Is Meaningful Use Meaningful?
Policy Driven Implementation of Health Information Technology from a Systems Perspective

By
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Date
Abstract

In March of 2012 the Department of Health and Human Services released the proposed rules for stage 2 of meaningful use; in addition to increasing the requirements for electronic health record implementation, the rules newly require that patients have continuous electronic access to their personal health information and lab results, a functionality accomplished by most providers through the use of “health portals” or “personal health records.” The purpose for the rules is to improve the efficiency and quality of care delivered, both clinically – improved patient outcomes - and on a systems level – reduced resource utilization. Little research exists on the clinical or systems level usefulness of health portals, yet stage 2 meaningful use, if approved, will greatly accelerate widespread portal implementation.

We performed a retrospective analysis of University of North Carolina (UNC) Emergency Department (ED) billing data to examine an association between access to the UNC Family Medicine health portal and inappropriate ED utilization. We used a subset of Ambulatory Care Sensitive Conditions, published by the Agency for Healthcare Research and Quality, to define inappropriate ED use. We examined mean total ED visits, mean inappropriate ED visits, and the mean ratio of inappropriate to total ED visits.

We observed no association between access to a health portal and either total or inappropriate ED utilization. The null findings highlight that the mere presence of a technology, especially one with little intrinsic functionality beyond
facilitating communication, does not ensure a change in resource utilization. If health portals as a technology do have a system level effect, it is likely moderated by variables not captured in our exploratory study, such as physician engagement or software usability.
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Introduction

The Health Information Technology for Clinical and Economic Health Act (HITECH) was passed in 2009 as a part of the American Reinvestment and Recovery Act (ARRA), known generally as the “stimulus bill”. Central to HITECH is “meaningful use”, legislation providing financial incentives to providers who not only purchase electronic health records (EHR) but use them in a way that lowers the cost and improves the quality of care. The Notice of Proposed Rule Making (NPRM) for stage 2 of meaningful use requires that all providers ensure that patients have continual electronic access to their personal health information (PHI), an objective being fulfilled by the widespread implementation of internet based patient portals or personal health records (PHR).

Personal health records and patient portals are ways for patients to see their health information, communicate with their physicians, and perform simple health care transactions such as scheduling an appointment or refilling a prescription. Though early adopters have already begun implementing these technologies, the emerging developments of the meaningful use criteria combined with significant incentive payments will greatly accelerate the process. Although we hypothesize that continual electronic access to PHI is beneficial to patient outcomes and quality of care, no data as yet demonstrate clinical benefits or cost savings (Tenforde, Jain, and Hickner 2011, 351-354).

Portals have theoretical benefits both on the individual level, with improved clinical outcomes, and on the system level via improved care coordination, reduced ED utilization, and fewer inpatient visits. The very few
extant randomized trials of portal technology focus primarily on the clinical utility of the technology; no studies directly examine systems level outcomes of portal technology (Archer et al. 2011, 515-522; Nazi et al. 2010, 62-67).

The emergency department (ED) has become a known repository for failure in the health care system. Lack of convenience, no prior provider relationships, or the inability to schedule a prompt appointment lead patients to seek primary care in the emergency room or to seek emergent care for an exacerbation of a process easily managed in an ambulatory setting (Shesser et al. 1991, 743-748). Theoretically, a patient portal is both a channel for provider access and a mechanism for patient engagement. If portals can make it easier for patients to access their PHI or contact a provider, they may alter when and where patients seek care.

The UNC Family Medicine practice has a proprietary patient portal that provides web-based scheduling, secure messaging with providers, and access to self-care information – common features of most health portals and PHR. We provide a preliminary exploration of associations between portal access and appropriate emergency room utilization, and commence an examination of the consequences of internet portals, a significant technology in the context meaningful use criteria, from a systems perspective.

This and larger future studies can provide useful data for health care decision makers both in demonstrating potential effects on the cost of care as well as highlighting variables that moderate the utility of new technology. Furthermore, our study joins the growing number of necessary inquiries into the
consequences of national policy implemented in a variety of clinical and organizational contexts (Archer et al. 2011, 515-522), all asking the same essential question: “Is meaningful use meaningful?”

**Background**

The U.S. health care system remains the most expensive in the world yet does not produce outcomes proportional to its spending (World Health Organization 2000; Anderson et al. 2003, 89-105). The Institute of Medicine’s landmark report, *To Err is Human*, estimated that 44,000 to 98,000 patients die each year from preventable medical error (Kohn, Corrigan, and Donaldson 2000). As medical knowledge grows and increased specialization further fragments care processes, it is natural to expect medical errors to continue or even to increase.

Even though health care is an industry dependent on the management and interpretation of data, it has been slow to adopt modern information technology; as of 2008 only 17% of providers and 12% of hospitals had implemented EHR. (DesRoches et al. 2008, 50-60) The major preoccupations of health care delivery have changed from provision of acute care to the management of chronic disease, requiring the intensive coordination of many providers. Efficient communication is essential to reductions of both redundancy and error – a process made difficult by the persistence of paper charting.

The delays in HER implementation have many causes. The fee-for-service payment structure creates a context in which investment in technology is against the financial self-interest of most providers, and providers are reluctant to invest in complex systems they lack the expertise to evaluate. Logistical barriers also
exist: many benefits of EHR are realized through information sharing between providers, a complex functionality requiring the collaboration of stakeholders who are often direct competitors as the system is organized now. Finally, with new forms of information sharing come a new set of patient concerns about the confidentiality and security of their PHI, a regulatory issue beyond the scope of any one provider or EHR vendor. (Blumenthal 2011, 2323-2329; Tang et al. 2006b, 121-126)

The HITECH act combines up to $27 billion dollars in incentives with the threat of reduced Medicare and Medicaid reimbursement to catalyze the widespread adoption of EHR; it empowers the Office of the National Coordinator of Health Information Technology (ONCHIT) to create an array of programs that provide a comprehensive, multi-pronged response to the distinct barriers that have prevented a market-driven adoption of HIT thus far. Included in the bill are strategies such as training a new body of HIT experts, developing state-level Regional Extension Centers, and modifying the Health Insurance Portability and Accountability Act (HIPAA) to be more stringent. However, the central provision, that which all other components of HITECH directly or indirectly support, is “meaningful use.”

Meaningful use, defined and implemented by the department of Health and Human Services (HHS), guides the disbursement of funds to physicians, via Medicare and Medicaid, initially for EHR implementation and eventually, in later stages, for demonstrated improvement in clinical outcomes and quality measures. It is a strategy without academic, legal, or political precedent.
The initial bill authorized a disbursement of up to $44,000 for Medicare dominant provider groups and up to $63,750 for Medicaid dominant provider groups, each payment distributed over a 5 year period; hospitals were offered from $2 million to $10 million. The incentives are awarded in annual increments, the amount of each gradually reducing over several years, finally to terminate in 2015 for Medicare and 2017 for Medicaid. (Blumenthal 2011, 2323-2329)

Stage 1 involves meeting approximately 25 criteria – varying slightly between physicians and hospitals – among which are a set of required “core” objectives and optional “menu” objectives. Providers must demonstrate meaningful use by the end of 2012 to be eligible for the full incentive amount; planned deadlines for stage 2 and stage 3 are 2013 and 2016 respectively, and these deadlines must be met to continue to receive payments. The objectives for future stages are yet to be written; stage 2 was released in March, 2012 as a Notice of Proposed Rule Making (NPRM) and at this writing is in the 60 day window of public commentary.

The changes and requirements in the NPRM demonstrate a balance of clear movement forward towards goals of demonstrating clinical and quality improvement with restraint to ensure that objectives remain feasible for providers still struggling to adopt basic EHR. As its own Health IT web site (http://www.healthit.gov/providers-professionals/meaningful-use-definition-objectives) makes clear in the framing of definitions, the central thrust of meaningful use was to promote specific functionalities previously demonstrated to provide clinical and quality benefits, including computerized prescribing with
decision support, quality benchmark reporting, and health information exchange. The proposed stage 2 rules in the Notice incrementally increase requirements in each of the three domains.

Computerized provider order entry (CPOE) requirements have been expanded so that most orders now must occur electronically. A large list of quality measures have been suggested as candidates for required reporting to achieve meaningful use. Initially, stage 1 only required that providers purchase EHR with the ability to share information, but stage 2 requires that providers actually use the functionality. Notably, the NPRM has increased the requirement for patients to access their own PHI; the revised stage 1 and proposed stage 2 rules require that 50% of patients have the ability to view, download, and transmit their data and that 10% actually do so. This requirement, if passed, will effectively mandate that providers implement a patient portal or PHR.

The American Health Information Management Association (AHIMA) defines Personal Health Records (PHR) as an “an electronic lifelong resource of health information needed by individuals to make health decisions. Individuals own and manage their own and manage the information in the PHR, which comes from healthcare (sic) providers and the individual. The PHR is maintained in a secure and private environment, with the individual determining rights of access. The PHR does not replace the legal record of any provider” (Tang et al. 2006a, 121-126). Older versions of PHR were populated manually by patients but more recent, “tethered” PHR automatically extract information from provider’s records. Patient portals are similar to PHRs in that they provide patients with online access
to their PHI, and they also have additional functionalities such as scheduling and communication. Portals, however, are often directly associated with a provider, where as a PHR is often independent and may interface with several providers. Currently, the distinction between PHR and portals, both in clinical implementation and academic literature, is minimal, as most PHR or portals are implemented and managed by a single provider.

**Methods**

We conducted a retrospective cohort study using an original dataset generated by merging data extracted from two databases: the UNC Physicians and Associates (P&A) billing database and the UNC Family Medicine Patient Communication Tracking System (PCTS). Our period of interest for the study, the time for which we tracked ED use, was between January 1st 2011 and January 1st 2012. Our query was designed to capture a population of patients that had been seen in the 18 months prior to the study and were still active UNC Family Medicine patients during the study.

To establish an initial study population, we queried the P&A database for all patients who had visited the UNC Family Medicine Clinic (FMC) at least once from July 1st 2009 to January 1st 2010 and at least once from January 1st 2011 to January 1st 2012. Included in this query were demographic variables and ICD-9 diagnostic codes pertaining to baseline health status (Appendix 1). We performed a sub-query of the resultant list of Family Medicine patients for all ED visits made by these patients during the period of interest – January 1st 2011 to January 1st
This dataset included ICD-9 diagnostic codes forming the basis for our outcome measure. For data pertaining to portal access, we queried the UNC Patient Communication Tracking System, a dataset that tracks multiple vectors of communication between patients and physicians. We examined all instances of portal access by our patient sample between the dates of January 1st 2010 and January 1st 2011.

The first author coded the data for the FMC by ICD-9 codes to indicate the presence or absence of three chronic diseases: Congestive Heart Failure, Diabetes Mellitus Type II, and Hypertension. The first author also coded data for ED visits to indicate if a visit included a diagnostic code we had determined to be an inappropriate use of the ED because it reflected one of the ambulatory-sensitive conditions we used to discriminate between causes of ED visits (see below). The PCTS data were reduced to a unique list of medical record numbers, indicating those patients that had used the portal at least once during the aforementioned time period. The FMC, ED, and PCTS datasets were then merged using the medical record number as a common unique identifier. We performed statistical analysis on the resulting merged data to determine whether those who had used the patient portal were less likely to appear in the ED with an ambulatory-sensitive condition (See Appendix 1 for further explanations of variable creation)

**DATA**

**Population:** We chose to define the study population as all FMC patients seen 18 months prior to the study period and at least once during the study period who had also visited the ED at least one time during the study period. This was a
smaller subset of the larger, general FMC population. We chose to define the study as such to improve the possibility of detecting a signal that indicated an association between portal access and inappropriate ED use. The weakness of this strategy is that the mean values for many of our outcomes will be higher than the mean values of the entire FMC population, limiting our ability to interpret the absolute values of the outcomes measured – our choice has created something of a ceiling effect.

**Independent variable:** The UNC Family Medicine portal provides three functions: scheduling, secure messaging, and access to self-care information. This varies from a traditional portal or PHR in that the patient does not have access to personal health information. The UNC Family Medicine portal, in providing secure messaging, serves as an example of electronic access to a provider, a common, meaningful feature of many portals or PHR.

**Dependent variable.** To define the outcome of “inappropriate” emergency room use we used a subset of the list of Ambulatory Care Sensitive Conditions (ACSC) published by the Agency for Healthcare Research and Quality (AHRQ). ACSC are conditions for which appropriate ambulatory care can prevent or reduce inpatient admissions. From the list we selected those conditions that were pertinent to adults, equally applicable to men and women, and were diagnoses with a care- seeking component – in which accessing a provider earlier may have prevented the presentation to the emergency room. The entire list of AHRQ ACSC can be found in Appendix 1, Table 3; our list of outcome conditions includes severe ENT, pulmonary conditions including COPD, bacterial
pneumonia, and asthma; CHF, a particular target of CMS readmission reduction policies; hypertension and angina, cellulitis, conditions related to diabetes, and dental conditions. All these conditions should, ideally, be managed with ambulatory care such that their symptoms or exacerbations do not lead to ED visits.

Defining inappropriate ED use is difficult; there is no standard method in the literature and significant variation accompanies different attempts to quantify inappropriate visits (Lowe and Bindman 1997, 133-136). We chose to use ACSCs as the basis for our outcomes measure because this approach to defining unnecessary ED use relies on conclusions by the federal agency charged with assuring quality of care, uses ICD-9 billing codes, and has historic use in the literature (Oster and Bindman 2003, 198).

The challenge of using ACSC as a sentinel for inappropriate ED use is that these conditions can be prevented by early primary care. The exacerbations of the conditions being tracked with the ACSC list are actually appropriate for the emergency room, but it is inappropriate that the exacerbations ever occurred. Several of the ACSC conditions are related to receiving appropriate immunizations or basic preventive care. We chose to select conditions that would result from either the inappropriate management of chronic disease or emergent conditions that are usually preceded by a sub-acute presentation treatable in an ambulatory setting, such as bacterial pneumonia.

Using ICD-9 billing codes to evaluate diagnoses, we created a demanding test of inappropriate use by coding any visit in which the primary diagnosis was
one of the ICD-9 codes in our ACSC subset as “inappropriate.” We created a variable that recorded the total number of ED visits per patient, another variable that recorded the total number of inappropriate visits per patient, and a final variable, the ratio of inappropriate ED visits to total ED visits. We then created a further summary dummy variable indicating that a patient had inappropriately used the ED at least once.

Our goal for the study was to detect a signal indicating an association between ED use and portal access, not to quantify inappropriate ED use or establish causal direction. We chose four different variables to track ED use in order to provide an opportunity to triangulate our results. If multiple outcomes all demonstrate a similar coherent signal, the observation is less likely to be random. Conversely, if all four methods of examining the outcome demonstrate a null finding, the observation that no association exists is strengthened.

**Fidelity of the outcome measurement.** The outcome we created was not intended to capture all instances of inappropriate ED use, as any attempt to do so would be questionable validity, and be so complicated as to be outside of the scope of the study. Rather we attempted to construct a highly correlated proxy for the amorphous concept of inappropriate ED use. Additionally, the measurement process of the outcome is complicated by a lack of reliability in how ICD-9 codes are documented in the UNC Physicians & Associates billing database. Diagnoses are categorized into primary and secondary diagnoses for each ED visit. Our data only included the primary diagnosis recorded at the time of each visit.
It is important to emphasize that the primary endpoints are only interpretable in the context of relative comparisons; they are not adequate to quantify an absolute number of unnecessary visits. It is unlikely that the coding of ICD-9 data varied systematically between the control and intervention group - as those coding the data were unlikely aware of portal status. However, our method only captures a subset of ED visits determined by ACSC criteria to be inappropriate and likely underestimates the actual level of inappropriate.

**Controls:** Age was calculated from the date of birth and we included other demographic information – sex, race, payer status – as recorded in the original dataset. Payer status was our only option for creating a proxy for the patient’s socio-economic status and education. This proxy is admittedly coarse, and thus likely understates the potential effectiveness of portal use. Although Medicare and private insurance patients can vary significantly in income, education, and internet access, Medicaid insurance likely corresponds to lower income and less education. Demonstrating an effect independent of Medicaid status, thus, will be strongly suggestive that at least part of the effect is also independent of income and education. Internet access is quickly becoming ubiquitous, but discrepancies in access by age, socioeconomic status, and race may persist. We do not directly measure internet access; we know that it may underlie any association between other demographic variables and portal use.

In addition to the important demographic, literacy, and internet access variables we cannot directly measure, we also lack direct measures of health status and patient engagement. We control for the baseline presence of three
chronic diseases: Hypertension, Diabetes Mellitus Type II, and Congestive Heart Failure. Those with such diagnoses may have disproportionately worse health status than those in the other arm of the study, for whom we do not control for other chronic disease. Poor health may be associated with greater use of the ED in itself, and it may be associated with greater rates of portal access because sick patients have a greater need for health care resources. Though total ED visits could also be used as a measure of health status, it is also a variable influenced by a propensity to seek health care. Recording the presence of chronic disease seemed to be a more direct measurement of the variable of interest.

Analysis

We examined differences in mean values or frequencies between the portal access and non-portal access groups on each of the demographic and health status variables with 2-sample t-tests for continuous variables and a Pearson’s chi-square test for dichotomous or categorical variables. For those categorical variables with more than two values, each value of the variable was analyzed separately as a dichotomous variable using Pearson’s chi-square.

Using a binary variable indicating one or more inappropriate visits to the ED, we calculated the unadjusted risk ratio of inappropriate ED use by portal access. Our goal was to examine the isolated association of portal access, our intervention, on inappropriate ED use, the outcome. We performed two multiple linear regressions, a full model adjusting for all demographics and a reduced
model adjusting for only those demographic variables with a potential confounding effect, for each of three outcomes: total ED visits, total inappropriate ED visits, and a ratio of inappropriate ED visits to total ED visits. The sequence of analysis for each outcome variable was identical and is described below.

Prior to running the model we created dummy variables for the categorical variables with more than 2 categories - race and payer status. We initially ran a linear regression for the effect of portal access on the outcome of interest, adjusting for all measured demographic variables. We noted the Beta value for portal access. We then used bivariate analysis to explore the association of any other measured variable to the intervention, portal access; we used a 2 sample t-test for continuous variables and a Pearson’s chi-square test for categorical variables. For those variables with more than 2 categories, we created binary dummy variables for each value of the variable and used Pearson’s chi-square test to examine association between the newly created dummy variable and the outcome of interest. We then reran a multiple linear regression with a reduced model, including only those variables that demonstrated an independent association with the outcome of interest, and excluding African American race and Medicaid payer status, since these two variables showed little association with portal access. We confirmed that the beta and the calculated mean in the reduced model did not differ from those in the full model. We reported the mean values for the outcome of interest by portal access, the 95% confidence interval, and the associated p-value.
Results

Our study population, Family Medicine patients who had also visited the ED between January 1st 2011 and January 1st 2012, totaled 2,977; this is only 17.05% of Family Medicine patients in the period. Thirty percent of Family Medicine patients had accessed the portal at least once during the period (patients manually enter their medical record numbers, and we found that we could not match an additional 6.7% of patients who had used the portal to a valid medical record number in the Family Medicine Clinic dataset, so the actual number of portal users may be closer to 40%).

Most measured variables did significantly vary by portal access. As we have noted, the two exceptions were African American race and Medicaid payer status. (Table 1) Portal users were more likely to be older, female, white, insured by Medicare, and have a chronic disease. Those who did not use the portal were more likely to be self- or privately insured. Though the unadjusted frequency of inappropriate ED use did not vary significantly by portal access, it is notable that a fifth of the patients in this subsample had used the ED for a diagnosis we flagged as inappropriate.

The unadjusted risk ratio of inappropriately using the ED at least once lacked statistical significance (RR = 1.08; 95% CI 0.93 – 1.25). We ran multiple linear regressions for each of the three outcomes of interest controlling for all other measured variables and did not find a statistically significant correlation between portal access and the outcomes: total ED visits (β = 0.131, P=0.123),
total inappropriate ED visits (β = -0.004, p=0.866), and the ratio of inappropriate to total ED visits (β = -0.009, p=0.425). In the three reduced-model linear regressions, controlling only for those variables that demonstrated an association with portal access, a lack of statistically significant correlation persisted across all measured outcomes; the beta values and statistical significance were unchanged for all three variables.

The adjusted mean values calculated by each linear regression also did not vary significantly. Portal users had more, but not significantly more, total ED visits than did those who had not used the portal (Portal: 2.02, No Portal: 1.88; p=0.123), and we found no significant variation in mean inappropriate ED visits (Portal: 0.239, No Portal: 0.243; p=0.866) or the mean ratio of inappropriate ED visits to total ED visits (Portal: 0.120, No Portal: 0.130; p=0.420).
Table 1: Distribution of demographic variables by intervention

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Total</th>
<th>No Portal Access (proportion or mean)</th>
<th>Portal Access (proportion or mean)</th>
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<tr>
<td>Age (mean) **</td>
<td>48.37</td>
<td>45.18</td>
<td>53.74</td>
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<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male **</td>
<td>38.02</td>
<td>41.39</td>
<td>32.37</td>
</tr>
<tr>
<td>Female</td>
<td>61.98</td>
<td>58.61</td>
<td>67.63</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>White*</td>
<td>53.85</td>
<td>51.58</td>
<td>57.64</td>
</tr>
<tr>
<td>African-American</td>
<td>38.29</td>
<td>38.55</td>
<td>37.86</td>
</tr>
<tr>
<td>Asian *</td>
<td>1.68</td>
<td>2.04</td>
<td>1.08</td>
</tr>
<tr>
<td>Other**</td>
<td>6.18</td>
<td>7.83</td>
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<tr>
<td>Payer</td>
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<tr>
<td>Self-Pay*</td>
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<td>Private**</td>
<td>27.51</td>
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<td>Managed Care*</td>
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<td>Medicare**</td>
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<td>Medicaid</td>
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<td>Baseline Health Status</td>
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<td>CHF**</td>
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<td>HTN**</td>
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<tr>
<td>DM Type II**</td>
<td>15.62</td>
<td>10.78</td>
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<tr>
<td>1 or more inappropriate ED visit</td>
<td>19.52</td>
<td>18.93</td>
<td>20.50</td>
</tr>
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Statistical significance calculated using 2 sided t-tests for continuous variables and Pearson’s Chi-square for categorical variables.
*p<0.05
**p<0.0001

Table 2: Risk Ratio of 1 or more inappropriate ED visits by portal access

<table>
<thead>
<tr>
<th>Variable</th>
<th>RR</th>
<th>95% CI</th>
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<tr>
<td>1 or more inappropriate ED visits</td>
<td>1.08</td>
<td>0.93 – 1.25</td>
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Table 3: Adjusted* Mean or Percent of ED visits comparing Portal Access to No Portal Access

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Portal Access</th>
<th>95% CI</th>
<th>No Portal Access</th>
<th>95% CI</th>
<th>p value</th>
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<tr>
<td>Total ED visits</td>
<td>2.02</td>
<td>1.88 – 2.13</td>
<td>1.88</td>
<td>1.78 – 1.97</td>
<td>0.1231</td>
</tr>
<tr>
<td>Inappropriate ED visits</td>
<td>0.239</td>
<td>0.21 – 0.27</td>
<td>0.243</td>
<td>0.217 – 0.269</td>
<td>0.866</td>
</tr>
<tr>
<td>Inappropriate/Total visits**</td>
<td>0.120</td>
<td>0.102 – 0.138</td>
<td>0.130</td>
<td>0.116 – 0.143</td>
<td>0.42</td>
</tr>
</tbody>
</table>

* based on beta estimates of a multiple linear regression model controlling for age, sex, payer status, race, and baseline health status
**proportion of inappropriate ED visits to total ED visits
Discussion

The lack of significant association between the primary outcomes of the study – total ED use, total inappropriate ED use, and the ratio of inappropriate to total ED use – and portal access provides useful insight into the implementation of portals. The data demonstrate that whatever care process led to the overall rate of inappropriate ED visits in the Family Medicine population, the presence or absence of a portal did not meaningfully alter that process for the sample as a whole. Without knowing much more about the patients who can and do use a portal, we cannot say that the mere presence of a portal can change outcomes.

Two conclusions can stem from our observations: portals do not have the ability to modify rates of inappropriate ED use, or portals do have the ability to modify ED use but that capacity is unrealized in this instance. A similar conclusion can be made by most studies of portals and PHR with null findings. A portal is a channel, with little implicit unique value; it primarily facilitates care process that could occur in other, more resource intensive venues, such as a face-to-face visit; it has the potential to deliver a similar care process but at greater convenience and, potentially, lower cost, to the provider and patient.

If a provider does not have an existing care process that can produce an outcome – be it reduced inappropriate ED visits or improved HbA1C – it is unlikely that the presence of a portal will do so. If a care process has been shown to generate outcomes but a provider refuses to use the portal, or the patient refuses to use the portal, then the presence of the portal will not produce meaningful change. A portal likely does not offer independent utility but rather provides a
way to practice a style of care that may be otherwise financially or logistically infeasible without electronic communication.

Many physicians are concerned that technology such as health portals will have a poor return on investment (DesRoches et al. 2008, 50-60); this is in part due to fee-for-service financial arrangements that do not reimburse physicians for efficiency, or for generating administrative and technologic investment. Though meaningful use and the accompanying funds generate a temporary financial incentive to drive the purchase and implementation of technologies like health portals, the underlying payment structure causing provider reluctance to invest in EHR and related technologies still exists. Physician involvement will likely be the minimum required to remain eligible for incentive funds. However, without genuine physician investment it is unlikely that many technologies, especially those that primarily facilitate communication and information sharing between patient and providers will produce meaningful benefit.

Though by no means conclusive, the findings and results of other studies are suggestive that measuring provider involvement and attitudes is important (Grant et al. 2008, 1776; Wagner et al. 2012; Green et al. 2008). Our study, similar to other retrospective analyses of portal based interventions, did not capture physician engagement or perception; nor could it parse the potential differences among patients – for example, the possibility that older women, who are (somewhat surprisingly) more likely to be portal users, are also more likely to be worried about symptoms, and therefore more likely to use both the portal and the ED.
The common challenge of most PHR and portal studies, especially those of observational design, is the confounding relationship of patient engagement. The theoretical causal pathway of portal benefit is that a portal generates patient engagement that in turn causes improved health behaviors – such as improved self-care or better use of health care resources. However, patients that are engaged at baseline may more likely to use a health portal; portal access may act merely as a marker of patient engagement rather than a cause of it. Our inability to account for patient engagement with our data is a significant shortcoming. Though we did not observe an effect, if we had, the effect may have been caused not by the intervention, but rather a baseline difference between the two cohorts, as we have suggested.

The usability of technology is a significant, but unaddressed variable that moderates the usefulness of technology. As mentioned previously, the term “health portal” is a broad term encompassing a broad range of functions; across varying health portals, designed by a multitude of vendors, is significant heterogeneity in design and quality. The nuances of the user interface of a portal both patient-facing, and provider-facing can dictate if a technology is useful or cumbersome. The implementation of poorly designed software, driven by policy requirements, is a significant risk of the meaningful use strategy; yet software design is infrequently addressed in studies of portals or PHR.
Conclusion

Our study corresponds to other research examining portal or PHR use in that it did not find a significant outcome clearly attributable to the presence of a portal (Tenforde, Jain, and Hickner 2011, 351-354). However, the lack of findings does not conclusively demonstrate that portals are valueless. Rather, from the process of our exploration, it is the unanswered questions that inform future research. Baseline patient engagement, physician engagement, and the design of technology are important variables to capture when evaluating the utility of a portal. The mere presence of a technology tells us nothing about how patients and providers use it.

Meaningful use is reaching the end of the first stage, the stage of purchasing and implementing EHR. Only future stages will reveal if policy has the ability to generate meaningful outcomes from “meaningful use.” Some have pointed to the lack of meaningful change in clinical or quality oriented outcomes as evidence of the ineffectiveness of meaningful use, but that conclusion is likely premature. It is unrealistic to assume that the presence of a technology itself will produce change.

The role of the physician is important in the success or failure of meaningful use policy, but without payment reform, providers attempting to implement technology as required by meaningful use, will be doing so against their financial self-interest. Though meaningful use incentives offset the cost, the larger financial context for providers is unchanged; there is a risk that provider
engagement with technology will be superficial during the meaningful use process and recede once the incentive funds have been fully disbursed.

Stage 1 requirements of meaningful use are such that providers can achieve objectives without significantly modifying clinical processes. The risk is that the true burden of meaningful use will only become apparent in the future stages. Currently providers may not have to grapple with usability issues, seeing the collection of basic data as a minor inconvenience. However, when later meaningful use stages begin to require demonstrated change in outcomes, a process that will require a significant cultural shift and integration of technology into the clinical workflow, more serious challenges may emerge.

The lack of a broader financial context that rewards physicians for expending administrative effort to leverage technology and streamline care combined with a distinct absence of focus on user interface and product design from HIT vendors, may create a scenario in which providers reluctantly interface with cumbersome, or even worse, error-ridden, technology. Meaningful use criteria themselves, far from pushing health care into the 21st century, can burden the system with unrealistic expectations and drive the national implementation of unrefined software.

The true challenge of meaningful use is in the cultural shift that must occur within practices, in which technology is embraced as an integral part of clinical care. It is unlikely that a set of criteria, however comprehensive, can achieve this in isolation. However, HITECH does include other programs to provide individualized, ground-level support, such as regional extension centers
and a newly trained body of HIT experts. Meaningful use and the accompanying financial incentives open a window in which providers are willing to invest, however reluctantly, in EHR and other technology. This space can provide room for dialogue in which more meaningful change occurs, not by the adherence to objectives but rather through the shifting of provider perspectives toward technology as a whole.
References


Methods Appendix

Data collection methods were submitted to and approved by the University of North Carolina (UNC) Internal Review Board for clinical research. Data were extracted from UNC Physicians and Associates billing database and the UNC Patient Communication Tracking System (PCTS) – a proprietary software that tracks instances of communication between patients and providers. Database queries were executed by the data custodians for each database, Sonya Buford and Todd Meath, respectively. The first author was the single coder of the ICD-9 codes used to create the outcome variable and is responsible for any errors that may have occurred.

Table 1: Query date chart

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>UNC P&amp;A Billing Data – ER visits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCTS Data – Portal Visits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNC Continuity Clinic – Patient roster</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</table>

Table 2: Data points collected by dataset

<table>
<thead>
<tr>
<th>UNC Family Medicine Clinic</th>
<th>UNC Emergency Department</th>
<th>Patient Communication Tracking System</th>
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<tr>
<td>Medical Record #</td>
<td>Medical Record #</td>
<td>Medical Record #</td>
</tr>
<tr>
<td>DOB</td>
<td>Date of visit</td>
<td>Date of visit</td>
</tr>
<tr>
<td>Date of visit</td>
<td>ICD-9 Diagnosis</td>
<td>Date of Portal Query</td>
</tr>
<tr>
<td>ICD-9 Diagnoses</td>
<td></td>
<td>Reason for Portal Query</td>
</tr>
<tr>
<td>Insurance Status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
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Table 3: Ambulatory Care Sensitive Conditions and study outcomes

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Comments</th>
<th>Study outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congenital syphilis [090]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immunization-related and preventable conditions [033, 037, 045, 320.0, 390, 391]</td>
<td>Hemophilus meningitis [320.2] age 1 - 5 only</td>
<td></td>
</tr>
<tr>
<td>Grand mal status and other epileptic convulsions [345]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Convulsions &quot;A&quot; [780.3]</td>
<td>Age 0-5</td>
<td></td>
</tr>
<tr>
<td>Convulsions &quot;B&quot; [780.3]</td>
<td>Age &gt;5</td>
<td></td>
</tr>
<tr>
<td>Severe ENT infections [382, 462, 463, 465, 472.1]</td>
<td>Exclude otitis media cases [382] with myringotomy with insertion of tube [20.01]</td>
<td>x</td>
</tr>
<tr>
<td>Pulmonary tuberculosis [011]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other tuberculosis [012-018]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease [491, 492, 494, 496, 466.0]</td>
<td>Acute bronchitis [466.0] only with secondary diagnosis of 491, 492, 494, 496</td>
<td>x</td>
</tr>
<tr>
<td>Bacterial pneumonia [481, 482.2, 482.3, 482.9, 483, 485, 486]</td>
<td>Exclude case with secondary diagnosis of sickle cell [282.6] and patients &lt; 2 months</td>
<td>x</td>
</tr>
<tr>
<td>Asthma [493]</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Congestive heart failure [428, 402.01, 402.11, 402.91, 518.4]</td>
<td>Exclude cases with the following surgical procedures: 36.01, 36.02, 36.05, 36.1, 37.5, or 37.7</td>
<td>x</td>
</tr>
<tr>
<td>Hypertension [401.0, 401.9, 402.00, 402.10, 402.90]</td>
<td>Exclude cases with the following procedures: 36.01, 36.02, 36.05, 36.1, 37.5, or 37.7</td>
<td>x</td>
</tr>
<tr>
<td>Angina [411.1, 411.8, 413]</td>
<td>Exclude cases with a surgical procedure [01 - 86.99]</td>
<td>x</td>
</tr>
<tr>
<td>Cellulitis [681, 682, 683, 686]</td>
<td>Exclude cases with a surgical procedure [01- 86.99], except incision of skin and subcutaneous tissue [86.0] where it is the only listed surgical procedure</td>
<td>x</td>
</tr>
<tr>
<td>Skin grafts with cellulitis [DRG 263, DRG 264]</td>
<td>Exclude admissions from SNF/ICF</td>
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Table 4: Index of variables in final dataset

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Values</th>
<th>Description</th>
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<tr>
<td>patientmrn</td>
<td>-</td>
<td>MR# of the patient, key for database</td>
</tr>
<tr>
<td>age</td>
<td>0 - 999</td>
<td>Age, in years, calculated from DOB</td>
</tr>
<tr>
<td>sex</td>
<td>Male, Female</td>
<td>Sex of patient</td>
</tr>
<tr>
<td>patientrace</td>
<td>White, African American, Asian, Other</td>
<td>race of patient</td>
</tr>
<tr>
<td>insurance</td>
<td>Private, Managed Care, Medicare, Medicaid, Self Pay</td>
<td>FISC payer status</td>
</tr>
<tr>
<td>CHF</td>
<td>0,1</td>
<td>defines the presence or absence of a diagnosis of CHF during any FMC visit</td>
</tr>
<tr>
<td>DMII</td>
<td>0,1</td>
<td>defines the presence or absence of a diagnosis of DMII during any FMC visit</td>
</tr>
<tr>
<td>HTN</td>
<td>0,1</td>
<td>defines the presence or absence of a diagnosis of HTN during any FMC visit</td>
</tr>
<tr>
<td>ED_totalvisit</td>
<td>0 - 99</td>
<td>total ED visits</td>
</tr>
</tbody>
</table>

*Those conditions marked with "x" and highlighted in white are the selected outcomes used for the study.*
<table>
<thead>
<tr>
<th>Variable</th>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ED_totalinapp</td>
<td>0 - 99</td>
<td>total inappropriate ED visits</td>
</tr>
<tr>
<td>ED_itratio</td>
<td>0 - 1</td>
<td>inappropriate ED visits / total ED visits</td>
</tr>
<tr>
<td>edinapp</td>
<td>0,1</td>
<td>Indicates if patient had 1 or more inappropriate ED visits. Used for caculating a risk ratio</td>
</tr>
<tr>
<td>portal</td>
<td>0,1</td>
<td>Indicates if patient had portal access</td>
</tr>
</tbody>
</table>
Background Appendix

**HITECH act**

The Heath Information Technology for Economic and Clinical Health (HITECH), passed in 2009 as part of the American Reinvestment and Recovery Act (ARRA), is the legislative catalyst for the current, widespread adoption of electronic medical records (EHR). The bill combines up to $27 billion dollars in incentives with the threat of decreased Medicare and Medicaid reimbursement and drives physicians to not only purchase health information technology but to use it in a way that may improve the quality and efficiency of care. The many components of the bill respond to distinct barriers that have prevented a market-driven adoption of HIT thus far.

**Information Technology in Health care**

The success of early adopters of EHR, such as Kiser Permanente and the Veterans Administration (VA), provided promising empirical backing to the benefits of HIT implementation. Some attribute the transformation of the VA, from a low-quality provider to a leader in the provision of high-quality care, to their intense leveraging of health information technology. (Jha et al. 2003, 2218-2227) Additionally, the experience of physicians have also been positive, 90% of physician EHR users reported positive experiences and could observe specific quality benefits to EHR use. (DesRoches et al. 2008, 50-60)

Not all data were uniformly positive and there are safety concerns surrounding rapid HIT implementation on a large scale. (Han et al. 2005, 1506-1512; Koppel et al. 2005, 1197-1203; Koppel and Kreda 2009, 1276-1278; Sittig et al. 2009, 375-377; Sittig and Singh 2011, e1042-e1047); It’s also questionable if the benefits demonstrated by
custom designed EHR implemented in large health networks are generalizable to late adopters purchasing out-of-the-box software packages. (Wu et al. 2006, 742-752)

However, systematic reviews of the body of literature found an overall benefit to EHR implementation mostly realized through specific functionalities such as decision support and reduced testing through information sharing. (Buntin et al. 2011, 464-471).

Need for Legislation

Counterproductive financial incentives, product complexity, the need for collaborative information exchange, and privacy concerns have each contributed to the general industry level resistance towards information technology. Current market dynamics have thwarted the necessary collaboration amongst stakeholders to meaningfully implement health information technology. Policy makers believed that each barrier was one that would not resolve spontaneously and would benefit from legislative intervention, and the provisions of the HITECH act are structured to respond to each challenge. (Blumenthal 2011, 2323-2329)

Currently, most physicians are paid on a fee-for-service basis and in this form of reimbursement providers are dissuaded from investing in efficiency generating processes. Installing information technology is an expensive initial investment and, if successful, will lead to a process of care that requires fewer tests and fewer visits. Though payers and patients benefit from effective care, providers suffer financially; without significant changes to provider reimbursement, it is unlikely that they will spontaneously embrace HIT. Market failures such as this are generally agreed upon by economists as an appropriate intervention for government intervention. (Salvatore 2003, 02)

The variety of health information technology products and their respective complexity makes it difficult for providers to be well informed as to the appropriateness
of a given product. Providers are reluctant to invest in systems of which they are uncertain and lack the expertise to competently evaluate. Furthermore, the management of IT systems can be complicated and require skills that may not exist in many practices. A successful effort to drive the use of EHR in New York City suggests that the government can mitigate barriers to expertise through the provision of intellectual support. (Mostashari, Tripathi, and Kendall 2009, 345-356)

Exchanging information between providers is an important but complicated capacity of health information systems; it requires standardization and collaboration of a myriad of vendors and product developers, many of which are direct competitors to each other. Some policymakers have considered mandating the national use of a single EHR – such as the system used for the VA. (Stark 2010, 12) However, current vendors would likely provide strong resistance and many providers have already invested significant time and capital implementing other EHR systems.

The most feasible solution is to the problem of data standardization is to facilitate the free exchange of information between multiple platforms. It is outside the interest and financial resources of any one vendor or provider to coordinate standard methods of communication and to ensure adherence to those standards. HITECH supports the development an infrastructure, certification process, and regulatory body to manage the standardization and sharing of health information.

Finally, a public concern is ensuring the privacy of health information as it is exchanged amongst providers. There have been reports of breaches in security (Department of Health and Human Services, Office for Civil Rights, 2010), and a lack of trust on part of the public could quickly undermine the political will for pushing information technology forward. The legislation that now protects health information,
the Health Insurance Portability and Accountability Act (HIPAA), needs to be modified to account for new ways of sharing and storing health information – such as personalized health records and health information exchanges.

**Implementation**

The HITECH act first established the Office of the National Coordinator for Health Information Technology (ONCHIT) and budgeted $27 billion dollars over the course of 10 years to support the implementation and subsequent meaningful use of EHRs. Meaningful use will occur in 3 stages over the course of the next 5 years and combines two broad strategies: outcomes-based reimbursement and direct payment for EHR purchase.

To reimburse physicians based on demonstrated clinical improvement creates a natural incentive to adopt EHRs but may isolate benefits only to clinical care; there are other research and public health benefits that would be underemphasized or wholly ignored through this approach. The other strategy, to directly pay physicians to use EHRs, risks physicians purchasing electronic systems but never appropriately using them.

Meaningful use, drafted and implemented by the HHS, guides the disbursement for incentive funds to physicians, via Medicare and Medicaid, initially for EHR implementation and eventually, in later stages, for demonstrated improvement in clinical outcomes and quality measures. The use of a broad portfolio of requirements, instead of simple reimbursement for the purchase of EHR, allows HITECH to promote broad functionality beyond clinical care - such public health monitoring and care quality reporting.

Most other provisions of the HITECH act were are managed by the Office of the National Advisor of Health Information Technology (ONCHIT) and serve to support the
actualization of meaningful use. To overcome logistic and technical challenges of purchasing and implementing EHR, HITECH created a national network of regional extension centers (REC). Mimicking a previously existing government program that assists farmers in staying current with agricultural technology, RECs provide hands-on intellectual support to providers in purchasing, implementing, and maintaining EHR systems. (Blumenthal 2011, 2323-2329)

Too few HIT experts are available to support providers in transitioning to EHR use; in 2009, studies estimated that 50,000 additional health information technology professionals would be needed to match demand. (Rollins 2010, 28-34) The HITECH act mandated that the ONC train a sufficient professional body to interact with vendors, providers, and REC to realize policy goals. (Blumenthal 2011, 2323-2329) As a mechanism of consumer protection for providers newly adopting EHR, the bill required ONCHIT to establish and manage a certification process for meaningful use appropriate technology.

The exchange of health information across platforms and providers is also a focus of the legislation. ONCHIT was provided $300 million dollars to fund state level efforts in constructing regional information exchanges and $2 billion to construct a national health information exchange. The exchanges must fulfill several functions including creating standards for compatibility, establishing and maintaining an information-sharing specific infrastructure, and reinforcing the adherence to established norms.

Promoting information sharing increases the risk of breaching confidentiality; the HITECH act restructured existing HIPAA laws to be more robust and have greater consequence. The maximum penalty for an episode of a negligent breach was increased
from $25,000 to $1.5 million and restrictions for the use of health information for marketing and fund-raising purposes were strengthened.

**Initial Challenges of Implementation**

The scope and complexity of the HITECH act cannot be emphasized too strongly. A country of such size, heterogeneity, and political decentralization as the U.S. faces significant challenges in the creation of a coordinated national exchange of health information. The central provision of HITECH, Meaningful Use criteria, has no legal, political, or academic precedent. The remaining programs of the HITECH act have to be created anew by a nascent political committee, ONCHIT, with very little legislative experience and within a timeline that is considered, by those that drafted the legislation, ambitious. (Stark 2010, 12)

The secretary of Health and Human Services was required to draft meaningful use criteria, the standards for meaningful use appropriate technology, and the certification process to support those standards, within 10 months. Given the lack of precedence and the policy’s far reaching scope, the timeline was challenging. Similarly, the initial schedule for implementing MU criteria was rapid. The criteria were to be released by December 31, 2009; hospitals could begin receiving MU reimbursements by October 1, 2010 and professionals could receive payments by January 1, 2011. Reimbursements were scheduled to significantly decrease by 2012 and end by 2016, frontloading the reimbursement schedule to encourage providers to rapidly adopt EHR. (Blumenthal 2011, 2323-2329)

Having the entire country purchase EHR is, alone, a challenging goal. However, at the time the bill was passed, no infrastructure existed to support providers in acquiring EHRs and achieving meaningful use. RECs had to be created and staffed, technicians
trained, and health information exchange programs developed. The rapid timeline doesn’t allow for the refinement of the many programs being developed before they are scaled to a national level.

Furthermore, the pace of meaningful use implementation and accompanying financial incentives threaten to redirect the development of HIT in an unproductive way. Providers will focus on implementing certified HIT to ensure full reimbursement, and vendors on modifying existing software to adhere to new meaningful use certification requirements. The risk of severely redirecting provider and vendor energy is delaying the refinement clinically meaningful systems in favor of superficially modifying products with concerning usability issues in order to meet policy requirements. (Karsh et al. 2010, 617-623)

Meaningful Use

Among the objectives of meaningful use are complex functions such as information exchange, electronic prescribing, and automated reporting of quality performance – lofty goals for a system still dominated by paper charting. Many of the demonstrated cost and quality benefits of HIT have been associated with the use of decision support and information sharing (Wu et al. 2006, 742-752; Walker et al. 2005, 5), and policy makers felt that requiring only the purchase of EHR would be inadequate to reap the potential benefits of widespread EHR implementation. (Stark 2010, 12)

Incentives

The drafting of the requirements for meaningful use are the responsibility of the HHS and the dispersion of incentive funds that CMS. The initial bill authorized a disbursement of up to $44,000 for Medicare dominant providers and up to $63,750 for Medicaid dominant providers, each distributed over a 5 year period; hospitals were
offered from $2 to $10 million dollars. The incentives are awarded in annual increments, the amount of each gradually reducing over several years, to finally terminate in 2015 for Medicare and 2017 for Medicaid. (Blumenthal 2011, 2323-2329)

Criteria

Meaningful use is planned to occur in three stages, each with increasingly demanding requirements. The objective of stage 1 criteria is to promote the purchase of certified EHRs, the entry and reporting of structured data, and the development of an infrastructure to facilitate information sharing. Later stages will progress to requiring bi-directional exchange of information – with both other providers and patients - and eventually demonstrated improvements in quality, efficiency, and population health.

Stage 1 involves approximately 25 criteria – the amounts vary slightly between physicians and hospitals – of which are a set of required “core” objectives and optional “menu” objectives. Physicians, for example, must achieve all 15 core objectives and 5 of 10 menu objectives to be eligible for the incentive payments; hospitals have only 14 core objectives but must also achieve 5 of 10 menu objectives. Providers must demonstrate meaningful use by 2012 to be eligible for the full incentive amount; planned deadlines for stage 2 and stage 3 are 2013 and 2016 respectively and must each be met to continue to receive payments.

Stage 2 Meaningful Use

The Notice of Proposed Rule Making (NPRM) for Stage 2 of Meaningful Use was recently released by HHS and read by the Office of the National Coordinator of Health Information Technology (ONCHIT). Some believe that meaningful use should be more aggressive, requiring the demonstration of clinical benefits, while other believe that the bar for meaningful use is already too high and should step back, offering incentives
for just acquiring EHRs. The changes and requirements in the NPRM demonstrate a balance of clear movement forward but also restraint to ensure that objectives remained feasible achievable for most providers.

The central thrust of meaningful use, from its inception, was to promote specific functionalities in addition to EHR adoption: computerized prescribing with decision support, quality reporting, and health information exchange. To that, stage 2 rules stay true, incrementally increasing requirements in each of those three domains.

1. Computerized provider order entry (CPOE) requirements have been raised to require that most orders occur electronically.

2. A host of quality measures have been proposed for required reporting to achieve meaningful use.

3. Stage 1 only required providers to purchase EHRs with the ability to information share, stage 2 requires that they actually use the functionality.

A significant move forward, one that received attention from the ONC upon release of the NPRM, is the increased requirement for patients to access their own data. Previously, providers only needed to be able to provide patients an electronic copy of their health information upon request; the revised stage 1 and proposed stage 2 rules require that 50% of patients have the ability to view, download, and transmit their data and that 10% actually do so.

The final rule may differ, as providers will likely object to being held accountable for a patient’s behavior, but regardless, it signifies the importance of technologies such as health portals or personal health records moving forward. As subsequent revisions of meaningful use objectives shift to require electronic patient
access to health information, health portals will become increasingly ubiquitous and the line of inquiry into their utility will intensify.

**Personal Health Records**

Patient engagement and patient access to health information are becoming increasingly important concepts in an era of health care reform. Patient centered medical homes, accountable care organizations, and new modifications to meaningful use objectives all embrace the importance of patients becoming more directly involved with their health care processes. A recent HIT action agenda states that access to personal health information (PHI) ‘empowers patients to actively partner with their health care providers in making important health care decisions, which can potentially lead to better health care and better health outcomes.’ (Wilson C 2010) Though data exist to demonstrate better health behaviors with patient engagement (Hibbard et al. 2007, 1443-1463), no literature has yet to demonstrate an association between electronic access to health information and patient engagement.

The American Health Information Management Association (AHIMA) defines Personal Health Records (PHR) as an “an electronic lifelong resource of health information needed by individuals to make health decisions. Individuals own and manage own and manage the information in the PHR, which comes from health care providers and the individual. The PHR is maintained in a secure and private environment, with the individual determining rights of access. The PHR does not replace the legal record of any provider.” (AHIMA e-HIM Personal health Record Work Group 2005, 1-7) The methods by which PHRs are filled with PHI vary. Initial versions were populated manually by the patient, but more recent PHRs, “tethered” to a provider, automatically pull data from the provider’s records. Personal health records can also
have additional functionality such as electronic communication with a provider, scheduling, and self-management tools.

Patient portals are similar to PHRs in that they provide patients with online access to their PHI and also have additional functionalities such as scheduling and communication. Portals, however, are often directly associated with a provider, where as a PHR is often independent and may interface with several providers. Currently, the distinction between PHRs and portals, especially in the academic literature, is minimal. PHR seems to be the most inclusive and commonly used term, though the technology described within many PHR studies could just as easily be referred to as a patient portal - as most of the PHRs used in studies are directly associated with the researching institution.

The current rates of PHR use by patients are modest. Although most believe that a PHR would provide significant benefit in managing their health care, there are significant concerns about privacy and security. (Fuji, Galt, and Serocca 2008) A study of a large health cooperative, which encouraged all patients to use PHR, observed a 42% signup rate but only 16% active use rate. (Yamin et al. 2011, 568) Similar patterns of low registration and low utilization were observed in many of the recent studies of PHR and health portals. The current low utilization is in contrast to consumer survey research which has shown growing interest in using PHRs. (Kaelber et al. 2008, 729-736)

Most current research of PHRs has focused on cross-sectional explorations of PHR use, internet access, and patient attitudes toward PHRs. (Kaelber et al. 2008, 729-736) Newer literature has examined utility of PHRs in improving the clinical outcomes for specific chronic diseases. The few randomized trials that have published did not demonstrate benefits clearly attributable to the use of a PHR. (Archer et al. 2011, 515-
Additionally, there remains a clear need to explore potential benefits on a systems level. (Archer et al. 2011, 515-522)

Significant drivers for the political interest in health information technology are both its potential to improve the quality of care and reduce the cost of care. The theoretical cost savings occur, not only on an individual level – with decision support tools - but on a systems level, through the prevention of unnecessary use of emergency or inpatient resources. Many episodes of inpatient care are the exacerbations of chronic disease and preventable by improving access to primary care and improved care coordination.

The emergency room has become known as a repository for failures in the health care system. Inadequate disease management or poor access to primary care leads patients either to seek primary care in the emergency room or to need emergent care for a disease that could have been treated earlier in an ambulatory setting. PHRs, especially those with secure messaging, constitute a form of increased access to a provider, but is it a type of access that is meaningful? In giving a channel of constant communication to physicians and improved access to personal health information, do PHRs or patient portals have the ability to change care seeking behavior?

Our study explores the utility of PHRs from a system perspective; in an adult population of family medicine patients, is having portal access, provided by a primary care practice, associated with a decrease in inappropriate emergency room visits? Our question touches on a topic that is both financially and clinically relevant and initiates an inquiry into a body of knowledge useful to large health care organizations dedicating significant resource toward the development of patient portal capacity.
References


Systematic Review Appendix

Introduction

The language surrounding health information technology, and specifically internet access to health information, is yet to be standardized. Lay-language is common and multiple terms refer to the same concept. A “patient portal” is a web page which allows a patient to access her health information. This access can include recent lab reports or portions of the physician’s documentation. Portals can also include additional functionalities such as secure messaging with a provider or online scheduling.

Personal health records (PHR) are another relevant technology that provides patients with access to personal health information. PHRs exist independent of a single provider and allow patients to store, manage, and share personal health information. The method by which PHRs are populated with PHI vary; initially they existed separately of the clinician’s records and had to be filled in manually by patients, but more recently “tethered” PHRs automatically populate themselves from a provider’s records. The information stored in a PHR is separate of the clinician’s records and does not replace any medical documentation. PHRs can also include functionalities like secure messaging and scheduling.

The line between a portal and a PHR are unclear. The most significant differentiator of the two terms is that portals are associated with a single provider while a PHR is a separate third-party service. In research however, most HIT systems used are affiliated directly with the institution performing the research. The use of the term PHR rarely signifies a system that exists independently of a provider or a system that manages the health information of multiple providers. The term PHRs appears to be the more

A3-1
common and inclusive term in the literature - encompassing the portal concept – but thematically contiguous research is occurring under both terms.

The most well developed body of literature in terms of portals is an examination of access, use, and attitudes. (Archer et al. 2011, 515-522) Recently, there has been a move beyond this approach into examining portal use in a clinical context via clinical outcomes - however this body of research is comparatively new. Though the focus of this systematic review is to explore system level research of portals, little literature exists on the topic. (Kaelber et al. 2008, 729-736; Nazi et al. 2010, 62-67) We have broadened the scope to capture the growing literature of clinically oriented research which will serve as a platform to extend into systems level research.

Methods

We searched MEDLINE database from January 2002 through May 2012 using a combined key word search of “("personal health records" or "secure messaging" or "electronic messaging" or "patient portal" or "internet portal" or "web portal" or "online portal") AND outcomes.” We supplemented these sources by searching with the keywords “personal health record” and “secure messaging” in EMBASE and Web of Science as well as hand searching bibliographies. The search was executed in May of 2012 and returned 329 unique titles. A single reviewer performed title reviews and abstract reviews of the initial search results based on predetermined inclusion and exclusion criteria (Table 1). Of the articles remaining, the bibliographies were examined for additional articles; these articles were subjected to the same selection process as the initial search results.

The search produced 7 studies for inclusion in the systematic review (Figure 1). We selected comparative studies examining the effect of secure-messaging or health
portal access on clinical outcomes or healthcare utilization and specifically excluded studies of custom-designed, internet-based clinical interventions - unless the primary medium of the intervention was the use of a PHR or health portal. Using USPSTF methodology a single reviewer evaluated the selected articles and rated the quality of the study design on a three variable scale: good, fair, and poor. We abstracted relevant information to be included in the systematic review and briefly commented on the strengths and weaknesses of each included article.

Table 1: Selection Criteria

<table>
<thead>
<tr>
<th>Study Design</th>
<th>Inclusion Criteria</th>
<th>Exclusion Criteria</th>
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<tbody>
<tr>
<td></td>
<td>prospective or retrospective</td>
<td>descriptive studies; systematic reviews; non-systematic literature reviews</td>
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<td></td>
<td>comparative studies; meta-analysis</td>
<td></td>
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<tr>
<td>Intervention</td>
<td>Online access to tethered health information; access to secure messaging</td>
<td>Untethered personal health records; provider facing HIT; educational programs delivered online; remote monitoring; tele-medicine</td>
</tr>
<tr>
<td>Outcomes</td>
<td>use of health services; disease specific outcomes</td>
<td>use, attitudes, or access to information technology</td>
</tr>
<tr>
<td>Population</td>
<td>family medicine or internal medicine adult population</td>
<td>Specialty-based; pediatric; inpatient</td>
</tr>
</tbody>
</table>
Figure 1: Systematic Review Flow Diagram

Total Results: 382
PUBMED: 75
Web of Science: 25
EMBASE: 273
Hand-pulled: 9

Unique results: 329

Title Review: 329
Eliminated: 277

Abstract Review: 62
Eliminated: 33
Pediatric/Psychiatric Population: 4
No clinical / utilization endpoint: 19
No PHR/Portal intervention: 1
Systematic Review/Descriptive study design: 9

Full Review: 29
Initial Search: 20
Hand-pulled: 9
Eliminated: 22
Pediatric/Psychiatric Population: 3
No clinical / utilization endpoint: 7
No PHR/Portal intervention: 4
Systematic Review/Descriptive study design: 8

Studies for Inclusion: 7
Initial Search: 3
Hand-pulled: 4
Limitations

We consciously compromised several components of a large-scale systematic review to maintain a project scope appropriate for our time and resource limitations. The query was refined and focused to limit the volume of initial results. A more extensive analysis would use broader search terms and place more emphasis on title and abstract review.

Only a single reviewer evaluated titles and abstracts for inclusion; having a second independent reviewer and a set protocol for evaluating discordance between reviewers is an important facet of a thorough systematic review. Similarly, though we used a standard method to assess the quality of studies, this evaluation was only done by one reviewer. Having a second independent reviewer to evaluate a sample or all of the articles would strengthen the reliability of the quality assessments.

We extracted 7 comparative studies of personal health records or secure messaging with clinical or healthcare utilization outcomes. 5 studies were randomized controlled trials, 1 was a retrospective cohort study, and 1 was a comparative analysis of cross-sectional data. The current literature can be organized broadly by intervention: those that examine general access to PHRs and those that study custom-designed, disease-specific interventions delivered via a PHR.

All studies were executed in an adult, outpatient setting. All studies examined clinical markers for management of either hypertension or diabetes: systolic blood pressure, diastolic blood pressure, LDL cholesterol, or glycosylated hemoglobin (HbA1c). One study tracked health care utilization in the form of clinical visits, both inpatient and outpatient.

*Access to Personal Health Records.* Wagner et al. is the strongest study to date that examines the effects of PHR use in a clinical context. Though the primary outcomes,
systolic and diastolic blood pressure, were not significantly different between the control and intervention arms, several aspects of the study provide insight into the null finding. The interest and utilization of PHR technology was low in the study; only 26% of potential participants agreed to participate – the most commonly sighted reason being lack of interest. Of the participants randomized to the intervention, utilization was still inconsistent; 54% used the PHR less than 2 times in 9 – 12 months.

A subgroup analysis demonstrated an association between more frequent PHR use and a significant decrease in BP. The association could suggest the presence of a threshold “dose” of PHR use required to generate clinical change or could merely be an association confounded by an overall drive to engage on the part of the patient. Patients with low baseline activation also demonstrated low PHR use and those with high baseline activation demonstrated high PHR use – suggesting that activation could be a moderator of use. Higher use of PHR was also noticed in association with greater provider-patient communication.

Teneford et al. used an observational study design which allowed a larger sample size and also measured frequency of portal use to examine a potential dose-response relationship between portal use and outcomes. The baseline characteristics of the intervention and non-intervention group varied significantly on important variables; portal users were generally healthier, wealthier, younger, more educated, and more likely to identify as Caucasian. After adjusting statistically for measured differences, small benefits were observed with several diabetes quality measures though the differences were likely not clinically significant. However, the study did not measure a baseline level of engagement, which is a significant confounder – the measurement and adjustment of which would likely shift findings toward the null.

The study also recorded frequency of use and observed two significant patterns: there were clinically significant differences between non-users and users of at least one
day; clinical outcomes changed only slightly with frequency of use – a 10 day increase was associated with a clinically insignificant change in HbA1c (0.02%, p<0.01). The data did not clarify if portal access provided a benefit independent of engagement or was only a marker for a more engaged patient. The lack of significant dose response relationship suggests the latter is more likely true and portal access, in its current form, does not significantly changing health outcomes.

Shaw and Ferranti et al. found that portal use was not a predictor of LDL or total cholesterol levels. There was a small, statistically significant, unadjusted difference in HbA1c between the two groups for both Type I (portal: 7.89, non-portal: 8.16, p<0.0001) and Type II diabetes (portal: 7.19, non-portal: 7.39, p<0.0001). The analysis showed no correlation between amount of portal use and clinical outcomes. The study design and analysis did not adjust or capture potential confounders and was unable to determine if the clinical difference could be attributed to portal use or was an artifact of other, unmeasured differences between the groups – such as baseline engagement.

**Portal based interventions.** Grant et al. published an RCT which examined a diabetes mellitus (DM) specific intervention delivered via a web-portal-like interface. Participants viewed DM related laboratory data, answered questions about concerns or barriers, and received custom generated care plans. The study used an active control, access to the portal and non-DM-specific health information. The difference between the control and intervention arm was the content made available through the portal rather than portal access itself.

The study had several challenges; though many patients were approached only few agreed to join the study (6797 approached, 244 enrolled). The two arms of the study appeared roughly comparable, but there were significant demographic differences between study participants and the general population. The low enrollment and
participation rates limited the power of the study, and statistical analysis was limited to exploratory, unadjusted bivariate analysis.

Of those participants in the intervention arm, 51% submitted a “care plan” via the portal; those that submitted a care plan were more likely to have a medication adjustment compared to the control group (29% vs 15%, p=0.10), and those that had medication adjustment had a significant unadjusted decrease in HbA1c (0.57% [%1.00], paired t-test p=0.009) and LDL-C (32.1[31.9] mg/dl; paired t test p=0.02)

The findings of the study are limited. In a select population subgroup, likely one that is highly engaged at baseline, only a percentage actively participated by submitting care plan and of that group only a percentage altered their medication which was associated with a modest improvement in DM outcome measures. Concerned about physicians resisting an intervention that required more time or investment, the study did not specifically train doctors or patients nor did it require that participating physicians change their care routine.

Ralston et al used an RCT to examine a PHR based intervention that involved both access to a PHR as well as personal consultations with a case manager. The study did demonstrate a significant decrease in HbA1c (-0.7%; p = 0.01) with the intervention but did not demonstrate significant change in other clinical outcomes - total cholesterol and blood pressure - or healthcare utilization. The intervention group had a greater prevalence of HbA1c < 7.0% after 12 months (33% vs 11%; p=0.03).

The study design was limited in that the control group had neither access to a portal nor counseling by a case manager. The observed beneficial effects of the intervention cannot be attributed to the use of the portal per se as they are unable to be distinguished from the effect of the personal case manager. Healthcare utilization was not a primary outcome nor was the study powered to detect a meaningful difference. An exploratory analysis did not demonstrate correlation between decreased healthcare
resource use and portal use though the small sample size makes the observation far from conclusive.

Green et al. is another RCT that examines a hypertension specific intervention. The study has three arms: usual care, web training with home monitoring, and web training, home monitoring and web based communication with a pharmacist. All participants were given an account to a health portal which had several functionalities including viewing labs and secure messaging with providers. The difference of the intervention is the use of home monitoring and web communication with a pharmacist – rather than access to a PHR or secure messaging.

The web training consisted of a brief personal tour of the web based services offered by the portal. Participants of the second arm of the study, those with home monitoring and web portal training, demonstrated a non-statistically significant trend towards clinical improvement, a greater portion of the intervention had controlled hypertension compared to the control group (RR 1.2; 95% CI, 0.95 – 1.56). The pharmacist based arm did demonstrate statistically and clinically significant improvement in both systolic and diastolic blood pressure as well as portion of the population with controlled hypertension compared to the control (RR 1.84; 95% CI, 1.48 – 2.29).

Similar to Grant et. al the study did not isolate access to a portal as the intervention but rather examined different methods of using a portal. Though the study was well designed to show that web based communication with a pharmacist can be beneficial, it is unclear if similar or better outcomes would be realized with a telephone or face-to-face interaction with a pharmacist. Additionally, the inclusion criteria limited the study to a very select sub-population that is likely to be more engaged at baseline. Though the study did provide insight into the use of a multi-disciplinary team to managed chronic disease it did not clarify the underlying question “does the use of a PHR or secure-messaging provide a distinct benefit?”
Discussion

Within the current PHR literature there is an even distribution of observational and randomized control studies, which either examine general portal access or a disease specific intervention using a health portal as a channel for delivery. Methodological challenges and nuances in study design have made the evidence of PHR utility in a clinical context inconclusive.

A common challenge to all PHR studies is the relationship between patient engagement and likelihood to use a PHR. The hypothetical causal path for PHRs is utilization increases engagement which in turn generates healthier behavior and better outcomes. In practice, however, it is likely that patients more engaged with their care are also more likely to use a health portal; engagement is a moderator, not an outcome, of portal use. It is likely that a combination of both is true, engaged patients are more likely to use a portal but portal use also improves engagement.

Without a measure of baseline engagement there is no way to distinguish the confounding relationship from the causal. Most studies did not measure engagement or account for it with a proxy; the one study that did measure engagement, Wagner et al., did not demonstrate statistically significant changes in primary clinical outcomes. In observational studies the different study groups demonstrated significant differences across several demographic variables – portal users were generally wealthier, more educated, younger, and whiter. The differences in measured variables suggest that differences in unmeasured variables – such as engagement – exist as well. Regardless, changes in clinical outcomes were modest, lacked clinical significance, and were unable to be differentiated from the effect of potential confounders.
Randomized controlled trials, though better able to isolate the effect of the intervention, had limited generalizability. Most trials enrolled only a small percentage of a large group of potential participants. Amongst the reasons for non-participation, lack of interest or lack of internet access were cited frequently - in the study by Wagner et al. lack of interest or access accounted for approximately 20% of all exclusions. Extensive exclusion criteria have the benefit of creating an ideal environment to examine the effect of an intervention – more of the participants are engaged in their care and willing to use additional services. Any benefits demonstrated in such a carefully selected subgroup will provide little insight into the utility of the intervention in widespread practice. The low participation in studies and low utilization of PHR services during the studies contrast with prior surveys demonstrating a clear interest in electronic access to health information on the part of patients.

Active Control Studies. A few studies, in an attempt to eliminate the confounding effect of higher engagement in portal users, used an active control (Grant et al. 2008, 1776; Green et al. 2008, 2857; Ralston et al. 2009, 234-239) in which the control arm was given access to the portal. Additionally, the studies provided specialized content or management by a non-physician provider to the intervention group. The difference between the arms was content delivered via the portal, rather than portal access itself.

Though several active control studies did demonstrate clinically significant benefits, the multi-faceted nature of the interventions made researchers unable to attribute the benefit to portal use. Theoretically, if randomization is adequate, an active control is unnecessary, as baseline engagement – or lack thereof – would be equally distributed between the study groups. The use of active controls, instead of providing a more insightful look at the effect of a portal, effectively controlled for the effect of the portal. Benefits observed in the active control studies, some of the most significant of the health
portal literature, occurred *despite* portal use, not because of it. No studies suggest if better, same, or worse outcomes would occur if similar, multi-faceted interventions, were delivered in person or through another medium.

*Low utilization.* Studies which had a recruitment processes were significantly challenged by low baseline interest in participation. (Ralston et al. 2009, 234; Shaw and Ferranti 2011, 714-8; quiz 719-20; Wagner et al. 2012) In the hypertension study by Wagner et al. only 26% of those approached consented to be enrolled in the study, the most common reason for exclusion was patient disinterest (44%). Even among the minority of candidates that decided to participate in the studies, a cohort much more likely to be engaged compared to the general population, many studies noted low overall utilization. Teneford et al. observed median portal use rates of less than once a month and the majority (54%) of participants in the Wagner et al. study only used the portal 1 – 2 times in a 12 month period.

*Lack of clear dose-response relationship.* Several trials, as a secondary outcome, examined frequency of portal use as a predictor for clinical outcomes. In most studies, no significant linear relationship was observed though a few patterns did emerge. Teneford et. al observed a significant difference in health outcomes between non-users and those that used a portal at least once but no linear relationship between amount of use and clinical outcomes. Wagner et. al observed a difference in outcomes between the average user and those that were high-frequency users – even after controlling for baseline patient engagement - suggesting a threshold dose-response effect. Other studies which measured use did not have similar findings.

The two threshold effects could indicate a benefit related to the portal but could also merely be indicators of intrinsic patient engagement. The absence of a correlation between frequency of use and outcomes weakens the probability of the observed benefits being caused by portal access.
**Length of study and outcomes.** Most studies were limited to approximately one year and had little follow-up after completion of the intervention. It is uncertain if patient’s interest in the portal will fade after time or if patients will permanently shift the channels through which they seek care. Even if portals can be demonstrated to change clinical indicators, such as HbA1c and blood pressure, these are only intermediate measures of health. The longevity and consistency of use of the portal are critical mediators for demonstrated short-term reductions in clinical measures to translate to patient relevant benefits. No studies demonstrated or even suggested PHR use has the ability to meaningfully change the incidence of patient relevant morbidity and mortality: death, MI, symptomatic retinopathy, peripheral vascular disease, etc.

**Provider role.** Few studies addressed the role of a provider, either as a part of the intervention or as a noted element of the environment in which the study occurred. Grant et al. measured patient-provider interaction and observed a strong correlation between provider communication and portal use. Wagner et al. failed to demonstrate benefit with a portal based intervention; in the discussion they mentioned that, because of the general lack of provider willingness to engage, there was no specific provider training nor were providers requested to modify their care processes in any way.

In Green et al. a pharmacist communicated with patients via secure-messaging as part of the intervention. Though the median portal use in the control arm was low (1 – 2 uses over 12 months) the portal use for the intervention arm, those being managed actively by a pharmacist, was much higher (20 uses in 12 months). (Green et al. 2008, 2857) A majority of the portal uses in the intervention group were initiated by the managing pharmacist.
Conclusion

The language surrounding PHRs is idealistic, it is touted as bedrock for the future for providing high-quality and cost effective care. Additionally, literature exists which suggests the desire for and access to health information online. (Archer et al. 2011, 515-522; Shaw and Ferranti 2011, 714-8; quiz 719-20; Fuji, Galt, and Serocca 2008) However, the most recent studies examining the clinical utility of PHRs have had mixed and limited results. Even of those studies that did demonstrate clinically significant findings, the multifaceted nature of the interventions or the specifics of the study design make it difficult to know if the observed benefits could be attributed to the use of a PHR.

The heterogeneity of the results seems to be related two broad themes: patient disparities and provider engagement. Portal access in isolation seems to provide little meaningful benefit; however provider engagement with patients (Wagner et al. 2012) or proactive patient communication by team members via a portal (Green et al. 2008, 2857) appear to improve utilization and are associated with better outcomes.

The studies thus far have significant variation both in design and results. The current challenge is to more thoughtfully examine why similar interventions have differing outcomes. Technology, in most cases, is only a tool. If used properly it can improve a process, if used inappropriately, it can be a hindrance; it has little demonstrated implicit value.Though there is a lack of significant findings with most primary outcomes in most studies, the secondary outcomes and measures of portal use provide compelling exploratory data suggesting that PHR implementation itself has significance and other, currently unexamined, variables, such as the provider’s level of PHR engagement, may be critical mediators in the clinical benefit of PHR technology.

Those few studies with demonstrated clinical value often had proactive communication with the patient through the portal or improved portal use associated with
greater patient-provider communication; conversely, a study that was well-executed but did not require providers to change care processes demonstrated no significant benefit to the patient. No studies were specifically designed to isolate the role of the provider in moderating the clinical benefit of PHRs; at this point such observations are mostly speculative, informed by non-primary outcomes of a few studies, but still, they are suggestive enough to highlight the importance of considering the provider role. Additionally, it is intuitive that the providers perception and use of PHR technology would in some way influence the utility of the portal for the patient. The several multifaceted intervention studies demonstrate that a patient portal can be a viable channel for clinically beneficial care processes. It is unclear if portals, as a medium for care, are neutral to, detract from, or amplify the effect of the intervention if it were delivered through a more traditional face-to-face interaction.

**Future research.** Studying PHR implementation has similar methodological issues to much quality improvement research: there is a strong cultural component to the implementation. Cultural variables such as physician attitudes and proactive utilization by the care team of new channels of care are likely important. Early attempts to engage in focused randomized trials have been largely unsuccessful in demonstrating meaningful benefit. A mixed methods study, exploring provider engagement in tandem with tracking clinical outcomes, would inform future studies of important currently unaddressed confounders and help clarify the role of a portal in permitting or enhancing patient engagement.

Studies of multi-faceted, portal-based interventions, especially those that engage non-clinician providers, need to design studies that isolate the portal as an intervention to help more clearly delineate the effect of the portal as a medium for care. For example, a new study could have three arms: usual care, usual care with medication management by a pharmacist in person, or usual care with medication management by a pharmacist via a
web portal. Such a study, especially if combined with mixed methods could explore both
the clinical utility of the portal as well as the quality of the experience both for patients
and providers.

References
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Nazi, K. M., T. P. Hogan, T. H. Wagner, D. K. McInnes, B. M. Smith, D. Haggstrom, N. R. Chumbler,
<table>
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<th>Study</th>
<th>Design</th>
<th>Data Collection</th>
<th>Technology</th>
<th>Disease</th>
<th>Outcome</th>
<th>Key Finding</th>
<th>Strengths</th>
<th>Weaknesses</th>
<th>Quality</th>
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<tr>
<td>(Wagner et al. 2012)</td>
<td>RCT</td>
<td>Not stated</td>
<td>PHR access</td>
<td>HTN</td>
<td>BP</td>
<td>No statistically significant difference was found between the intervention and control group. A change in SBP and DBP was noticed in the most frequent users of PHR but it is not possible to determine if this is due to the intervention or self-directed health engagement. PHR presence itself had no discernible effect on clinical outcomes.</td>
<td>Adequate randomization and PHR focused intervention. Measured frequency of portal use. Accounted for baseline engagement of patients.</td>
<td>-</td>
<td>Good</td>
</tr>
<tr>
<td>(Shaw and Ferranti 2011, 714-8; quiz 719-20)</td>
<td>Cross-sectional analysis, secondary analysis of data</td>
<td>1/11/2009</td>
<td>Patient portal access</td>
<td>Diabetes</td>
<td>HbA1c, LDL, Total Cholesterol</td>
<td>Differences in A1C were observed between portal and non-portal users in both Type I DM - 7.89 and 8.16 for portal and non-portal users respectively - and Type II DM - 7.19 and 7.39 respectively.</td>
<td>-</td>
<td>The study only provided a crude analysis and did not capture or control for multiple confounders</td>
<td>Poor</td>
</tr>
<tr>
<td>(Tenforde et al. 2011)</td>
<td>Retrospective Audit</td>
<td>1/7/2008 – 1/6/2009</td>
<td>PHR access</td>
<td>Diabetes</td>
<td>HbA1c, LDL, BP</td>
<td>The study uniquely explored the level of engagement - quantified in times per month the PHR was accessed - and its effect on DM II outcomes. Statistically significant decreases were seen in PHR users: HbA1c (-0.29%), SBP (-1.13%), DBP (-0.54%). However, the changes were unlikely clinically significant and there was no meaningful relationship between extent of PHR use and clinical outcomes.</td>
<td>The study measured and controlled for baseline engagement. A large sample size provided adequate power to detect small differences. Conclusions were appropriately interpreted with regard to study design limitations</td>
<td>The observational study design creates a high probability of selection bias.</td>
<td>Fair</td>
</tr>
<tr>
<td>(Ralston et al. 2009, 234-239)</td>
<td>RCT</td>
<td>1/8/2002 – 1/5/2004</td>
<td>PHR based intervention</td>
<td>DMII, health care utilization</td>
<td>HbA1c, outpatient visits, inpatient visits, inpatient days</td>
<td>The mean HbA1c of the intervention group decreased (-0.7%, p=0.01) when adjusted for sex, age, and initial HbA1c - no confidence intervals provided. No statistically significant changes in health care utilization were noted.</td>
<td>-</td>
<td>Statistically significant differences were noted between the two study arms. Limited statistical adjustment for demographic differences.</td>
<td>Fair</td>
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<tr>
<td>Study Reference</td>
<td>Study Design</td>
<td>Start Date - End Date</td>
<td>Intervention Type</td>
<td>Condition</td>
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<td>Findings</td>
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<tr>
<td>Green et al. 2008, 2857-2867</td>
<td>RCT</td>
<td>1/6/2005 – 1/3/2007</td>
<td>Secure messaging based intervention</td>
<td>HTN BP</td>
<td>The intervention group did demonstrate a statistically and clinically significant decrease of SBP and DBP. Several design study issues mitigate this finding however, the most important of which is the intervention was a dual intervention: web messaging and pharmacist access. The control group had neither. Such a significant drop is most likely attributable to the pharmacist expertise than the use of secure messaging as a form of communication.</td>
<td>-</td>
<td>Poor</td>
<td></td>
<td></td>
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<tr>
<td>Grant et al. 2008, 1776</td>
<td>RCT</td>
<td>1/9/2005 – 1/3/2007</td>
<td>PHR based intervention</td>
<td>DMII HbA1c</td>
<td>No statistically significant difference was noted between intervention group and control group. The study used an active control design; both the intervention arm and the control arm were using PHR: the difference was content, rather than channel of delivery.</td>
<td>-</td>
<td>Poor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Holbrook et al. 2005, 982</td>
<td>RCT</td>
<td>Not stated</td>
<td>PHR based intervention</td>
<td>DMII HbA1c, BP</td>
<td>A statistically significant difference was noted with HbA1c (-0.2%, p=0.001) - confidence interval not provided. DBP also decreased: -2.68 mmHg, p=0.007, confidence interval not provided.</td>
<td>-</td>
<td>Poor</td>
<td></td>
<td></td>
</tr>
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References


