging with "enrollment and utilization of portals…hindered by several barriers" (Amante et al., 2014, p. 784). There have been few published studies identified that address the breadth of factors affecting PP implementation and use. Neuner et al. (2015), examined PP enrollment, use and satisfaction, but in the context of a later-adopting healthcare center. Amante et al. (2014), focused on a broad range of factors affecting PP use, however, targeted at a disease-specific cohort, in that case, diabetes. Most of the remaining research regarding PPs had been relegated to specific influencing factors, i.e., demographics, literacy, usability, and enrollment.

One interesting aspect of the literature related to PP use was recognition of a digital divide, i.e., identification that certain population cohorts have more or less access to and capability to use PPs. Many of the studies reviewed directly or inferentially addressed the presence of a digital divide that had a negative impact on PP use, with Yamin et al. (2011) specifically targeting that issue.

Several of the references to the digital divide were directly related to computer/Internet access. In a literature study concerning the use of PPs by patients with chronic illnesses, Kruse, Argueta, Lopez, and Nair (2015) concluded the digital divide is represented by differing levels of computer/Internet literacy. The presence of a digital divide related to challenges of computer/Internet access was also acknowledged by Smith et al. (2015).

A common theme evolved indicating that the digital divide is evidenced in disparities associated with age, income, and education, as represented by Deering and Baur (2015). Analysis of 75,056 patients treated by Partners HealthCare by Yamin et al. (2015), expanded the Deering and Baur position, finding that PP adoption was influenced by not only income, but by

race/ethnicity as well. Secondary data analysis conducted by Bailey et al. (2014) presented a modified position concluding that the digital divide exists for patients with limited health literacy, regardless of their associated age and socioeconomics. Levy, Janke, and Langa (2014) sampled 2,048 individuals 65 years of age and older and similarly concluded that health literacy defines the digital divide for PP use, i.e., subjects with low health literacy were less likely to use the Internet (OR=0.36, 95% CI).

There was interest in exploring if the use of PPs may actually exacerbate the digital divide (Ketterer et al., 2013; Levy et al., 2014), with Lugue et al. (2013), posing "increasing the health care disparities between advantaged and disadvantaged populations" (Ketterer et al., 2013, p. 264). This concern was amplified by Latulipe et al. (2015) noting "older adults' adoption and use of PPs is the most critical" and that "this population has the most barriers to adoption and use of PPs" (Latulipe et al., 2015, p. 3859). A possible mitigation to such concerns was offered by Sanders et al. (2013), where 654 patients from clinics in Rochester, NY, indicated that onsite personal assistance may be required to address digital divide disparities. The discussion of further aspects regarding the digital divide and PP use will be included in the individual sections concerning PP use factors.

Patient populations are naturally diverse with a wide spectrum of attributes to consider such as gender, age, race/ethnicity, education, income and insurance status. These patient demographics represent an interesting PP use factor in that studies identified both their direct relationship with PP use and an indirect relationship with PP use through their influence on other use factors of patient literacy and PP enrollment. The two most prevalent patient demographics discussed in PP use literature were age and race/ethnicity.

Some demographic attributes, e.g., gender and age, are routinely collected during patient registration and clinical encounters to be later available in the patient's EHR. Other demographic information, e.g., education and income, may need to be purposefully acquired, requiring customized EHR storage and access considerations. Discussion concerning various patient demographics affecting PP use follows.

Literature indicated that patient's age presented interesting and somewhat contradictory results concerning PP use. Most studies, as indicated in a literature review by Amante et al. (2014), concluded that PP use appeared to be higher for younger patients. For example, a national survey by Baird, Raghu, North, and Edwards (2014), regarding use of PP features by 1,038 respondents concluded that PP use was more prevalent among younger patients and found older patients were predictive of not accessing the Internet for health information. Similarly, of 5,622 patients receiving treatment at a federally qualified health center in New York City, Mikles and Mielenz (2015) found PP users more likely to be younger, i.e., classified as Millennials or Generation Xers.

Even when a PP is used, age was identified as having an impact on PP task performance with Sharit et al. (2014) noting that for tasks related to PP use, younger patients performed them at a higher level. They studied 40 veterans treated at a Florida Veterans' Administration medical center, also concluding that older patients "performed significantly worse" on PP tasks "critical for self-management of health" and thus "may be particularly compromised" (Sharit et al., 2014, p. 187). Based on a survey of 1,072 cancer patients over the age of 18, Girault et al. (2015) provided quantification of the impact of age on PP use, identifying a perceived seven percent decrease in perceived ability to use technology for each one-unit increase in age.

From a contradictory perspective, Neuner et al. (2015) identified that older, i.e., 50 to 65 years old, were more likely users of the Epic MyChart PP than younger patients (p<0.01). Performing data collection from 638 patients in the waiting rooms of five primary care clinics in the Midwest, Wakefield et al. (2012) concluded that PP users tended to be older, contradicting prior findings and conclusions. And further, a degree of bifurcation appeared evident in work by Levy et al. (2014) where it was determined there was higher Internet use for younger patients and lower Internet usage by patients older than 75 years of age. Despite the contradictory findings regarding the directional impact of the patient's age on the PP use, a study of patients from eight Virginia ambulatory care clinics resulted in Krist et al. (2014) concluding that patient age was a predictor of PP use.

As with age, PP use studies identified race/ethnicity as a determinant of PP use. Mikles and Mielenz (2015) found that of 5,622 urban patients, PP users were more likely to be white, with bivariate analysis confirming 70.08% of PP non-users to be non-white (p<0.0001). Using a sample of 534 patients from a general internal medicine clinic in an academic health system, Smith et al. (2015) determined white patients to be 10 times more likely than African-American patients to check clinical test results via a PP (AOR=10.53, 95% CI).

A study of 180 patients from a multispecialty group practice in New York City found significantly higher PP use by non-Hispanics (Ancker et al., 2014). Similarly, Amante et al. (2014) also determined PP use was significantly higher for non-Hispanics. While findings of Krist et al. (2014) supported those of Ancker et al. (2014) and Amante et al. (2014), Krist et al. (2014), found race/ethnicity to be a weaker predictor of PP use than the patient's age, although concluding blacks (OR=0.89, 95% CI) and Hispanics (OR=0.36, 95% CI) are less likely to use a

PP. And, Sanders et al. (2013) studied 654 inner-city patients, finding that PP use via the Internet did not correlate to race/ethnicity (OR (0.97-1.35), 95% CI)).

An analysis of 10 studies of Kaiser patients, found that race/ethnicity appeared to affect PP use (Goldzweig et al., 2013). One study of 718 disease management patients found blacks and Asians were less likely to use a PP than whites. A second study reviewed similarly indicated blacks were significantly less likely to use a PP than whites. And finally, analysis of a third study found "blacks, Latinos, and Filipinos were more than twice as likely not to sign on to the portal than whites." (Goldzweig et al., 2013, p. 684).

Education was also found to have a relationship to PP use, with Deering and Baur (2015) stating more highly educated patients tend to use PPs more than those less educated. Wakefield et al. (2012) examined patient preferences concerning PP communications concluding that PP users tended to be more highly educated (83.7% of 499 patients had some amount of college education). Mikles and Mielenz (2015) likewise determined PP users more likely to be more educated (41.6% of their 7,653 subjects). A literature review by Amante et al. (2014) found PP use was significantly higher for patients with postgraduate degrees. From a dialectic perspective, although analysis of 654 patients in Rochester, NY, by Sanders et al. (2013) found that Internet usage correlated with education, Taha, Sharit, and Czaja (2014), in a sample of 51 older (60 to 85 years of age) Miami patients, determined education was not a significant predictor of PP use.

Prior studies also indicated a relationship between PP use and patients' income level. Amante et al. (2014), Baird et al. (2014), as well as Milkes and Mielenz (2015) all found relationships between patients' income and PP use. Bailey et al. (2014) dimensioned the patient income level associated with PP use, finding that patients with income less than $20,000 per year were predictive of not accessing the Internet for health information. While Girault et al. (2015)

didn't analyze patients' income, a relationship was found between PP use and patients' employment which could serve as a proxy for income. The degree of impact of income on PP use is evidenced by Ancker et al. (2014) finding significantly higher PP use by patients currently employed, as well as by Amante et al. (2014) that found PP use was significantly higher for employed patients with higher incomes. Wakefield et al. (2012) also concluded that PP users tended to have higher income.

Studies indicate that patients with insurance are more likely to use PPs. It was found PP use was significantly higher for patients with insurance (Amante et al., 2014; Mikles and Mielenz, 2015). However, contradictory results were presented by Sanders et al. (2013), where no correlation was found between Internet usage and patients' insurances. Since the Amante et al. (2014) results specifically identified a relationship between PP use and a patient having private insurance, a question to be considered is whether insurance has a relation with PP use as a distinct, independent variable or whether it is indicative of another demographic variable such as employment status or income level.

Interestingly, despite the numerous studies of patient demographics and PP use, few found any significant relationships to patient gender. Baird et al. (2014), Milkes and Mielenz (2015), as well as Wakefield et al. (2012) in particular, posited that female patients are likely to use PPs more than males. From a supportive but different perspective, Bailey et al. (2014) found male patients were predictive of not accessing the Internet for health information.

Before a patient can access and use a PP, they must enroll, i.e., become associated with and connected to the PP. The results from Goel et al. (2011b) indicated that "overcoming barriers to enrollment in the portal is the most crucial next step to minimizing disparities in use of patient portal technology" (Goel et al., 2011b, p. 1115). PP enrollment is affected by multiple, distinct

issues such as awareness the PP exists, accessibility to required PP technology, desire to engage with and use a PP, and even a patient's existing relationship with their healthcare provider. The literature reviewed by Amante et al. (2014) concerning PP enrollment issues related to diabetic patients, partially supports this position identifying three categories of PP enrollment barriers – "capacity to use portals, desire to use portals, and awareness of portals" (Amante et al., 2014, p. 789). PP enrollment is also affected by the previously noted PP use factors of patient demographics and literacy. Although several similar relationships appeared to exist between patient demographics and PP use, there were also some differences identified. Therefore, some aspects of patient demographics and literacy will be reexamined in terms of their relation to PP enrollment. It is also of note that while PP enrollment is an antecedent of PP use, it is not dependable as a predictor of PP use. Thus, it cannot be presumed that because a patient enrolls with a PP, that patient will similarly use the PP either actively or even sporadically.

To use a PP, a patient needs to first enroll with that PP; and prior to enrolling, must be aware of its existence. While awareness of PPs is more common since their promotion by the Health Information Technology for Economic and Clinical Health Act, patients may know the term PP but do not know exactly what a PP is, whether one exists for their specific provider, and if it does exist, how to enroll with it. Amante et al. (2014) determined that a significant barrier to PP enrollment was the lack of awareness that a patient's provider had a PP. That finding was supported by Goel et al. (2011a) where 26% of the patients studied did not recall their provider ever discussing the availability of a PP with them. So, the first step to PP enrollment is ensuring patient awareness regarding the PP.

One approach to increasing patient awareness concerning the presence of PPs is to directly market the capability to patients. Ronda, Dijkhorst-Oei, and Rutten (2014) determined

the reasons for and barriers to diabetes mellitus patients enrolling with a PP. They assessed 1,390 patients, finding 72.4% of the patients who did not have PP access were not aware a PP even existed. Yamin et al. (2011) found that when aggressively applying more than five different marketing approaches, such as posters and kiosks, PP enrollment increased threefold. Ketterer et al. (2013) studied 13 pediatric primary care practices to understand PP enrollment dynamics. These practices employed varied methods for making patients' parents aware of the existence of a PP, including posters, brochures, personal communication by clinic staff, and phone calls. Of the entire 84,015 patient sample, 31,765 patients (38%) received access credentials with only 8,409 patients (10%) actually enrolling with the PP.

Enrollment with a PP can be inhibited due to multiple issues such as the lack of access to requisite technology, the lack of required PP enrollment information, and even patient error. Absence of the requisite technology, i.e., an access device such as a computer or tablet with Internet capabilities, makes any other PP use facilitator or inhibitor moot. Amante et al. (2014) concluded that if lack of computer/Internet access were inhibiting PP enrollment, a potential solution would be the use of mobile devices, e.g., smart phones, or strategically located kiosks. Lack of access to the Internet or a computer access device is further indication of the digital divide previously discussed and will not be revisited here.

The inability to access a specific PP frequently involves the lack of required PP enrollment information. In some instances, patients never requested access credentials, as was the case with 76.5% of the patients sampled by Ronda et al. (2014). Even if the patient has been made aware of the existence of a PP, the patient may have not received the required enrollment information, i.e., the PP URL (Uniform Resource Locator), PP user access credentials, or

specific PP enrollment technical instructions. And, as frequently occurs with many other types of online service portals, patients often lose or forget their user access credentials.

Login difficulties significantly inhibit PP enrollment as evidenced by Goel et al. (2011a), where 11% of the subjects had unsuccessfully attempted to log in to their assigned PP. Smith et al. (2015) found 93% of eligible patients were offered PP access, with whites (95.1%) and Other (94.7%) being offered access more than African Americans (89%). Of those patients offered PP access, Smith et al. (2015) found only 57.5% actually enrolled with the PP; the predictors of PP enrollment were more highly educated white males with adequate health literacy. They also concluded that a barrier to PP use was due to patients forgetting to enroll.

The lack of a capacity to use a PP was found to hamper PP enrollment (Amante et al., 2014). In a random sample of 1,000 subjects by Ancker et al. (2014), only 180 (18%) were provided PP access credentials, of which 113 (11% of all subjects and 62% of those provided access credentials) actually enrolled with the PP. Patients sampled by Girault et al. (2015) were found not to be reluctant to enroll in and use a PP, with 84% feeling comfortable with portal technology.

Interesting findings concerning patient PP enrollment patterns were identified by Krist et al. Eight primary care clinics in Virginia were provided PP access credentials for 112,893 associated patients. Only 25.6% (28,910) eventually enrolled with the PP. The average PP enrollment time was 59.5 days with a median of six days as 23.5% of the patients who enrolled did so within one day.

The impetus for a patient to enroll with a PP came from various sources. One of the most significant sources was the personal desire of the patient. Often, patients indicate an absence of such a desire based upon several reasons. Lack of time was cited as a significant inhibitor of a

desire to use a PP (Byczkowski, Munafo, & Britto, 2014). Even when patients had time to enroll with the PP, they purported other reasons for not enrolling.

One study found that 33% of the patients they studied were deterred from enrolling and using PPs due to privacy concerns (Vodicka et al., 2013). Ancker et al. (2014) also found that privacy concerns had a negative impact on PP use. However, this privacy concern was not substantiated by the findings from other studies. Byczkowski et al. (2014), as well as Ronda et al. (2014) indicated patients were not inhibited from enrolling with a PP due to privacy concerns. However, Baird et al. (2014) found that while only marginally significant, privacy and security concerns were negatively associated with perceptions of PPs. Similarly, 32% of the subjects considered by Girault et al. (2015) indicated they felt confidentiality was a concern with PPs. Subjects' concerns regarding the safety of secure messaging with providers was also identified (Kruse et al., 2015).

Another factor that affected patients' desire to enroll with and use a PP was encouragement (or lack thereof) to do so. Amante et al. (2014) noted that both family and provider recommendations have a positive effect on PP enrollment. Similarly, Ketterer et al. (2013) concluded that provider attitudes towards PPs affect PP enrollment.

A concern that patient attitudes may present barriers to PP use was noted by Lugue et al. (2013). They found that 22% of the subjects in his sample failed to use the Internet due to lack of interest in a PP. However, some patients embraced the concept of a PP, as indicated by Giardina, Modi, Parrish, and Singh (2015) finding that most of the subjects felt abnormal test results should be available through the PP. Similarly, results from Shultz, Wu, Matelski, Lu, and Cram (2015) indicated younger subjects were accepting of receiving clinical test results via electronic means, i.e., PPs.

Smith et al. (2015) concluded that barriers to PP use included patients' lack of trust in PPs and a general phobia towards technology. Results from Taha et al. (2014) found that 86% of the subjects would use a PP, and 94% felt use of a PP would improve their health self-management. Results from Amante et al. (2014) identified that different patients' desires to use a PP, or not, created a dialectic tension concerning PP enrollment. PP enrollment was facilitated by patients with a positive desire to use the PP, while lack of desire to use the PP served as an enrollment barrier. Lugue et al. (2013) found that 86% of the subjects in the sample would use a PP if made available to them. The same study also determined that positive family encouragement advocating use of the PP facilitated PP enrollment.

One interesting dialectic concerning PP enrollment and use concerns a patient's health status. Baird et al. (2014) concluded that patients with better health may relate to less PP usage. Neuner et al. (2015) did not substantiate the Baird et al. conclusion finding PP enrollment was slightly lower for patients with more medical conditions. It was also concluded PP use was influenced by patients having comorbid conditions (Krist et al., 2014), with patients with a high degree of computer/Internet literacy being likely to have a chronic disease (Wakefield et al., 2012).

Patients' relationships with providers have significant influence concerning patients' PP use, noting dissatisfaction with an existing patient-provider relationship served as a facilitator to PP enrollment (Amante et al., 2014). Mishuris et al. (2014) found conflicting positions concerning patients' use of PPs to communicate with physicians, with some patients refraining from PP enrollment due to established, positive relationships with their providers, while other patients would only enroll with and use a PP if they had good and trusted relationships with their

providers. They expanded on the point indicating a barrier to PP use was the patient being satisfied with the existing provider communication channels.

Lack of provider buy-in regarding PPs and patients' poor perceptions of providers' interactions with PPs formed barriers to patients' PP enrollment was also found (Amante et al., 2014). Apter (2014) found that some providers are not PP-literate, thus inhibiting patient interest in a PP, further indicating the significance of provider support for PPs. Not surprisingly, Mikles and Mielenz (2015) reported finding that active PP users were likely to be associated with providers who have higher patient-PP use ratios. Interestingly, Krist et al. (2014) concluded that patients are less likely to use a PP if their provider is older. While not precisely resulting from a distinct type of patient-provider relationship, Baird et al. (2014) concluded that increased provider visits are associated with increased PP use.

An interesting result was identified by Taha et al. (2014) where it appeared younger patients were more likely to request PP enrollment, but once enrolled, older patients were actually more likely to use the PP. However, the Neuner et al. (2015) sample found PP enrollment to be highest in the 50 to 65-year-old cohort. Amante et al. (2014) determined increased PP enrollment occurred for patients who were younger, non-Hispanic or black, more highly educated, and had higher income and private health insurance. Baird et al. (2014) found that perceptions of PPs were generally elevated for younger females of higher income levels. Goldzweig et al. (2013) presented the findings of two Kaiser studies concerning the effect of patient demographics on PP enrollment. In one study of 1,777 patients, of the 35% enrolled, PP enrollment was most prominent by more highly educated whites. A second Kaiser study of 14,102 patients focused on the relationship of health literacy to PP enrollment found blacks, Latinos, and Filipinos least likely to enroll with the PP.

Another of the challenging factors to the use of PPs is ethics, both from the perspective of the patient and the physician. Multiple aspects of the impact of ethics on the use of PPs have been researched. Patients have become increasingly concerned with managing their ePHI at a very granular level (Caine & Hanania, 2012). Meslin et al. (2013) noted "a deliberate trend toward giving patients more information and more control over health decision making" (Meslin et al., 2013, p. 1137). Additionally, there was evidence of PP access concerns regarding increased sensitivity due to a patient's diagnosis as noted in the research by Ennis et al. (2014) stating "reluctance to introduce them to secondary mental health services…due to concerns of risk, confidentiality, and sensitivity of information" (Ennis et al., 2014, p. 305). Meslin et al. (2013) further explored how such ethics issues should be considered during the design of PPs.

Healthcare providers have expressed concerns regarding PPs' impact on patient-physician interactions and premature, and possibly inaccurate, interpretation of PP-provided medical results. Bates and Wells (2012) documented this concern commenting "physicians in particular have had some reservations about moving forward in this area, partly because of concern they will be bombarded with questions and that patients will have trouble interpreting their results" (Bates and Wells, 2012, p. 2034). From a physician-physician relationship concern, Bruno, Petscavage-Thomas, Mohr, Bell, and Brown (2014), commented on the concern of PP access to radiology reports, stating "Radiologists and their colleagues are understandably anxious about wider availability of their previously 'private' physician-physician communications." (Bruno et al., 2014, p. 864).

Despite the purported need for and advantages of PPs, adoption has been plagued by usability issues (Czaja et al., 2014). Such issues are evidenced by one patient's complaint to the government,

I am a pretty tech savvy, intelligent, educated patient. As of now, I have months of

experience with the patient portal (better characterized as a moat with drawn bridge) used

by the George Washington Med Faculty Associates, and the system used by Johns

Hopkins. They are both terrible. As a patient, I find them difficult to access; the

information is incomplete & inaccurate; and difficult to correct. (Canzoneri, 2014)

However, usability is not solely impacted by incomplete ePHI; there is also concern that PPs

may be "overwhelming patients and doctors with information" (Wynia & Dunn, 2010, p. 67).

Additional research regarding PP usability is of interest, similar to a study by Zarcadoolas,

Vaughon, Czaja, Levy, and Rockoff (2013) that sought to determine consumers' feelings

regarding the utility of PPs and specific desired functionality.

Lugue et al. (2013) found that 19% of the subjects in the sample failed to use the Internet

due to lack of knowing how to use the PP. They also found that 70% of the subjects would use

the PP if instructed how to effectively do so. In addition to the patient demographic factors,

Amante et al. (2014) also identified that PP enrollment was influenced by patients'

computer/Internet and health literacies. Kruse et al. (2015) reported patients indicated PP use

was inhibited by complexity of the PP coupled with a lack of guidance regarding how to use the

PP. They concluded that a tutorial regarding PP use, available to patients prior to PP enrollment,

would be beneficial.

In summary, literature has proffered, and research identified, multiple potential barriers

affecting PP use. The barriers include demographic aspects, such as age, race/ethnicity,

education, income, insurance, and health condition. PP use is also predicated on patients being

made aware of and granted access to PPs, for absent awareness and access evolving into PP

enrollment, usage is not possible. Additionally, patient literacies, e.g. computer/Internet, health,

and numeracy, may also present barriers to PP use. While not discounting the impact, other barriers may potentially have on PP use, this study, and the associated literature research will focus on these three specific patient literacies.

Patient Portal Literacy Issues

It has been shown that PP use is significantly related to various literacy dimensions of patients. While the most common literacy dimension discussed was computer/Internet literacy, as noted by Taha et al. (2014), patients' literacy in the areas of health, numeracy, and graphics also demonstrated relationships to PP use. As previously identified, there was also a relationship between literacy dimensions and patient demographics identified in the literature. Where relevant, the impacts of patient demographics will be presented during the review of each literacy dimension.

The analyses of patients' literacy dimensions were complicated by two factors. First, there was an absence of universally accepted measures for the various literacy dimensions (Beaunoyer, Arsenault, Lomanowska, & Guitton, 2017; Haun, Valerio, McCormack, Sørensen, & Paasche-Orlow, 2014; Sudbury-Riley, FitzPatrick, & Schulz, 2017). Thus, while multiple studies may have studied the same literacy dimension, they used different patient populations and metrics to quantify the patients' competencies in that dimension, making inter-study comparative analyses challenging (Woods et al., 2017). The second challenge with analyzing literacy dimensions is that such information was not routinely captured during usual and customary patient registration processes (Sand-Jecklin, Daniels, & Lucke-Wold, 2017). The targeted capture and assessment of such patients' literacies required distinct interventions

(Eubanks et al., 2017; Welch, VanGeest, & Caskey, 2011). Such challenges will be further explored within the discussion of each literacy dimension.

As noted, computer and Internet literacy represented a commonly studied literacy that affect PP use. This literacy dimension significantly contributed to the digital divide previously noted (Irizarry, DeVito Dabbs, & Curran, 2015; Irizarry et al., 2017; Yarmin et al., 2011). The determination of a patient's computer/Internet literacy to be used in studying PP use factors was made using different methods (Bush, Barlow, Pérez, Vazquez, Mack, & Connelly, 2018; Graetz, Gordon, Fung, Hamity, & Reed, 2016; Mayberry, Kripalani, Rothman, & Osborn, 2011). One approach was to acquire patients' email addresses. While such a method was convenient, the ability to determine the presence or absence of a patient's email address was likely to serve as only a limited proxy for computer/Internet literacy. It was not uncommon for patients to have email addresses but possess little or no computer/Internet skills. Additionally, some patients were concerned with the privacy and security aspects of PPs, and thereby reluctant to provide the email address information, further inhibiting the ability to estimate the patients' computer/Internet literacy.

Ancker et al. (2014) and Apter (2014) both found PP use to be significantly higher by patients who were computer/Internet literate, with Apter determining that patients were more likely to use PPs if they possessed at least an adequate level of computer/Internet literacy. Computer/Internet literacy was also a function of having access to that technology as supported by the findings of Mishuris et al. (2014). They identified three barriers to PP use, with one being "limited computer and Internet access" (Mishuris et al., 2014, p. 4). Work by Taha et al. (2014), concluded that computer/Internet skills are significant to PP use, especially as related to performing more complex PP tasks, but lower computer/Internet literacy may affect older

patients' performance of even basic PP tasks. They further determined computer/Internet literacy was a significant predictor of PP use performance. Sharit et al. (2014) examined 40 United States' veterans leading to the conclusion that for performing tasks related to PP use, younger patients performed at a higher level.

Relative to patient demographics' impact on computer/Internet literacy, studies noted that race/ethnicity, age, and income were significant determinants. Taha et al. (2014), as well as Sanders et al. (2013), determined computer/Internet experience was a significant predictor of PP use. Mishuris et al. (2014) found limited knowledge of the functional aspects of a PP constitutes a barrier to PP use.

How well a patient understands health and medical terms and concepts constitutes their health literacy (Kindig, Panzer, & Nielsen-Bohlman, 2004). Given that effective use of a PP is at least partially predicated on a patient's ability to view and correctly interpret health and medical terms, health literacy is a critical factor in PP use (Coughlin et al., 2018). However, determining a patient's health literacy is challenging and a metric not routinely collected about the patient. One method used to evaluate patients' health literacy was to have them complete a self-evaluation of their competency level. However, such assessments may be prone to bias, with patients either over or under-estimating their degree of health literacy (Diviani, Van den Putte, Meppelink, & van Weert, 2016).

Another evaluation method to determine patients' health literacy is to administer the Test of Functional Health Literacy in Adults (TOFHLA). Established by Parker et al. (1995), TOFHLA combines 50 questions regarding reading comprehension with 17 questions related to numeracy literacy. The reading segment of TOFHLA evaluates a patient's ability to read and understand common health information such as found on medical forms, health insurance

applications, and informed consent forms. The numeracy questions focus on understanding medication instructions and monitoring personal health values. Analysis of the combined questions results in a score between 0 and 100, which is classified into one of three categories – adequate (greater than 74), marginal (60 to 74), and inadequate (less than 60). While the TOFHLA method produces a more objective measure, it can be questioned as to how accurately it truly determines a patients' health literacy. TOFHLA scores, while providing a more objective measurement metric, were sometimes discarded as when Taha et al. (2014) found lack of variability in the scores of their sample patients.

An additional approach used to measure health literacy was the Newest Vital Sign (NVS) (Huang et al., 2018; Shealy, & Threatt, 2016). NVS uses six questions concerning the interpretation of nutrition information found on an ice cream container. An NVS score is produced by totaling the number of correct answers to the questions, resulting in a value between 0 and 6. NVS then categorizes the individual's health literacy based on the score – adequate health literacy (4-6), possible limited health literacy (2-3), and likelihood of limited health literacy (0-1). With such a limited number of questions and constrained ranges for categorizing the patient's health literacies, as with the TOFHLA method, the applicability of NVS's validity have been questioned, but found to be reliable (Chung, & Nahm, 2015).

Literature indicated that health literacy has a relationship with PP use and can be a significant predictor. Baily et al. (2014) found that low health literacy is a predictor of limited use of the Internet, i.e., PPs, to access health information. Secondary analysis of subjects' NVS data from a National Institute of Aging study, *Health Literacy and Cognitive Function among Older Adults* (LitCog), and a patient pharmaceutical study funded by McNeil Consumer Healthcare, found only 41% of the 1,077 subjects in the sample to have adequate health literacy.

Results by Baily et al. (2014) determined that 86.3% of the patients with adequate health literacy used the Internet to access health information, with a precipitous drop to only 40.8% of the patients with low health literacy accessing health information via the Internet. Supporting the findings of Baily et al. (2014), Levy et al. (2014) quantified the impact of health literacy on PP use, finding that patients with at least adequate health literacy were three times more likely to use the Internet to access health information than patients with low health literacy. From this finding, it can be concluded that health literacy is an important predictor of PP use.

Health literacy also was found to have a relationship to patients' performance in using PPs, with more health literate patients performing PP tasks at a higher level than patients less health literate (Sharit et al., 2014). Levy et al. (2014) determined that for older adults, low health literacy created a significant barrier to using the Internet, while Sharit et al. found that health literacy was significant in determining PP user performance, especially for older patients. Smith et al. (2015) found that PP use varied by PP function but, in general, patients with adequate health literacy were more likely to use the PP. In fact, they identified that health literate patients were eight times more likely to use the PP to message their providers than health illiterate patients. This finding differed from the results of the Zikmund-Fisher, Exe, and Witteman (2014) which concluded higher patients' health literacy reduced the need to contact their providers.

The importance of health literacy to PP use is further evidenced by Kruse et al. (2015) where it was noted that PP use is negatively influenced by patients' inability to understand medical terminology. The results went on to identify that the effects of limited health literacy on PP use were exacerbated due to patients' inability to understand health education material provided through the PP along with the absence of a PP interactive health library. They concluded that such a PP interactive health library would assist with health literacy disparities.

Zikmund-Fisher et al. (2014) believed patients' limited health literacy would inhibit their ability to interpret PP results, with the associated results leading to a conclusion that limited health literacy is highly related to difficulties using PPs.

Positing that health literacy has increasingly been impacted by information available through electronic resources, Norman and Skinner took a different approach, introducing eHealth literacy as "a different or at least expanded set of skills to engage in health care" (Norman & Skinner, 2006, p. 3). They defined eHealth literacy as representative of six specific literacies – "traditional literacy, health literacy, information literacy, scientific literacy, media literacy, and computer literacy" (Norman & Skinner, 2006, p. 3). To assess an individual's eHealth literacy, Norman and Skinner devised the eHealth Literacy Scale (eHEALS). The eHEALS was comprised of eight or ten items, each using a 5-point Likert scale "ranging from 'strongly agree' to 'strongly disagree'" (Norman & Skinner, 2006, p. 6). Because of its confined set of items and self-administration, eHEALS provided a more convenient measure of eHealth literacy.

Given the quantity and importance of numeric information presented on PPs, patients' numeracy literacy was an important factor in PP use. As was the case with health literacy, numeracy literacy was not a patient metric routinely collected during a patient encounter but had to be collected as part of a specialized activity. In the studies reviewed, collection of numeracy literacy assessments involved methods ranging from subjective patient self-assessments through administration of the Subjective Numeracy Scale (SNS), to an objective measurement provided by the patient answering eight numeracy questions. Taha et al. (2014) compared subjects' SNS scores to those from the objective numeracy measurement and found that many participants overrated their numeracy skills.

Developed by Fagerlin et al. (2017), SNS is a self-assessment of a person's numeracy literacy. The measure is targeted at individuals who prefer information to be presented in numeric rather than narrative form. Consisting of eight questions, four each concerning the individual's perceived ability to perform mathematical calculations and preference for numerical presentation, respondents answer each question using a 6-point Likert scale. SNS scores range from 8 at the lowest end to 48 at the highest rating.

Findings in the literature indicated numeracy literacy had an impact on PP use. Sharit et al. (2014) found patient PP use performance was higher for patients who were more numeracy literate. Taha et al. (2014) produced similar results with numeracy literacy found to be a significant predictor of PP use performance. Analysis of patients' use of a PP to evaluate clinical test results concluded difficulties in interpretation were highly related to limited numeracy literacy. Zikmund-Fisher et al. (2014) believed patients' limited numeracy literacy would inhibit their ability to interpret PP results, especially when presented in a tabular manner, with the associated results leading to a conclusion that limited numeracy literacy is highly related to difficulties using PPs.

Closely associated with numeracy literacy, graphic literacy is also a factor in PP use. Graphic literacy is the least common use factor to be collected and evaluated as part of the patient encounter process. Yet, graphic representation is a fundamental visualization method used by PPs to depict key patient information. The importance of graphic literacy to PP use is evidenced by Sharit et al. (2014) finding that patients' graphic literacy was "the most diagnostic predictor of (PP use) performance" (Sharit et al., 2014, p. 188), accounting for 39% of the variance.

Conclusion

PPs are a critical component to healthcare's pursuit of improved health at lower cost and essential to the engagement of patients actively participating in the self-management of their health. However, PP adoption and use has been far less than expectations and desires. Studies have identified multiple factors that influence PP use. These factors included patient demographics, patient literacies, and PP enrollment. Additionally, literature has noted the presence of a digital divide, a technological chasm, resulting from some of the patient demographic and patient literacy factors that potentially segments PP user populations, disadvantaging some of the patients.

Existing literature lacked consensus regarding the effect specific factors have on PP use and likewise their applicability as predictors of PP use. The single exception appears to be PP enrollment, at least from a singular perspective. Given that PP enrollment is an absolute antecedent to PP use, the absence of PP enrollment guarantees a corresponding lack of PP use. The reverse however is not true, i.e., PP enrollment has been found to not be a consistently accurate predictor of PP use.

Studies have demonstrated that patient demographics influenced PP use, with age, race/ethnicity, and education being the most commonly identified predictors of PP use. However, studies offered conflicting results concerning whether specific patient demographics affected PP use; and even in some instances when concluding a specific patient demographic did affect PP use, there were inconsistencies regarding the directional impact of the effect. Additionally, as patient demographics were found to have some effect on PP use, they similarly were found to affect PP enrollment as well.

Literacy was portrayed in much of the literature reviewed to have an impact on PP use. Computer/Internet literacy especially was shown to impact PP enrollment as well as PP use. Similarly, health literacy was found to be an important PP use factor that may inhibit both initial and ongoing PP use. Numeracy literacy, and to a lesser degree graphic literacy, was also designated as impacting PP use. Given the health-orientation and numeric/graphic presentation formats of information presented via PP portals, lack of literacy in these domains was found to adversely impact PP use.

As a result of the review of the literature, it appeared evident that additional research regarding the impact of patient literacies on PP use is warranted. Further examination of these literacies would enable both healthcare organizations and patients to estimate and predict the probability of PPs to be effectively used by patients. While TAM/TAM2/UTAUT/UTAUT2 constructs have been applied to understand the acceptance of technology in healthcare, including acceptance of PPs, they did not expose a PUI that could be readily produced. Thus, this review of the literature creates a platform from which to launch additional research into impact literacies have on PP use.

Chapter 3

Methodology

The expanded adoption of electronic health records (EHRs) has led to increased access to electronic personal health information (ePHI) via patient portals (PPs). However, the use of PPs has proven to be less than anticipated, due to various barriers including limited patient literacies. The review of the pertinent literature indicates there is no defined Portal Use Index (PUI) that attempts to predict PP utilization based upon a patient's literacies, thereby warranting further research. To examine the potential development of a PUI, three research questions were posed:

1. How do specific patient literacies, i.e., computer/Internet, health, and numeracy, affect PP use?

2. What tools can be effectively used to evaluate a patients' literacies?

3. What is the construct for a PUI that can accurately predict a patient's PP use based upon their literacies?

Research Design

The research design followed a hypothetico-deductive method (Sekaran & Bougie, 2013). The relational research sought to determine the relationship between specific patient literacies - computer/Internet, health, and numeracy, and PP use. The study attempted to extend the understanding of these relationships into the development of a PUI construct that can be empirically validated to predict a patient's PP use. Availability of an accurate PUI will

potentially enable healthcare organizations develop interventions to increase a patient's ability to use a PP.

The initial step was to broadly define the problem area. For this study, the broad problem was defined as the inadequate adoption and use of PPs. The hypothetico-deductive method then sought to evolve the broad problem area into a definitive problem statement. As previously noted, the problem statement was summarized as there is a gap in the body of knowledge concerning the definitive impact of certain patient literacies on PP use.

The study then proceeded with a critical literature review. The focus of the literature review was to answer the first research question, i.e., "What are the current perspectives on factors affecting PP use?" To conduct this portion of the study, the hypothetico-deductive method was augmented using Preferred Reporting Items for Systematic reviews and Meta-Analyses as evolved by Moher, Liberati, Tetzlaff, and Altman (2009).

A theoretical framework was then devised, including hypothesis development, that addressed the other two research questions – "How do specific patient literacies, i.e., computer/Internet, health, and numeracy, affect PP use?" and "To what extent can a PUI, based on a patient's literacies, accurately predict the patient's PP use?" As amended by the information obtained during the literature research, the variables to be considered in the associated hypotheses were the specific patient literacies serving as the initial independent variables, with the dependent variable being actual PP usage. To answer the third research question, a new independent variable was introduced, the PUI, to determine its relationship to the dependent variable.

The sample consisted of University of Maryland Medical System (UMMS) patients who have had the ability to access *My*Portfolio. Data related to these patients was collected from three

sources – 1) email addresses from the UMMS *My*Portfolio registry, 2) patient literacy data from responses to surveys emailed to UMMS patients, and 3) PP utilization metrics obtained from *My*Portfolio utilization statistics. The data obtained from the three sources were quantitatively analyzed to determine the relationship between the variables. Initially, the analyses were used to perform testing of the hypotheses related to the second research question. Once completed, the results were intended to be used to create the PUI construct. This construct was to be applied to the patient literacy data to produce a PUI for each patient. The PUI would then be quantitatively analyzed relative to the patient's actual *My*Portfolio usage to answer the hypotheses related to the third research question and determine the PUI's ability to accurately predict PP use.

Finally, a report was composed presenting the findings. In addition to describing the approach used, the report disclosed the results and conclusions. It also identified any study limitations and opportunities for future related research.

The UMMS Patient Portal

UMMS implemented its PP, *My*Portfolio (http://www.umms.org/services/myportfolio), through the use of MyChart technology from Epic, the UMMS EHR vendor. *My*Portfolio provides UMMS patients with functionality grouped into eight major categories:

- Message Center – enables patients to communicate with UMMS by sending and receiving secure emails. A patient may request medical advice also via a secure email. Additionally, the Message Center enables a patient to view their current medication list and request prescription refills.

- Appointments – patients are able to view both their previous appointments, as well as their upcoming, scheduled appointments. *My*Portfolio provides functionality for patients to request an appointment. However, unlike some PPs, the patient is not able

to automatically schedule an appointment, but rather only issue a request and wait for the appointment to be scheduled by UMMS' schedulers.

- My Medical Record – the most functionally robust segment of *My*Portfolio provides the patient with extensive medical information. My Medical Record contains three major sets of functions:

  - o View Test Results – provides results and/or status of laboratory, radiology, and other diagnostic tests;

  - o View Health Summary – presents and enables the download of a patient's health issues, medications, allergies, immunizations, preventive care, and problem list;

  - o History – offers the patient's medical, surgical, hospital admission, and social histories, as well as the family's status and medical history;

- Billing and Insurance – permits the ability to query the patient's insurance summary, including coverage and eligibility details and, if desired, pay any outstanding patient bill for services;

- Health Library – offers patients access to extensive medical information via MedlinePlus;

- Current Admission – provides a patient, in the hospital, with a summarized view of what services the patient will encounter that day;

- Questionnaires and Surveys – presents and allows a patient to respond to UMMS' questionnaires and surveys; and

- My Account – enables the patient to manage his/her *My*Portfolio experience, e.g., change demographics, change password, set preferences and notifications, print

forms and a patient-medical wallet card, and access frequently asked questions

concerning UMMS and *My*Portfolio.

UMMS believes that cost-effective and high-quality healthcare is best achieved when

patients are actively engaged in the self-management of their health. Effective health self-

management is predicated on the availability of, and access to, robust and accurate health

information, in this case, via *My*Portfolio. Thus, each new patient who encounters UMMS is

introduced to the PP through the following procedure:

- For hospital inpatients, patients are introduced to *My*Portfolio and provided

    associated registration, sign-in, and access instructions by a nurse who visits them

    in their hospital room prior to discharge;

- For ambulatory patients, including those presenting for ancillary diagnostic

    procedures, patients are introduced to *My*Portfolio and provided associated

    registration, sign-in, and access instructions by clerical staff at check-out;

- Patients must then sign in to *My*Portfolio, establishing their permanent password.

Instrumentation

To assess eHealth literacy, encompassing both computer/Internet and health literacies, a

self-assessment eHEALS questionnaire was used. Literature notes several different instruments

that have been used to assess health literacy, e.g. TOFHLA, NVS, eHEALS, and Single Item

Literacy Screener. As previously noted, instruments used to assess health literacy have been

challenged as to their reliability in accurately assessing health literacy. For this study, the 10-

item version of the eHEALS instrument was used (see Appendix E). The eHEALS was selected

for several reasons – 1) it is an instrument that has been validated for use in multiple studies, 2) it

provides responses to multiple assessment questions rather than a single question, such as Single

Item Literacy Screener employs, and 3) utilizing only eight questions, it presents a less onerous instrument for the subject to complete than the 67-question TOFHLA.

A patient's numeracy literacy is not normally determined at any point during patient registration. While objective numeracy measurements have been found to be more accurate than self-assessment, such as SNS (Taha et al., 2014), submitting nearly 400 subjects to an individual objective numeracy assessment is not practical. Therefore, for purposes of this study, SNS was used to assess patients' numeracy literacies (see Appendix F).

*My*Portfolio utilization was not assessed using an instrument. Rather, PP utilization was retrieved from the *My*Portfolio utilization database maintained by UMMS. Of interest, were number and frequency of total *My*Portfolio access as well as major classifications of *My*Portfolio functionality accessed.

Approach

Applying a "generalized scientific guideline for sample sizes," (Sekaran & Bougie, 2013, p. 267), it was proposed that, based on approximately 80,000 current *My*Portfolio users, at least 383 participants would be required to conduct a valid study (Sekaran & Bougie, 2013, p.268). Assuming an anticipated response rate of 10%, 3,830 current *My*Portfolio users were needed to be approached to participate. Receiving approvals by the Institutional Review Boards (IRBs) of UMMS and NSU (see Appendices A and B), a random subject selection method was employed by selecting every 21st *My*Portfolio user, from the UMMS Epic patient registry, who is alive, older than 17 years of age, and had granted approval to participate in UMMS surveys and studies. Their email addresses were extracted and stored in a dataset with a generated record identifier. A second dataset was also created containing the record identifier and the patient's

age, gender, race/ethnicity, and *My*Portfolio utilization metrics. The patients selected then received emailed literacy survey instruments to assess their computer/Internet, health, and numeracy literacies.

Similar to the approach used by Zikmund-Fisher et al. (2014), emails were sent to the sample population to obtain subjects' literacies. In addition to a letter recruiting the subject to participate in the study (see Appendix C), an explanation of the study's purpose (see Appendix D), the email contained the generated record identifier and a link to the literacy questionnaire. Questionnaires were provided, processed, and reported by Survey Monkey, an independent, cloud-based online survey provider. The questionnaire contained items for both eHEALS and SNS, thereby assessing both eHealth and numeracy literacies. Comparisons were then performed to determine any correlation between *My*Portfolio utilization and the literacy scores. Such correlations were to be used to construct the PUI.

The Health Insurance Portability and Accountability Act (HIPAA) is of particular concern in any study involving patient information. While no patient clinical information was accessed or used in this study, accessing and using patients' email addresses do present potential HIPAA exposures from a protected health information perspective. To obviate HIPAA concerns, two steps were taken. First, the patients' email addresses were stored in a separate dataset from the patients' literacy scores and *My*Portfolio utilization metrics, linked only by generated record identifiers that had no relation to any other patient information. The dataset with the email addresses was deleted immediately upon the emailing of the literacy instruments, prior to receiving any patient responses. Thus, once the email dataset was deleted, there was no ability to associate any responses with a specific, identifiable patient. And second, 36 months following conclusion of the study, the second dataset containing all patient responses will similarly be

deleted, eliminating any ability to attempt to link responses to a specific patient. SurveyMonkey was contacted to ensure that no identifiable patient information, i.e., user identifier, URL, email address, etc., would be returned or retained along with the survey results. Therefore, responses to the surveys have no potential to violate any HIPAA security or privacy provisions.

The procedures that was used to gather data on each research question follow. Research question 1: *How do specific patient literacies, i.e., computer/Internet, health, and numeracy, affect PP use?* To identify the current perspectives of factors affecting PP use, a comprehensive literature review was conducted. The literature review followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses approach successfully employed in similar PP research by Amante et al. (2014). The four Preferred Reporting Items for Systematic reviews and Meta-Analyses phases - identification, screening, eligibility, and inclusion - were followed to identify the pertinent PP research to be considered. Databases searched included PubMed and the Cumulative Index of Nursing and Allied Health Literature (CINAHL) (Amante et al., 2014), as well as, ProQuest (Health and Medicine), and Google Scholar (Roberts, Chaboyer, Gonzalez, & Marshall, 2017). Targeted searches used a combination of the following terms – "patient portal" and "computer literacy," "health literacy," and "numeracy literacy." After screening and eligibility phases, focused on PP utilization, research articles were pruned to the appropriate subset to identify the proposed effect of patients' literacies on their PP use.

Ancker et al. (2014), Bailey et al. (2014), Levy, Janke, and Langa (2014), Smith et al. (2015), as well as, Zikmund-Fisher et al. (2014), compared various patient literacies to actual and anticipated PP use. Such effects were empirically evaluated during this study, by having each responding subject's patient literacy scores compared to their *My*Portfolio utilization metrics. The intent of the analysis was to identify correlations between a patient's literacies and his/her

*My*Portfolio utilization. Such potential correlations were analyzed at a macro level, i.e., overall *My*Portfolio utilization compared to overall patient literacy, as well as at the micro level, e.g., the correlation between numeracy literacy and utilization of *My*Portfolio test results.

Research question 2: *What tools can be effectively used to evaluate a patients' literacies?* Two instruments, i.e., eHEALS and SNS, were used to evaluate patients' literacies. Defined by Norman and Skinner (2006), eHEALS has been frequently used for more than a decade to evaluate individuals' health literacies, achieving such notoriety as "becoming an established and well-respected scale with which to measure eHealth literacy" (Sudbury-Riley et al., 2017, para. 15), and "widely adopted" (Britt, Collins, Wilson, K., Linnemeier, & Englebert, 2017, para.1). Similarly, SNS, created in 2007 (Fagerlin et al., 2017), has been routinely used to evaluate patients' numeracy literacies (Kiechle, Bailey, Hedlund, Viera, & Sheridan, 2015; Lopez et al., 2016; Taha et al., 2014). Correlations between scores from the instruments and *My*Portfolio utilization metrics were then evaluated.

Research question 3: *What is the construct for a PUI that can accurately predict a patient's PP use based upon their literacies?* Assuming correlations existed between the literacy scores and *My*Portfolio utilization, a proposed PUI was to be constructed that models those correlations. The resultant PUI could then be empirically tested in future studies to validate its ability as a predictor of PP use, rather than solely a retrospective reflection of use that has occurred.

Data Collection and Analysis

As previously described, for a valid study, approximately 400 UMMS' PP users needed to serve as subjects. In mid-March 2019, following approval by the IRBs, the email address data for selected patients in the *My*Portfolio registry was extracted and stored in a dataset with a

generated record identifier. A second dataset, containing the record identifier and the patient's *My*Portfolio utilization statistics, was also created.

In early April 2019, 4,000 initial emails, followed by an additional 16,000 emails, were sent to the sample population containing information describing the study, a waiver of informed consent certifying that, by responding, the patient agrees to participate in the study, the generated record identifier, and a link to a SurveyMonkey containing the eHEALS and SNS questions. Subjects were given one month to respond. Using the record identifier for record matching, a unique score for each of the literacies on the returned instruments were appended to the corresponding record in the second dataset. Only replies responding to all literacies were considered valid for use in the study's analyses.

Analyses were then performed to determine any correlation between *My*Portfolio utilization and the literacy scores. Specifically, eHEALS and SNS literacy scores were treated as independent variables to evaluate their impact on the dependent variable, *My*Portfolio usage. Finally, analysis was conducted to evaluate the feasibility of developing a PUI capable of accurately predicting PP utilization based on a patient's literacies.

Format for Presenting Results

Results are presented in two sections. The first section presents empirical findings of the presence, or absence, of correlations between the literacies and actual PP usage. Assuming that correlations are identified, the second section will present the construct of a PUI, depicting its ability to predict PP utilization based on literacies. Both sections consist of narrative descriptions supported by figures and charts presenting the corresponding statistics.

Resources

To successfully conduct the study, multiple resources were required.

People – The NSU Dissertation Committee were required to assess and guide the dissertation process. THE IRB Committees of NSU and the University of Maryland, Baltimore were required to review and approve the dissertation proposal. J. Kathleen Tracy, Ph.D., Associate Professor, Epidemiology & Public Health for the University of Maryland, Baltimore School of Medicine, served as the researcher's affiliate student sponsor. The Clinical and Transitional Research Informatics Center (CTRIC) at the University of Maryland, Baltimore, provided the technical resources to extract the data from the *My*Portfolio database and provide the datasets for the study. Assistance with data analysis was provided by Vernon Chinchilli, Ph.D., Distinguished Professor and Chair, Department of Health Sciences, Penn State College of Medicine. And most importantly, the UMMS patients who were solicited as subjects to participate in the study.

Technology – Information resources at UMMS were used to extract the *My*Portfolio subjects and their utilization metrics. The two data files were provided by CTRIC, and transferred, via a secure, encrypted link, to the researcher's personal computer to be used to store, perform analyses on the literacies and utilization statistics, and compose the final report. SurveyMonkey was used to issue the literacy questionnaires, collect the responses, and present them to the researcher. Data analysis was performed using the statistical software package SAS, version 9.4.

Summary

Increased patient self-management of their health is predicated on timely and accurate access to their ePHI. Such access is greatly facilitated by PP utilization. However, PP use has been inhibited, partially due to limited patient literacies, i.e., computer/Internet, health, and numeracy. A study was designed to determine the correlation between PP utilization and literacies. The study was then extended to develop a PUI capable of predicting PP utilization based on a patient's literacies.

Chapter 4

Results

The increased availability of EHRs, via PPs, provide patients access to substantial amounts of PHI. However, adoption and utilization of PPs has been less than anticipated and desired. An exploratory study was designed to determine if certain patient characteristics, specifically, health and numeracy literacies, have an impact on PP utilization.

*My*Portfolio is the UMMS PP providing access to patients' EHRs. A random group of UMMS patients, registered with access to *My*Portfolio were emailed invitations to participate in a study to analyze relationships between their health and numeracy literacies and the PP utilization. Results are presented as follows: first, the subject response rate is discussed; second, subjects' demographics and descriptive statistics are examined; third, *My*Portfolio utilization by the subjects is described; fourth, results of the subjects' literacy surveys are displayed; fifth, correlations between the literacy scores and PP utilization are identified; and finally, a determination is made with regard to the correlations supporting definition of a PUI.

Subject Response Rate

To obtain the required 400 responses, it was estimated that, based on a presumed 10% response rate, email invitations would need to be sent to approximately 4,000 subjects. Obtaining the 400 responses actually required a significantly larger quantity of invitations to be emailed, i.e., 20,000. Review of the response statistics indicated that 3% of the target email addresses were invalid. Of patients with valid email addresses, 30% opened the email, with 6% activating

the SurveyMonkey link, and only 2% actually completing the literacy surveys. Once 400 survey responses were recorded, access to SurveyMonkey was terminated.

Demographics and Descriptive Statistics

The 400 responding subjects were UMMS patients registered with access to *My*Portfolio, who were not deceased, 17 years of age or older, and had granted permission to contact them for use in UMMS surveys and studies. Females represented 58% (233) of the subjects with the remaining 42% (167) being male. Subjects' ages ranged from 19 to 97, with a mean age of 57.56 years. The largest age group of respondents was the 60-69 cohort (120 - 30%), followed by the 70+ year old's (92 – 23%) and the 50-59 group (79 – 20%). Respondents younger than 50 only constituted 27% (109) of the subjects. The majority of the subjects' race was coded in *My*Portfolio as "white" (334 – 84%), followed by "black" (32 – 8%), and all others (34 – 8%).

*My*Portfolio Utilization

*My*Portfolio contains 88 functions, that span the eight major groupings previously described. Some of the functions are health related, some containing numeracy visualization, and others that involve neither, e.g. Login, Logout. In addition to totaling all *My*Portfolio accesses, to appropriately correlate specific literacies with PP utilization, access to certain functions were aggregated to represent health accesses and numeracy accesses. Figure 1 identifies how such aggregation was performed.

Table 1. *My*Portfolio Aggregation of Functions

*My*Portfolio Function	Messaging	Health	Numeracy	Admin
Messaging	X			
Lab Tests		X	X	
Lab Results		X	X	
Login				X
Logout				X
Appointment Review	X			
Health Maintenance		X		
Medications		X		
Problem List	X	X		
Result Component Graphing		X	X	
Immunizations		X		
Allergies		X		
Appointment Details	X			
Health Snapshot		X		
Terms and Conditions				X
Inpatient Admissions	X			
Medication Renewal Request		X		
Account Inquiry				X
Encounter Details		X		
Histories		X		
History Questionnaire		X		
Appointment Schedule	X			
Personal Preferences				X
Audit Trail				X
Change Password				X
Proxy Access (View)				X
Appointment Autoschedule				X
Insurance				X
Coverage View				X
Appointment Confirm	X			
Wallet Card				X
Secondary Identity Validation				X
Account Payment				X
Download CCD		X		
HB Account Details				X

Upcoming Orders		X		
Demographics				X
Recent Payments				X
Procedures		X		
Switch Context				X
Appointment Cancel	X			
Proxy Context Enter				X
Proxy Context Exit				X
Benefit Details				X
Download Visit Summary		X		
Account Details				X
Device - Auth				X
Provider Details				X
Health Maintenance Schedule		X		
View Visit Summary		X		
Eligibility				X
Letters				X
Hospital Statement Details				X
Device - List				X
Address Change Request				X
Log In From External System				X
View Clinical Notes		X		
Account ReEnable				X
View Requested Records		X		X
Scheduling and Other Preferences				X
Questionnaire		X		
View Care Everywhere Authorization				X
Flowsheet Reports List		X	X	
Update Medications		X		
Referral Review	X	X		
Driving Directions				X
Research Studies				X
Appointment Direct Cancel	X			
Account Signup For Proxy Use				X
Update Problems		X		
eCheck-In	X	X		
Update Insurance			X	
Password Reset Question Answer				X
Update Allergies		X		
Device - Add				X
Healthplan Demographic			X	

Transmit Visit Summary		X	
Device - Remove			X
Signed CE Authorization Form			X
Former Proxy Account Signup			X
Referral Request	X		X
Patient Initiated Questionnaires		X	X
Download Requested ROI Record		X	X
Device - Remove All			X
View Education Title			X
PB Statement Details			X
Update Wait List			X

Given that the subjects had registered for *My*Portfolio access on different dates, subjects would have varied lengths of time available to access the PP. To be able to normalize this variation, a portal access frequency was calculated. First, the number of days available to access *My*Portfolio was calculated based on comparing the subject's *My*Portfolio registration date to the date the utilization data was collected, April 1, 2019. The portal access frequency was then calculated by dividing the number of *My*Portfolio accesses by the number of days available. For each subject, portal access frequencies were calculated for total accesses, health-related accesses, and numeracy-related accesses. Table 2 presents the average, minimum, and maximum portal access frequencies by gender, race, and age cohorts.

Table 2. Patient Portal Access Frequencies by Gender, Race, and Age Cohorts

Demographic	Total Access	Health Access	Numeric Access
Gender - Female (N=233)			
Average	0.8342	0.4150	0.1708
Minimum	0.0116	0.0019	0.0000
Maximum	28.0444	13.7333	3.7747
Gender - Male (N=167)			
Average	0.6277	0.3112	0.1737
Minimum	0.0043	0.0000	0.0000
Maximum	8.7677	5.2997	4.2811
Age - <50 (N=109)			
Average	1.0336	0.4809	0.1622
Minimum	0.0235	0.0088	0.0000
Maximum	28.0444	13.7333	1.9327
Age - 50-59 (N=79)			
Average	0.5779	0.2900	0.1493
Minimum	0.0137	0.0019	0.0000
Maximum	10.1342	5.9823	3.7747
Age - 60-69 (N=120)			
Average	0.8052	0.4208	0.2362
Minimum	0.0075	0.0000	0.0000
Maximum	8.7677	5.2997	4.2811
Age - 70+ (N=92)			
Average	0.4810	0.2486	0.1194
Minimum	0.0043	0.0021	0.0000
Maximum	2.9767	1.4884	1.1065
Race - Black (N=32)			
Average	0.5232	0.2529	0.1229
Minimum	0.0269	0.0067	0.0000
Maximum	1.8819	1.0251	0.7868
Race - Other (N=34)			
Average	1.3752	0.6448	0.1260
Minimum	0.0075	0.0000	0.0000
Maximum	28.0444	13.7333	1.1111
Race - White (N=334)			
Average	0.7057	0.3553	0.1814
Minimum	0.0043	0.0019	0.0000
Maximum	10.1342	5.9823	4.2811

Consistent with other PP studies (Baird et al., 2014; Milkes & Mielenz, 2015; Wakefield et al., 2012), female subjects had a higher average portal access frequency (0.8342) than males (0.6277). From a race perspective, all other races had a portal access frequency (1.3752) substantially higher than that of any of the black (0.5232) and white (0.7057) subjects. However, the small number of all other races' subjects (34) coupled with one such subject's high portal access frequency (28.0444) accounts for the higher average portal access frequency for the cohort. Both by gender and by race, there were individuals who had no numeracy-related accesses.

Analyzing by age group identified subjects less than 50 (1.0336) and 60 to 69 (.08052) as having the highest average portal access frequency. There were subjects in the 60 to 69 cohort who, while accessing the PP, had either no health-related accesses or numeracy-related accesses. In all age cohorts, there were individuals who had no numeracy-related accesses.

Literacy Scores

The average eHEALS score for males (3.8641) and females (3.9695) were relatively consistent. However, males scored higher on SNS averaging (5.1168) as compared to females (4.5665). Based on race, blacks (4.0000) scored slightly higher on eHEALS than all others (3.9912) and whites (3.9117), but exhibited lower numeracy literacy, averaging 4.0664, on SNS than all others (4.7463) and whites (4.8713). For health literacy by age, the 70+ cohort had the lowest average eHEALS score at 3.7870, yet, along with the 60-69 cohort (4.9854), had the highest SNS scores at 4.9348. For all age groups, the average literacy scores exhibit limited variation with eHEALS ranging from 3.7870 (70+) to 4.0321 (<50) and SNS averaging from

4.5459 (<50) to 4.9854 (60-69). Table 3 presents the average health (eHEALS) and numeracy

(SNS) literacy scores by gender, race, and age cohorts.

Table 3. eHEALS and Numeracy Scores by Gender, Race, and Age Cohorts

Demographic	Health (eHEALS)	Numeracy (SNS)
Gender - Female (N=233)		
Average	3.9695	4.5665
Gender - Male (N=167)		
Average	3.8641	5.1168
Age - <50 (N=109)		
Average	4.0321	4.5459
Age - 50-59 (N=79)		
Average	3.9253	4.6930
Age - 60-69 (N=120)		
Average	3.9350	4.9854
Age - 70+ (N=92)		
Average	3.7870	4.9348
Race - Black (N=32)		
Average	4.0000	4.0664
Race - Other (N=334)		
Average	3.9912	4.7463
Race - White (N=34)		
Average	3.9117	4.8713

Literacy-Utilization Correlations

To investigate the relationships between health literacy, using eHEALS scores, and numeracy literacy, using SNS scores, actual PP utilization, using portal access frequencies, Kendall tau-b correlation coefficients (Gibbons, K.M., 1990) were constructed. The correlation coefficients were adjusted by compensating for the difference in days of available access to *My*Portfolio, and the demographic variables of age, gender, and race. Calculations were performed using the statistical software package SAS, Version 9.4.

The resultant coefficients showed extremely little correlation between literacy scores and actual PP utilization. The combination of health literacy (eHEALS scores) and numeracy literacy (SNS scores) compared to total portal access frequency resulted in a correlation of 0.04812. Analyzing health literacy (eHEALS scores) versus health-related portal access frequencies produced a correlation coefficient of 0.04474. Correlating numeracy literacy (SNS scores) versus numeracy-related portal access frequencies produced a similar low coefficient of 0.03860.

Portal Use Index Construct

Once correlations between patient literacies and PP utilization were determined, the goal was to develop an associated portal use index that could be used to predict a patient's probable PP use based on his/her health and numeracy literacies. The associated Kendall tau-b analysis indicated limited correlation exist. Therefore, construction of a portal use index, based on these patient's literacies, is not possible.

Summary

In summary, review of the literature led to selecting health and numeracy as the literacies to be compared to PP utilization. To assess these literacies for the subject patients, the tools eHEALS and SNS were administered via emails. For each subject, their scores from the tools were compared to their *My*Portfolio utilization. Analysis using Kendall tau-b correlation coefficients indicated no significant correlation existed between the literacies and the PP utilization, either individually or in combination.

Chapter 5

Conclusions

The conclusions begin by exploring the results of the three research questions. Limitations of the study are then described, noting how they may have had an impact on the results. Next, implications and recommendations are posited to offer a context for further evolving the concept of a portal use index. A summary of the research study concludes the chapter.

Research Question 1: How do specific patient literacies, i.e., computer/Internet, health, and numeracy, affect PP use?

As noted in the review of literature, numerous studies have demonstrated a relationship between multiple variables and PP use. Such variables included patient demographics, as well as various patient literacies. However, there were few studies that focused solely on health and numeracy literacies.

The portal access frequencies, based on patient demographics, identified in this study, were largely consistent with PP utilization presented in other PP research. Unfortunately, given the lack of correlation between PP utilization and patients' health and numeracy literacies indicated in this study, it is not possible to empirically show how such literacies affect PP use.

Research Question 2: What tools can be effectively used to evaluate patients' literacies?

Most healthcare organizations do not assess a patient's literacy levels upon presentation for care. Patient registration processes are often sufficiently onerous as to preclude the addition of literacy evaluation, regardless of how simplistic. Yet, to assess how patient's literacies may potentially impact PP adoption and utilization, determining a patient's literacy levels may be useful.

The eHEALS tool has been validated as producing an accurate portrayal of a patient's health literacy. The tool is sufficiently comprehensive to determine the health literacy level, yet concise enough as to not discourage completion by the patient. Of the 400 survey respondents, all subjects answered all questions, indicating no apparent barriers to completion.

For numeracy literacy, the SNS tool proved equally acceptable, with all survey respondents totally completing the survey. The SNS tool also has been used in multiple surveys, producing an assessment of subjects' numeracy literacies. This tool is similarly concise, able to be administered with a minimum of effort on both the parts of the healthcare organization and the patient.

It is doubtful such tools would be routinely administered at the time of patient registration. Perhaps a more palatable approach is to administer the tools online, when the patient initially registers for his/her PP access. Such administration could lead to interventions that would compensate for deficient patient health or numeracy literacies.

Research Question 3: What is the construct for a PUI that can accurately predict a patient's PP use based upon their literacies?

For the subject population, patient literacies correlated poorly with PP utilization, i.e., approximately 0.04 for both health and numeracy. Absent any significant correlation, it was not possible to draw any empirically based relationship between PP utilization and patient literacies. Therefore, the study was unable to produce a PUI construct.

Limitations

Upon retrospective review, multiple study limitations were identified. First, the subjects had all granted prior permission to participate in UMMS studies. It is possible that such patients are more inclined to use PPs than patients not willing to participate. The challenge with attempting to survey this latter cohort of patients is that if they had not self-identified as willing to participate in studies, would they even actually participate in such a targeted study.

Similarly, the extremely low response rate, i.e., 2%, may have resulted in a biased sample. These respondents may have been more technically adept, not affected by a digital divide. Such patients may be more apt to utilize a PP regardless of their literacy levels.

A third limitation concerns the lack of accounting for a patient's health status. If a patient suffers from a chronic illness, has recently had an acute encounter, or is inclined towards an aggressively healthy lifestyle, there is the potential for heightened PP utilization. The study did not include analysis of the patients' health statuses.

Relative to patient demographics, there were reasonable age and gender distributions. However, race was dominated by white patients (84%). A more diverse distribution by race may have produced different results.

The study included no self-assessment by the subjects, as to the usability and value of *My*Portfolio. A question for the study to consider could have been - would their PP utilization patterns been different based upon their perceived usability and value of the PP.

Finally, the subjects included were those who had accessed *My*Portfolio and did not include anyone who had not accessed *My*Portfolio. The least number of accesses by a subject was four. There may be a subset of patients who never accessed the PP due to literacy issues, but the study was unable to identify any such correlation.

Implications and Recommendations

The ability for patients to leverage PPs in the self-management of their health is predicated on patients' ability to use, i.e., navigate and comprehend, the information provided. This navigation and comprehension may be compromised due to various barriers. While some of the barriers may be demographic oriented, e.g. gender and race, others, such as challenges with health and numeracy literacies, if identified, may benefit from interventions that could enhance PP utilization.

The identification and intervention of barriers to PP utilization offers the opportunity to increase PP use and thereby potentially enhance health self-management. The possibility that patient literacy, e.g. health and numeracy, could serve as barriers to PP utilization and comprehension needs to be further explored. PP terminology is health-ladened, potentially presenting challenges to patients who have a low degree of health literacy. Similarly, patients who are numeracy-challenged, including graphically, may have difficulties navigating and interpreting PP information.

While not routinely assessed at the time of patient registration, it would be beneficial to determine a patient's literacy levels, e.g. health and numeracy, early in their interaction with the healthcare system. Either conducted at the time of initial patient registration or during registration with the PP, using tools such as eHEALS and SNS should be used to provide a baseline assessment of such patient's literacies. Although this study failed to identify meaningful correlations between these literacies and actual PP utilization, understanding a patient's literacies still may provide insights leading to interventions that would enhance PP utilization and value.

Summary

PPs are serving as a crucial component in the expansion of access to ePHI contained in EHRs. The growth of PPs in both acute and ambulatory care settings is even accelerated as a result of the fragmentation in the healthcare delivery system, where patients are frequently forced to interact with multiple PPs, e.g., those of hospitals and multiple physicians. Yet, the use of PPs has proven to be challenging.

Research has exhibited and posited that there may be multiple barriers to PP utilization. Among such barriers are demographic aspects, e.g. gender, race, age, etc., and personal aspects such as health and numeracy literacies. Many demographic aspects are static in nature, e.g. race, with some degree of expected impact on PP utilization consistent from patient to patient. However, other aspects, e.g. literacies, are variable from patient to patient, having potentially different impact on PP utilization. Additionally, while most demographics are known or collected at the time of patient registration, it is extremely rare that a patient's health or numeracy literacies would be known.

If patient-specific PP barriers were known at the time a patient engages with a PP, interventions could be employed to increase the patient's utilization of and benefit from the PP. A study was devised to determine if there were specific barriers that could be used to predict PP utilization. The study was targeted to identify specific potential barriers to be assessed, the appropriate tools to assess those barriers for a patient, and if a PUI construct could be developed that would accurately predict a patient's PP utilization. Following approvals from the Institutional Review Boards of both Nova Southeastern University and the University of Maryland Baltimore, where the research was conducted, 400 subjects participated in a study to determine the correlation between a patient's health and numeracy literacies and their utilization of a PP, in this case *My*Portfolio.

A hypothetico-deductive method sought to determine the relationship between specific patient literacies - computer/Internet, health, and numeracy, and PP use. Subjects were selected from patients in the *My*Portfolio registry. A multi-phase project approach was used: a) two subject datasets, linked by a random-generated subject identifier, were created, one containing subjects' email addresses, and the other containing the subjects' *My*Portfolio utilization statistics; b) subjects received emails soliciting them to take health (eHEALS) and numeracy (SNS) literacy surveys; c) using the subject identifiers, survey results were merged with the *My*Portfolio utilization statistics, and d) Kendall tau-b correlation coefficients were constructed comparing the literacies to the utilization. The Kendall tau-b correlation coefficients indicated a lack of any significant correlation.

Despite the study finding the lack of any meaningful correlation between patient health and numeracy literacies and PP utilization, the study served to expand the body of knowledge concerning the effect of certain barriers on PP utilization. Based on the response by subjects, the

study served to provide an indication that eHEALS and SNS may serve as unobtrusive tools to assess patient health and numeracy literacies. Such tools could provide insights into fostering increased PP utilization.

Appendix A

Nova Southeastern University Institutional Review Board Approval

NSU NOVA SOUTHEASTERN UNIVERSITY
Institutional Review Board

MEMORANDUM

To: **William Reed**

From: **Ling Wang, Ph.D.,**
Center Representative, Institutional Review Board

Date: **August 8, 2018**

Re: **IRB #: 2018-399; Title, "The Factors That Impact Patient Portal Utilization"**

I have reviewed the above-referenced research protocol at the center level. Based on the information provided, I have determined that this study is exempt from further IRB review under **45 CFR 46.101(b) (Exempt 2: Interviews, surveys, focus groups, observations of public behavior, and other similar methodologies)**. You may proceed with your study as described to the IRB. As principal investigator, you must adhere to the following requirements:

1) CONSENT: If recruitment procedures include consent forms, they must be obtained in such a manner that they are clearly understood by the subjects and the process affords subjects the opportunity to ask questions, obtain detailed answers from those directly involved in the research, and have sufficient time to consider their participation after they have been provided this information. The subjects must be given a copy of the signed consent document, and a copy must be placed in a secure file separate from de-identified participant information. Record of informed consent must be retained for a minimum of three years from the conclusion of the study.

2) ADVERSE EVENTS/UNANTICIPATED PROBLEMS: The principal investigator is required to notify the IRB chair and me (954-262-5369 and Ling Wang, Ph.D., respectively) of any adverse reactions or unanticipated events that may develop as a result of this study. Reactions or events may include, but are not limited to, injury, depression as a result of participation in the study, life-threatening situation, death, or loss of confidentiality/anonymity of subject. Approval may be withdrawn if the problem is serious.

3) AMENDMENTS: Any changes in the study (e.g., procedures, number or types of subjects, consent forms, investigators, etc.) must be approved by the IRB prior to implementation. Please be advised that changes in a study may require further review depending on the nature of the change. Please contact me with any questions regarding amendments or changes to your study.

The NSU IRB is in compliance with the requirements for the protection of human subjects prescribed in Part 46 of Title 45 of the Code of Federal Regulations (45 CFR 46) revised June 18, 1991.

Cc: Gertrude Abramson, Ed.D.
Ling Wang, Ph.D.

Appendix B

University of Maryland Baltimore Institutional Review Board Approval

University of Maryland, Baltimore
Institutional Review Board (IRB)
Phone: (410) 706-5037
Fax: (410) 706-4189
Email: hrpo@umaryland.edu

EXEMPT DETERMINATION

Date: October 10, 2018

To: Kathleen Tracy
RE: HP-00081828
Type of Submission: Initial Review
Type of IRB Review: Exempt

Determination Date: 10/10/2018

This is to certify that University of Maryland, Baltimore (UMB) Institutional Review Board (IRB) has reviewed the above referenced protocol entitled, *"The Factors That Impact Patient Portal Utilization."*

Your protocol has been determined to be exempt under 45 CFR 46.101(b) from IRB review based on the following category(ies):
Category (4): Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. ("Existing" means "existing at the time the research is proposed."")

Category (2): Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that Human Subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the Human Subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, insurability, or reputation. If the research involves children the procedures are limited to (1) the observation of public behavior when the investigator(s) do not participate in the activities being observed and (2) the use of educational tests.

The IRB made the following determinations regarding this submission:
- A waiver of HIPAA authorization for release of the PHI identified in the CICERO application has been reviewed and approved for this research study.

In conducting this research you are required to follow the requirements listed in the INVESTIGATOR MANUAL. Investigators are reminded that the IRB must be notified of any changes in the study.
Research activity involving veterans or the Baltimore VA Maryland Healthcare System (BVAMHCS) as a site, must also be approved by the BVAMHCS Research and Development Committee prior to initiation. Contact the VA Research Office at 410-605-7131 for assistance.

The UMB IRB is organized and operated according to guidelines of the International Council on Harmonization, the United States Office for Human Research Protections and the United States Code of Federal Regulations and operates under Federal Wide Assurance No. FWA00007145.

If you have any questions about this review or questions, concerns, and/or suggestions regarding the Human Research Protection Program (HRPP), please do not hesitate to contact the Human Research Protections Office (HRPO) at (410) 706-5037 or HRPO@umaryland.edu.

Appendix C

Recruitment Email

Your participation is being requested in a research study, T*he Factors that Affect Patient Portal Utilization*. As a University of Maryland Medical System patient who is over 18 years of age and has been granted access to the patient portal, *My*Portfolio, you are eligible participate.

The purpose of this study is to examine how a patient's understanding of computers/Internet, health information, and numeric information, may impact their utilization of their patient portal, in this case *My*Portfolio.

Participation is totally voluntary and anonymous. You will not receive any compensation for participating in the study. The study requires you to take a survey, approximately 15 to 20 minutes long, at a time and location of your choice, by clicking on the link provided in the email. You will have up to 30 days to complete the survey.

This research study is being conducted by William C. Reed, M.S., an affiliate student with the University of Maryland, Baltimore School of Medicine. If you have questions, you may contact him at 570-877-5712 or wr264@nova.edu, for more information about this study.

If you have questions about the study but want to talk to someone else who is not a part of the study, you can call the University of Maryland Human Research Protections Office (HRPO) at (410) 706-5037 or email at hrpo@umaryland.edu.

Thank you for considering this request for your participation.

Sincerely,

William C. Reed, M.S.
Principal Investigator

Appendix D

Participant Letter

Participant Letter for Anonymous Surveys
UMB Consent to be in a Research Study Entitled
The Factors that Affect Patient Portal Utilization

Who is doing this research study?

The person doing this study is William C. Reed, M.S., an affiliate student with the University of Maryland, Baltimore. He will be helped by J. Kathleen Tracy, Ph.D.

Why are you asking me to take part in this research study?

You are being asked to take part in this research study because you are:
- a University of Maryland Medical System (UMMS) patient,
- who has access to the UMMS patient portal, *My*Portfolio, and
- who has access to a computer.

Why is this research being done?

The purpose of this study is to examine how a patient's understanding of computers/Internet, health information, and numeric information may impact their utilization of a patient portal, in this case *My*Portfolio.

What will I be doing if I agree to be in this research study?

You will be taking a one-time, anonymous survey. The survey will take you approximately 15 to 20 minutes to complete.

Are there possible risks and discomforts to me?

This research study involves minimal risk to you. To the best of our knowledge, the things you will be doing have no more risk of harm than you would have in everyday life.

What happens if I do not want to be in this research study?

You can decide not to participate in this research and it will not be held against you. You can exit the survey at any time.

Will it cost me anything? Will I get paid for being in the study?

There is no cost for participation in this study. Participation is voluntary, and no payment will be provided.

How will you keep my information private?

Your responses are anonymous. Information we learn about you in this research study will be handled in a confidential manner, within the limits of the law. Your email address, along with a randomly generated subject key, will be stored in an electronic file. The information in this file was used to email a questionnaire to you. Once the questionnaires were emailed to the patients, the email electronic file was deleted and permanently erased. A second file was also created containing the subject key and age, gender, race, and *My*Porfolio utilization statistics. When a response to the questionnaire is returned, the subject key will be used to match the response with the *My*Portfolio utilization statistics. The data contained in this file cannot be associated with any specific patient. This data will be available to the researcher, the Institutional Review Board and other representatives of this institution, and any granting agencies (if applicable). All data, in this file, will be encrypted and kept securely, with password protection, on the researcher's computer. All data will be kept for 36 months from the end of the study and destroyed after that time by deleting and erasing the file.

Who can I talk to about the study?

If you have questions, you may contact William C. Reed at 570-877-5712 for more information about this study.

If you have questions about the study but want to talk to someone else who is not a part of the study, you can call the University of Maryland Human Research Protections Office (HRPO) at (410) 706-5037 or email at hrpo@umaryland.edu.

Do you understand, and do you want to be in the study?

If you have read the above information and voluntarily wish to participate in this research study, please follow the directions provided in the email containing this Participant Letter.

Appendix E

eHealth Literacy Scale (eHEALS)

The following questions ask you for your opinion and about your experience using the Internet for health information. For each statement, tell me which response best reflects your opinion and experience *right now*.

1. How **useful** do you feel the Internet is in helping you in making decisions about your health?
    1) ◯ Not useful at all
    2) ◯ Not useful
    3) ◯ Unsure
    4) ◯ Useful
    5) ◯ Very useful

2. How **important** is it for you to be able to access health resources on the Internet?
    1) ◯ Not useful at all
    2) ◯ Not useful
    3) ◯ Unsure
    4) ◯ Useful
    5) ◯ Very useful

3. I know **what** health resources are available on the Internet
    1) ◯ Strongly Disagree
    2) ◯ Disagree
    3) ◯ Undecided
    4) ◯ Agree
    5) ◯ Strongly Agree

4. I know **where** to find helpful health resources on the Internet
    1) ◯ Strongly Disagree
    2) ◯ Disagree
    3) ◯ Undecided
    4) ◯ Agree
    5) ◯ Strongly Agree

5. I know **how** to find helpful health resources on the Internet

1) ◯ Strongly Disagree
2) ◯ Disagree
3) ◯ Undecided
4) ◯ Agree
5) ◯ Strongly Agree

6. I know **how to use** the Internet to answer my questions about health
   1) ◯ Strongly Disagree
   2) ◯ Disagree
   3) ◯ Undecided
   4) ◯ Agree
   5) ◯ Strongly Agree

7. I know how to use **the health information** I find on the Internet to help me
   1) ◯ Strongly Disagree
   2) ◯ Disagree
   3) ◯ Undecided
   4) ◯ Agree
   5) ◯ Strongly Agree

8. I have the skills I need to **evaluate** the health resources I find on the Internet
   1) ◯ Strongly Disagree
   2) ◯ Disagree
   3) ◯ Undecided
   4) ◯ Agree
   5) ◯ Strongly Agree

9. I can tell **high quality** health resources from **low quality** health resources on the internet
   1) ◯ Strongly Disagree
   2) ◯ Disagree
   3) ◯ Undecided
   4) ◯ Agree
   5) ◯ Strongly Agree

10. I feel **confident** in using information from the Internet to make health decisions
    1) ◯ Strongly Disagree
    2) ◯ Disagree
    3) ◯ Undecided
    4) ◯ Agree
    5) ◯ Strongly Agree

Source: Norman, C. D. & Skinner, H. A., 2006

Appendix F

Subjective Numeracy Scale (SNS)

For each of the following questions, please check the box that best reflects **how good you are at doing the following things**:

1. How good are you at working with fractions?
   1) ◯ Not at all good
   2) ◯
   3) ◯
   4) ◯
   5) ◯
   6) ◯ Extremely good

2. How good are you at working with percentages?
   1) ◯ Not at all good
   2) ◯
   3) ◯
   4) ◯
   5) ◯
   6) ◯ Extremely good

3. How good are you at calculating a 15% tip?
   1) ◯ Not at all good
   2) ◯
   3) ◯
   4) ◯
   5) ◯
   6) ◯ Extremely good

4. How good are you at figuring out how much a shirt will cost if it is 25% off?
   1) ◯ Not at all good
   2) ◯
   3) ◯
   4) ◯
   5) ◯
   6) ◯ Extremely good

For each of the following questions, please check the box that **best reflects your answer**.

5. When reading the newspaper, how **helpful** do you find tables and graphs that are parts of a story?
   - 1) ◯ Not at all helpful
   - 2) ◯
   - 3) ◯
   - 4) ◯
   - 5) ◯
   - 6) ◯ Extremely helpful

6. When people tell you the chance of something happening, do you prefer that they use **words** ("it rarely happens") or **numbers** ("there's a 1% chance")?
   - 1) ◯ Always Prefer Words
   - 2) ◯
   - 3) ◯
   - 4) ◯
   - 5) ◯
   - 6) ◯ Always Prefer Numbers

7. When you hear a weather forecast, do you prefer predictions using **percentages** (e.g., "there will be a 20% chance of rain today") or predictions using only **words** (e.g., "there is a small chance of rain today")?
   - 1) ◯ Always Prefer Percentages
   - 2) ◯
   - 3) ◯
   - 4) ◯
   - 5) ◯
   - 6) ◯ Always Prefer Words

8. How **often** do you find numerical information to be useful?
   - 1) ◯ Never
   - 2) ◯
   - 3) ◯
   - 4) ◯
   - 5) ◯
   - 6) ◯ Very Often

Source: Fagerlin, A., Zikmund-Fisher, B. J., Ubel, P. A., Jankovic, A., Derry, H. A., & Smith, D. M., 2007.

References

About Blue Button. (n.d.). Retrieved from http://www.healthit.gov/patients-families/blue-button/about-blue-button/

Agarwal, R., & Prasad, J. (1998). A conceptual and operational definition of personal innovativeness in the domain of information technology. *Information Systems Research, 9*(2), 204-215. doi:10.1287/isre.9.2.204

Alpert, J. M., Desens, L., Krist, A. H., Aycock, R. A., & Kreps, G. L. (2017). Measuring Health Literacy Levels of a Patient Portal Using the CDC's Clear Communication Index. *Health Promotion Practice, 18*(1), 140-149. doi:10.1177/1524839916643703

Alpert, J. M., Krist, A. H., Aycock, R. A., & Kreps, G. L. (2017). Designing user-centric patient portals: Clinician and patients' uses and gratifications. *Telemedicine and e-Health, 23*(3), 248-253. doi-org.ezproxylocal.library.nova.edu/10.1089/tmj.2016.0096

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 Technology & Therapeutics, 16*(11), 784-793. doi:10.1089/dia.2014.0078

Ancker, J. S., Barrón, Y., Rockoff, M. L., Hauser, D., Pichardo, M., Szerencsy, A., & Calman, N. (2011). Use of an electronic patient portal among disadvantaged populations. *Journal of General Internal Medicine, 26*(10), 1117-1123.doi: 10.1007/s11606-011-1749-y

Ancker, J. S., Osorio, S. N., Cheriff, A., Cole, C. L., Silver, M., & Kaushal, R. (2014). Patient activation and use of an electronic patient portal. *Informatics for Health and Social Care,* (0), 1-13. doi:10.3109/17538157.2014.908200

Ancker, J. S., Silver, M., & Kaushal, R. (2014). Rapid growth in use of personal health records in New York, 2012–2013. *Journal of General Internal Medicine, 29*(6), 850-854. doi;10.1007/s11606-014-2792-2

Apter, A. J. (2014). Can patient portals reduce health disparities? A perspective from asthma. *Annals of the American Thoracic Society, 11*(4), 608-612. doi:10.1513/annalsats.201401-032ps

Bailey, S. C., O'Conor, R., Bojarski, E. A., Mullen, R., Patzer, R. E., Vicencio, D., … & Wolf, M. S. (2014). Literacy disparities in patient access and health-related use of Internet and mobile technologies. *Health Expectations,* 1-9. doi:10.1111/hex.12294

Baird, A., Raghu, T. S., North, F., & Edwards, F. (2013). When traditionally inseparable services are separated by technology: The case of patient portal features offered by primary care providers. *Health Systems, 3*(2), 143-158. doi:10.1057/hs.2013.13

Baron, K. P. (2012). *Incorporating personal health records into the disease management of rural heart failure patient* (Doctoral dissertation). Retrieved from ProQuest, UMI Dissertations Publishing, 2012. (3544408).

Bartholomew, K. W. (2017). Technology acceptance of patient portals by providers and medical staff: A case study. *Journal of Information Sciences and Computing Technologies, 6*(1), 577-581. Retrieved from http://www.scitecresearch.com/journals/index.php/jisct/article/view/1039/725

Bates, D. W., & Wells, S. (2012). Personal health records and health care utilization. *Journal of the American Medical Association, 308*(19), 2034-2036. doi:10.1001/jama.2012.6816

Beaunoyer, E., Arsenault, M., Lomanowska, A. M., & Guitton, M. J. (2017). Understanding online health information: Evaluation, tools, and strategies. *Patient Education and Counseling, 100*(2), 183-189. doi:10.1016/j.pec.2016.08.028

Bell, S. K., Mejilla, R., Anselmo, M., Darer, J. D., Elmore, J. G., Leveille, S., ... & Walker, J. (2016). When doctors share visit notes with patients: A study of patient and doctor perceptions of documentation errors, safety opportunities and the patient–doctor relationship. *BMJ Quality & Safety*, bmjqs-2015. doi:10.1136/bmjqs-2016-005641

Blumenthal, D. (2010). Launching HITECH. *The New England Journal of Medicine, 362*(5), 382-385. doi:10.1056/NEJMp0912825

Bourgeois, F. C., Taylor, P. L., Emans, S. J., Nigrin, D. J., & Mandl, K. D. (2008). Whose personal control? Creating private, personally controlled health records for pediatric and adolescent patients. *Journal of the American Medical Informatics Association, 15*(6), 737-743. doi:10.1197/jamia.m2865

Britt, R. K., Collins, W. B., Wilson, K., Linnemeier, G., & Englebert, A. M. (2017). eHealth literacy and health behaviors affecting modern college students: A pilot study of issues identified by the American College Health Association. *Journal of Medical Internet Research, 19*(12). doi: 10.2196/jmir.3100

Bruno, M. A., Petscavage-Thomas, J. M., Mohr, M. J., Bell, S. K., & Brown, S. D. (2014). The "Open Letter": Radiologists' reports in the era of patient web portals. *Journal of the American College of Radiology, 11*(9), 863-867. doi:10.1016/j.jacr.2014.03.014

Bush, R. A., Barlow, H., Pérez, A., Vazquez, B., Mack, J., & Connelly, C. D. (2018). Internet Access Influences Community Clinic Portal Use. Health Equity, 2(1), 161-166. doi:10.1089/heq.2018.0019

Bush, R. A., Connelly, C. D., Fuller, M., & Pérez A. (2016). Implementation of the integrated electronic patient portal in the pediatric population: A systematic review. *Telemedicine and e-Health, 22*(2), 144-152. doi.org/10.1089/tmj.2015.0033

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

Byrne, J. M., Elliott, S., & Firek, A. (2009). Initial experience with patient-clinician secure messaging at a VA medical center. *Journal of the American Medical Informatics Association, 16*(2), 267-270. doi:10.1197/jamia.m2835

Caine, K., & Hanania, R. (2012). Patients want granular privacy control over health information in electronic medical records. *Journal of the American Medical Informatics Association*. Advance online publication. doi:10.1136/amiajnl-2012-001023

Canzoneri, S. (2014, June 29). One comment [Web blog post]. Retrieved from http://www.healthit.gov/buzz-blog/consumer/launching-fall-national-blue-button-consumer-campaign/

Centers for Medicare & Medicaid Services, U. S. Department of Health and Human Services. (2014). Eligible Professional Meaningful Use. Core Measures. Measure 7 of 17. Retrieved November 26, 2014, from http://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/downloads/Stage2_eligible providerCore_7_PatientElectronicAccess.pdf/

Chung, S.-Y., & Nahm, E.-S. (2015). Testing reliability and validity of the eHealth Literacy Scale (eHEALS) for older adults recruited online. *Computers, Informatics, Nursing: CIN, 33*(4), 150–156. doi:/10.1097/CIN.0000000000000146

Coughlin, S. S., Stewart, J. L., Young, L., Heboyan, V., & De Leo, G. (2018). Health literacy and patient portals. *International Journal of Medical Informatics, 113*, 43-48. doi.org/10.1016/j.ijmedinf.2018.02.009

Czaja, S. J., Zarcadoolas, C., Vaughon, W. L., Lee, C. C., Rockoff, M. L., & Levy, J. (2014). The usability of electronic personal health record systems for an underserved adult population. *Human Factors: The Journal of the Human Factors and Ergonomics Society*. Advance online publication. doi:10.1177/ 0018720814549238

Davis, F. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319-340. doi:10.2307/249008

Deering, M. J., & Baur, C. (2015). 6 Patient portals can enable provider-patient collaboration and person-centered care. In M. Grando, R. Rozenblum, & D. Bates (Eds.), *Information Technology for Patient Empowerment in Healthcare* (p. 93). Boston, MA: Walter de Gruyter, Inc.

Diviani, N., Van den Putte, B., Meppelink, C. S., & van Weert, J. C. (2016). Exploring the role of health literacy in the evaluation of online health information: Insights from a mixed-methods study. *Patient Education and Counseling, 99*(6), 1017-1025. doi:10.1016/j.pec.2016.01.007

Dixon, R. F. (2010). Enhancing primary care through online communication. *Health Affairs, 29*(7), 1364-1369. doi:10.1377/hlthaff.2010.0110

Egea, J. M. O., & González, M. V. R. (2011). *Computers in Human Behavior 27*, 319-322. doi:10.1016/j.chb

Electronic copy of health information. (n.d.). Retrieved from http://www.healthit.gov/providers-professionals/achieve-meaningful-use/core-measures/electronic-copy-of-health-information/

EHR incentive programs. (2016). Retrieved from https://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/Downloads/MedicaidStage3_PatientEl ectronicAccessTipsheet.pdf

Emani, S., Healey, M., Ting, D. Y., Lipsitz, S. R., Ramelson, H., Suric, V., & Bates, D. W. (2016). Awareness and use of the after-visit summary through a patient portal: evaluation of patient characteristics and an application of the theory of planned behavior. *Journal of Medical Internet Research, 18*(4). doi:10.2196/jmir.5207

Ennis, L., Robotham, D., Denis, M., Pandit, N., Newton, D., Rose, D., & Wykes, T. (2014). Collaborative development of an electronic personal health record for people with severe and enduring mental health problems. *BMC Psychiatry, 14*, 305-311. doi:10.1186/s12888-014-0305-9

Epic. (n.d.). Retrieved from http://www.epic.com/About.

Epic quarterly report. (2018). *Epic quarterly report.* Internal UMMS report: unpublished.

Esch, T., Mejilla, R., Anselmo, M., Podtschaske, B., Delbanco, T., & Walker, J. (2016). Engaging patients through open notes: an evaluation using mixed methods. *BMJ Open, 6*(1), e010034. doi:10.1136/bmjopen-2015-010034

Eubanks, R. D., Nodora, J. N., Hsu, C. H., Bagley, M., Bouton, M. E., Martinez, M. E., & Komenaka, I. K. (2017). The feasibility and time required for routine health literacy assessment in surgical practice and effect on patient satisfaction. *The American Surgeon, 83*(5), 458-464.

Fagerlin, A., Zikmund-Fisher, B. J., Ubel, P. A., Jankovic, A., Derry, H. A., & Smith, D. M. (2007). Measuring numeracy without a math test: Development of the Subjective Numeracy Scale (SNS). *Medical Decision Making, 27*(5), 672-680. doi: 10.1177/0272989x07304449

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), 148-154. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5363705/

Gibbons, K. M. (1990). Rank Correlation Methods. Charles Griffin Book Series (5th ed.). Oxford: Oxford University Press.

Girault, A., Ferrua, M., Lalloué, B., Sicotte, C., Fourcade, A., Yatim, F., ... & Minvielle, E. (2015). Internet-based technologies to improve cancer care coordination: Current use and attitudes among cancer patients. *European Journal of Cancer*, *51*(4), 551-557. doi:10.1016/j.ejca.2014.12.001

Goel, M. S., Brown, T. L., Williams, A., Cooper, A. J., Hasnain-Wynia, R., & Baker, D. W. (2011a). Patient reported barriers to enrolling in a patient portal. *Journal of the American Medical Informatics Association, 18*(Supplement 1), i8-i12. doi:10.1136/amiajnl-2011-000473

Goel, M. S., Brown, T. L., Williams, A., Hasnain-Wynia, R., Thompson, J. A., & Baker, D. W. (2011b). Disparities in enrollment and use of an electronic patient portal. *Journal of General Internal Medicine, 26*(10), 1112-1116. doi:10.1007/s11606-011-1728-3

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. *Annals of Internal Medicine, 159*(10), 677-687. doi:10.7326/0003-4819-159-10-201311190-00006

Gordon, N. P., & Hornbrook, M. C. (2018). Older adults' readiness to engage with eHealth patient education and self-care resources: A cross-sectional survey. *BMC health services research, 18*(1), 220-212. doi:org/10.1186/s12913-018-2986-0

Graetz, I., Gordon, N., Fung, V., Hamity, C., & Reed, M. E. (2016). The digital divide and patient portals. *Medical Care, 54*(8), 772-779. doi:10.1097/MLR.0000000000000560

Greenberg, A. J., Serrano, K. J., Thai, C. L., Blake, K. D., Moser, R. P., Hesse, B. W., & Ahern, D. K. (2017). Public use of electronic personal health information: Measuring progress of the Healthy People 2020 objectives. *Health Policy and Technology, 6*(1), 33-39. doi:10.1016/j.hlpt.2016.08.003

Groen, W. G., Kuijpers, W., Oldenburg, H. S., Wouters, M. W., & Aaronson, N. K. (2017). Supporting lung cancer patients with an interactive patient portal: Feasibility study. *Journal of Medical Internet Research Cancer*, *3*(2), e10-e10. doi:10.2196/cancer.7443

Guendelman, S., Broderick, A., Mlo, H., Gemmill, A., & Lindeman, D. (2017). Listening to communities: Mixed-method study of the engagement of disadvantaged mothers and pregnant women with digital health technologies. *Journal of Medical Internet research, 19*(7), e240. doi:10.2196/jmir.7736

Haun, J. N., Valerio, M. A., McCormack, L. A., Sørensen, K., & Paasche-Orlow, M. K. (2014). Health literacy measurement: An inventory and descriptive summary of 51 instruments,

Journal of Health Communication, 19:sup2, 302-333.
doi:10.1080/10810730.2014.936571

Heath, S. (2017). Retrieved from https://patientengagementhit.com/news/patient-portal-use-lagging-despite-strong-provider-support

Hitech Programs Advisory Committee. (n.d.) Retrieved from http://www.healthit.gov/policy-researchers-implementers/hitech-programs-advisory-committee

Holden, R. J., & Karsh, B-T (2010). The technology acceptance model: Its past and its future in healthcare. *Journal of Biomedical Informatics, 43*, 159-172. doi:10.1016/j.jbi.2009.07.002

Hsiao, C.-J., Hing, E., & Ashman, J. (2014). Trends in electronic health record system use among office-based physicians: United States, 2007-2012. *National Health Statistics Report, 75*, 1-17.

Hu, P. J., Chau, P. Y., Sheng, O. R. L., & Tam, K. Y. (1999). Examining the technology acceptance model using physician acceptance of telemedicine technology. *Journal of Management Information Systems, 16*(2), 91-112. doi:10.1080/07421222.1999.11518247

Huang, Y.-M., Shiyanbola, O. O., Smith, P. D., & Chan, H.-Y. (2018). Quick screen of patients' numeracy and document literacy skills: The factor structure of the Newest Vital Sign. *Patient Preference and Adherence, 12*, 853–859. doi:10.2147/PPA.S165994

Internet users by country. (2016). Retrieved from http://www.internetlivestats.com/internet-users-by-country.

Irizarry, T., DeVito Dabbs, A., & Curran, C. R. (2015). Patient portals and patient engagement: A state of the science review. *Journal of Medical Internet Research, 17*(6), e148. doi:10.2196/jmir.4255

Irizarry, T., Shoemake, J., Nilsen, M. L., Czaja, S., Beach, S., & DeVito Dabbs, A. (2017). Patient portals as a tool for health care engagement: A mixed-method study of older adults with varying levels of health literacy and prior patient portal use. *Journal of Medical Internet Research, 19*(3), e99. http://doi.org/10.2196/jmir.7099

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, 17*(2), e42. http://doi.org/10.2196/jmir.3157

Ketterer, T., West, D. W., Sanders, V. P., Hossain, J., Kondo, M. C., & Sharif, I. (2013). Correlates of patient portal enrollment and activation in primary care pediatrics. *Academic Pediatrics*, *13*(3), 264-271. doi:10.1016/j.acap.2013.02.002

Kiechle, E. S., Bailey, S. C., Hedlund, L. A., Viera, A. J., & Sheridan, S. L. (2015). Different measures, different outcomes? A systematic review of performance-based versus self-

reported measures of health literacy and numeracy. *Journal of General Internal Medicine, 30*(10), 1538-1546. doi: 0.1007/s11606-015-3288-4

Kim, H., & Xie, B. (2017). Health literacy in the eHealth era: A systematic review of the literature. *Patient Education and Counseling, 100*(6), 1073-1082. doi: 10.1016/j.pec.2017.01.015

Kindig, D. A., Panzer, A. M., & Nielsen-Bohlman, L. (Eds.). (2004). Health Literacy: A Prescription to End Confusion. Washington, D.C.: National Academies Press.

Klein, R. (2007). An empirical examination of patient-physician portal acceptance. *European Journal of Information Systems 16*, 751-760. doi:10.1057/palgrave.

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. *The Annals of Family Medicine*, *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. *Journal of Medical Internet Research*, *17*(2), 40-52. doi:10.2196/jmir.3703

Latulipe, C., Gatto, A., Nguyen, H. T., Miller, D. P., Quandt, S. A., Bertoni, A. G., … & Arcury, T. A. (2015). Design considerations for patient portal adoption by low-income, older adults. *CHI 2015*. 3859-3868. doi:10.1145/2702123.2702392

Lazard, A. J., Watkins, I., Mackert, M. S., Xie, B., Stephens, K. K., & Shalev, H. (2016). Design simplicity influences patient portal use: The role of aesthetic evaluations for technology acceptance. *Journal of the American Medical Informatics Association, 23*(e1), e157–e161. doi.org/10.1093/jamia/ocv174

Levy, H., Janke, A. T., & Langa, K. M. (2014). Health literacy and the digital divide among older Americans. *Journal of General Internal Medicine*. Advance online publication. doi:10.1007/s11606-014-3069-5

Lopez, K. D., Wilkie, D. J., Yao, Y., Sousa, V., Febretti, A., Stifter, J., Johnson, A., … Keenan, G. M. (2016). Nurses' numeracy and graphical literacy: Informing studies of clinical decision support interfaces. *Journal of Nursing Care Quality, 31*(2), 124-130. doi: 10.1097/NCQ.0000000000000149

Luque, A. E., van Keken, A., Winters, P., Keefer, M. C., Sanders, M., & Fiscella, K. (2013). Barriers and facilitators of online patient portals to personal health records among persons living with HIV: Formative research. *JMIR Research Protocols*, *2*(1), 8-21. doi:10.2196/resprot.2302

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 Technology & Therapeutics, 13*(10), 1005-1012. doi:10.1089/dia.2011.0055

Medicare and Medicaid Programs; Electronic Health Record Incentive Program-Stage 3 and Modifications to Meaningful Use in 2015 Through 2017, 80 Fed. Reg. 62762 (October 16, 2015) (to be codified at 42 C.F.R. pts. 412, 495).

Mery, G., Majumder, S., Brown, A., & Dobrow, M. J. (2017). What do we mean when we talk about the triple aim? A systematic review of evolving definitions and adaptations of the framework at the health system level. *Health Policy, 121*(6), 629-636. doi:10.1016/j.healthpol.2017.03.014

Meslin, E. M., Alpert, S. A., Carroll, A. E., Odell, J. D., Tierney, W. M., & Schwartz, P. H. (2013). Giving patients granular control of personal health information: Using an ethics "points to consider" to inform informatics system designers. *International Journal of Medical Informatics, 82*(12), 1136-1143. doi:10.1016/j.ijmedinf.2013.08.010

Mikles, S. P., & Mielenz, T. J. (2015). Characteristics of electronic patient-provider messaging system utilisation in an urban health care organisation. *Journal of Innovation in Health Informatics, 22*(1), 214-221. doi:10.14236/jhi.v22i1.75

Miller Jr, D. P., Latulipe, C., Melius, K. A., Quandt, S. A., & Arcury, T. A. (2016). Primary care providers' views of patient portals: interview study of perceived benefits and consequences. *Journal of Medical Internet Research, 18*(1), e8.

Mishuris, R. G., Stewart, M., Fix, G. M., Marcello, T., McInnes, D. K., Hogan, T. P., ... & Simon, S. R. (2014). Barriers to patient portal access among veterans receiving home-based primary care: a qualitative study. *Health Expectations*, 1-10. doi:10.1111/hex.12199

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Annals of Internal Medicine, 151*(4), 264-269. doi: 10.7326/0003-4819-151-4-200908180-00135

Monkman, H. & Kushniruk, A. W. (2013). Applying usability methods to identify health literacy issues: An example using a personal health record. *Enabling Health and Healthcare Through ICT, 183,* 179-185. doi:10.3233/978-1-61499-203-5-179

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research, 2*(3), 192-222. doi:10.1287/isre.2.3.192

Moores, T. T. (2012). Towards an integrated model of IT acceptance in healthcare. *Decision Support Systems, 53*, 505-516. doi:10.1016/j.dss.2012.04.014

Nazi, K. M., Turvey, C. L., Klein, D. M., Hogan, T. P., & Woods, S. S. (2015). VA OpenNotes: Exploring the experiences of early patient adopters with access to clinical

notes. *Journal of the American Medical Informatics Association, 22*(2), 380–389, doi:10.1136/amiajnl-2014-003144

Neuner, J., Fedders, M., Caravella, M., Bradford, L., & Schapira, M. (2014). Meaningful Use and the patient portal: Patient enrollment, use, and satisfaction with patient portals at a later-adopting center. *American Journal of Medical Quality*. Advance online publication. doi:10.1177/1062860614523488

Norman, C. D., & Skinner, H. A. (2006). eHEALS: The health literacy scale. *Journal of Medical Internet Research, 8*(4), 1-13. doi:10.2196/jmir.8.4.e27

North, F., Crane, S. J., Chaudhry, R., Ebbert, J. O., Ytterberg, K., Tulledge-Scheitel, S. M., & Stroebel, R. J. (2014). Impact of patient portal secure messages and electronic visits on adult primary care office visits. *Telemedicine and e-Health, 20*(3), 192-198. doi:1089/tmj.2013.0097

Office of the National Coordinator for Health Information Technology, U. S. Department of Health and Human Services. (2014a). How to implement EHRs. Step 5: Achieve Meaningful Use. Retrieved from http://www.healthit.gov/policy-researchers-implementers/hitech-programs-advisory-committees

Office of the National Coordinator for Health Information Technology, U. S. Department of Health and Human Services. (2014b). Your health records. About Blue Button. Retrieved from http://www.healthit.gov/patients-families/blue-button/about-blue-button/

Office of the National Coordinator for Health Information Technology, U. S. Department of Health and Human Services. (2014c). How to implement EHRs. Step 5: Achieve Meaningful Use. Retrieved from http://www.healthit.gov/providers-professionals/achieve-meaningful-use/core-measures/electronic-copy-of-health-information/

Office of the National Coordinator for Health Information Technology, U. S. Department of Health and Human Services. (2014d). How to implement EHRs. Step 5: Achieve Meaningful Use. Retrieved from http://www.healthit.gov/providers-professionals/achieve-meaningful-use/core-measures-2/use-secure-electronic-messaging

Office of the National Coordinator for Health Information Technology, U. S. Department of Health and Human Services. (2014e). What is a patient portal? Retrieved from http://www.healthit.gov/providers-professionals/faqs/what-patient-portal/

Otte-Trojel, T., de Bont, A., Rundall, T. G., & van de Klundert, J. (2013). How outcomes are achieved through patient portals: A realist review. *Journal of the American Medical Informatics Association*. Advance online publication. doi:10.1136/amiajnl-2013-002501

Parker, R. M., Baker, D. W., Williams, M. V., & Nurss, J. R. (1995). The test of functional health literacy in adults: A new instrument measuring patients' literacy skills. *Journal of General Internal Medicine, 10*(10), 537-541. doi:10.1037/t10545-000

Patel, V., & Johnson, C. (2018). Individuals' use of online medical records and technology for health needs. *ONC Data Brief No. 40*. Retrieved from https://www.healthit.gov/sites/default/files/page/2018-04/HINTS-2017-Consumer-Data-Brief-april-2018.pdf

Payment adj hardship. (n.d.). Retrieved from https://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/PaymentAdj_Hardship.html

Price-Haywood, E. G., Harden-Barrios, J., Ulep, R., & Luo, Q. (2017). eHealth literacy: Patient engagement in identifying strategies to encourage use of patient portals among older adults. Population Health Management, 20(6), 486-494. doi:10.1089/pop.2016.0164

Roberts, S., Chaboyer, W., Gonzalez, R., & Marshall, A. (2017). Using technology to engage hospitalised patients in their care: A realist review. *BMC Health Services Research, 17*(1), 388. doi:10.1186/s12913-017-2314-0

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. *Journal of Medical Internet Research*, *16*(11), e263. doi:10.2196/jmir.3457

Sand-Jecklin, K., Daniels, C. S., & Lucke-Wold, N. (2017). Incorporating health literacy screening into patients' health assessment. *Clinical Nursing Research, 26*(2), 176-190. doi:10.1177/1054773815619592

Sanders, M. R., Winters, P., Fortuna, R. J., Mendoza, M., Berliant, M., Clark, L., & Fiscella, K. (2013). Internet access and patient portal readiness among patients in a group of inner-city safety-net practices. *The Journal of Ambulatory Care Management*, *36*(3), 251-259. doi:10.1097/jac.0b013e31829702f9

Sarkar, U., Karter, A. J., Liu, J. Y., Adler, N. E., Nguyen, R., Lopez, A., & Schillinger, D. (2010). The literacy divide: Health literacy and the use of an internet-based patient portal in an integrated health system-results from the diabetes study of northern California (DISTANCE). *Journal of Health Communication, 15*(Suppl 2), 183-196. doi:10.1080/10810730.2010.499988

Schnipper, J., Gandhi, T., Wald, J., Grant, R., Poon, E., Volk, L., Businger, A., Williams, D., Siteman, E., Buckel, L., & Middleton, B. (2012). Effects of an online personal health record on medication accuracy and safety: a cluster-randomized trial. *Journal of the American Medical Informatics Association, 19*, 728-734. doi:10.1136/amiajnl-2011-000723

Sekaran, U., & Bougie, R. (2013). Research Methods for Business: A Skills Building Approach. West Sussex, United Kingdom: John Wiley & Sons Ltd.

Sharit, J., Lisigurski, M., Andrade, A. D., Karanam, C., Nazi, K. M., Lewis, J. R., & Ruiz, J. G. (2014). The roles of health literacy, numeracy, and graph literacy on the usability of the

VA's personal health record by veterans. *Journal of Usability Studies*, *9*(4), 173-193. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi:10.1.1.568.6582&rep=rep1&type=pdf

Shealy, K. M., & Threatt, T. B. (2016). Utilization of the Newest Vital Sign (NVS) in practice in the United States. *Health Communication, 31*(6), 679-687. doi: 10.1080/10410236.2014.990079

Shih, T. H., & Fan, X. (2009). Comparing response rates in e-mail and paper surveys: A meta-analysis. *Educational Research Review, 4*(1), 26-40. doi:10.1016/j.edurev.2008.01.003

Shultz, S. K., Wu, R., Matelski, J. J., Lu, X., & Cram, P. (2015). Patient preferences for test result notification. *Journal of General Internal Medicine, 30*(11), 1651-1656. doi:10.1007/s11606-015-3344-0

Smith, S. G., O'Conor, R., Aitken, W., Curtis, L. M., Wolf, M. S., & Goel, M. S. (2015). Disparities in registration and use of an online patient portal among older adults: Findings from the LitCog cohort. *Journal of the American Medical Informatics Association*, 1-21. doi:10.1093/jamia/ocv025

Stage2 EP Core 7 patient electronic access. (n.d.). Retrieved from http://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/downloads/Stage2_EPCore_7_Patient ElectronicAccess.pdf/

Stephenson, L. S., Gorsuch, A., Hersh, W. R., Mohan, V., & Gold, J. A. (2014). Participation in EHR based simulation improves recognition of patient safety issues. *BMC Medical Education, 14*, 224-231. doi:10.1186/1472-6920-14-224

Sudbury-Riley, L., FitzPatrick, M., & Schulz, P. J. (2017). Exploring the measurement properties of the eHealth Literacy Scale (eHEALS) among baby boomers: A multinational test of measurement invariance. *Journal of Medical Internet Research, 19*(2), e53. doi.org/10.2196/jmir.5998

Taha, J., Sharit, J., & Czaja, S. J. (2014). The impact of numeracy ability and technology skills on older adults' performance of health management tasks using a patient portal. *Journal of Applied Gerontology*, *33*(4), 416-436. doi:10.1177/0733464812447283

Talboom-Kamp, E. P., Verdijk, N. A., Kasteleyn, M. J., Harmans, L. M., Talboom, I. J., Looijmans-van den Akker, I., van Geloven, N., Numans, M. E., …& Chavannes, N. H. (2017). The effect of integration of self-management web platforms on health status in chronic obstructive pulmonary disease management in primary care (e-Vita Study): Interrupted time series design. *Journal of Medical Internet Research, 19*(8), e291. doi:10.2196/jmir.8262

Tavares, J., & Oliveira, T. (2016). Electronic health record patient portal adoption by health care consumers: An acceptance model and survey. *Journal of Medical Internet Research, 18*(3), e49. doi:10.2196/jmir.5069

Use secure electronic messaging. (n.d.). Retrieved from http://www.healthit.gov/providers-professionals/achieve-meaningful-use/core-measures-2/use-secure-electronic-messaging

van der Vaart, R., Drossaert, C. H., Taal, E., Drossaers-Bakker, K. W., Vonkeman, H. E., & van de Laar, M. A. (2014). Impact of patient-accessible electronic medical records in rheumatology: Use, satisfaction and effects on empowerment among patients. *BMC Musculoskeletal Disorders*, *15*(1), 102. doi:10.1186/1471-2474-15-102

Vanneste, D., Vermeulen, B., & Declercq, A. (2013). Healthcare professionals' acceptance of BelRAI, a web-based system enabling person-centred recording and data sharing across care settings with interRAI instruments: a UTAUT analysis. *BMC Medical Informatics and Decision Making, 13*(1), 129. doi:10.1186/1472-6947-13-129

Venkatesh, V., & Davis, F. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science 46*(2), 186-204. doi:10.1287/mnsc.46.2.186.11926

Venkatesh, V., Morris, M., Davis, G., & Davis, F. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), 425-478. Retrieved from http://search.proquest.com.ezproxylocal.library.nova.edu/docview/218137148/fulltext PDF/F5D27B05D632439FPQ/5?accountid=6579

Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. *MIS Quarterly, 36*(1), 157-178. Retrieved from http://www.jstor.org/stable/41410412

Vodicka, E., Mejilla, R., Leveille, S. G., Ralston, J. D., Darer, J. D., Delbanco, T., ... & Elmore, J. G. (2013). Online access to doctors' notes: Patient concerns about privacy. *Journal of Medical Internet Research*, *15*(9), 208-220. doi:10.2196/jmir.2670

Wakefield, D. S., Kruse, R. L., Wakefield, B. J., Koopman, R. J., Keplinger, L. E., Canfield, S. M., & Mehr, D. R. (2012). Consistency of patient preferences about a secure Internet-based patient communications portal: Contemplating, enrolling, and using. *American Journal of Medical Quality*, *27*(6), 494-502. doi:10.1177/1062860611436246

Welch, V. L., VanGeest, J. B., & Caskey, R. (2011). Time, costs, and clinical utilization of screening for health literacy: A case study using the Newest Vital Sign (NVS) instrument. *Journal of the American Board of Family Medicine, 24*(3), 281-289. doi:10.3122/jabfm.2011.03.100212

Wilson, E. V., & Lankton, N. K. (2004). Modeling patients' acceptance of provider-delivered E-health. *Journal of the American Medical Informatics Association, 11*(4), 241-248. doi:10.1197/jamia.1475

Woods, S. S., Forsberg, C. W., Schwartz, E. C., Nazi, K. M., Hibbard, J. H., Houston, T. K., & Gerrity, M. (2017). The association of patient factors, digital access, and online behavior on sustained patient portal use: A prospective cohort of enrolled users. *Journal of Medical Internet Research, 19*(10), e345. doi:10.2196/jmir.7895

Wright, E., Darer, J., Tang, X., Thompson, J., Tusing, L., Fossa, A., ... & Walker, J. (2015). Sharing physician notes through an electronic portal is associated with improved medication adherence: quasi-experimental study. *Journal of Medical Internet Research, 17*(10), e226. doi:10.2196/jmir.4872

Wynia, M., & Dunn, K. (2010). Dreams and nightmares: Practical and ethical issues for patients and physicians using personal health records. *Journal of Law, Medicine & Ethics, 38*(1), 64-73. doi:10.1111/j.1748-720x.2010.00467.x

Yamin, C. K., Emani, S., Williams, D. H., Lipsitz, S. R., Karson, A. S., Wald, J. S., & Bates, D. W. (2011). The digital divide in adoption and use of the personal health record. *Archives of Internal Medicine, 171*(6), 568-574. doi:10.1001/archinternmed.2011.34

Yarbrough, A. K., & Smith, T. B. (2007). Technology acceptance among physicians: a new take on TAM. *Medical Care Research and Review, 64*(6), 650-672. doi:10.1177/1077558707305942

Yuan, S., Ma, W., Kanthawala, S., & Peng, W. (2015). Keep using my health apps: Discover users' perception of health and fitness apps with the UTAUT2 model. *Telemedicine and e-Health, 21*(9), 735-741. doi:10.1089/tmj.2014.0148

Zarcadoolas, C., Vaughon, W. L., Czaja, S. J., Levy, J., & Rockoff, M. L. (2013). Consumers' perceptions of patient-accessible electronic medical records. *Journal of Medical Internet Research*, *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. *Journal of Medical Internet Research*, *16*(8), 187-203. doi:10.2196/jmir.3241