**Does ‘Meaningful Use’ of EMR Improve the Quality and Efficiency of Health Care? An Exploratory Analysis of Ambulatory EMR Usage**

*(Research in Progress)*

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**Abstract**

The US government has initiated incentive programs to encourage the adoption of Electronic Medical Records (EMR). To qualify for the incentive payment, healthcare providers need to demonstrate ‘meaningful use’ of EMR systems, which requires the use of certified EMRs and the implementation of a set of standard functionalities. In this research-in-progress paper, we examine how the meaningful use of EMRs will affect health care outcomes in outpatient settings. Our preliminary results show that the use of core functionalities required by ‘meaningful use’ criteria has positive impact on the quality and efficiency of health care. We also find the relationship between the meaningful use and quality of care is moderated by the length of use. In addition, using certified EMR could improve quality and efficiency of health care. Our future research plan is also presented.

**Keyword:** Health IT, EMR, meaningful use, Ambulatory, quality and efficiency
Introduction

The US government is pushing for the adoption of Electronic Medical Records (EMR) systems to transform the healthcare industry. Significant financial incentives have been provided to encourage the “meaningful use” of EMR systems. Although the major motivation of implementing EMR systems is to improve the health care quality (Adams et al. 2003), reduce the cost (Wang et al. 2003), enhance the patients’ safety (Bates and Gawande 2003), and improve efficiency (Agarwal et al. 2008), findings regarding the relationship between EMR systems and health care outcomes are mixed. For example, Furukawa et al. (2010) found no evidence that EMR systems could reduce patients length of stay in hospital. On the contrary, they found the advanced EMR systems increase hospital’s cost and nurse staffing level. Similarly, Romano and Stafford (2011) find there is no significant difference in terms of patient satisfaction between patients whose doctors have adopted EMR and those whose doctors haven’t. The causes of the unsuccessful EMR adoption include the long learning curve of using EMR systems, physicians’ resistance to information systems and ignoring systems alerts (Sidorov 2006).

To understand the issues of using EMR systems, we intend to explore the factors facilitating the systems to achieve desirable outcomes, especially the efficiency and quality of health care. Understanding the relationship between EMR adoption and efficiency and quality of health care will advance our knowledge of the effectiveness of using EMRs. It will provide insights into how EMR systems should be designed and implemented. It will also inform regulators on how to manage and coordinate the scope and pace of EMR adoption as well as healthcare providers on the decision of adoption and use of EMRs. In this paper, we attempt to investigate the following two questions regarding EMR usage and quality and efficiency of health care delivery: (1) Will ‘meaningful use’ of EMR improve health care outcomes in outpatient settings? (2) What other factors could affect the outcome of EMR usage?

Our research makes the following contribution: First, since the publication of final rules on meaningful use of health IT, our research is one of the first to empirically examine the impact of using functionalities identified in final rules on health care outcomes. Although the impacts of different EMR functionalities on health care outcomes have been examined in previous studies, few of them have focused on meaningful use criteria. As meaningful use criteria have become the primary regulation in guiding and shaping EMR adoption in the next few years, understanding its impact is needed. Second, while most IS literature studies the impact of health IT in hospital settings, our research investigates the effect of EMRs on health care outcomes in ambulatory environments. Third, our research contributes to IT value literature by examining how the characteristics of IT usage, including the extent of use, length of use and quality of systems, affect IT values.

In this research-in-progress paper, we used data from 222 primary care practices to test our hypotheses. Our preliminary results show that the use of core functionalities required by ‘meaningful use’ criteria has positive impact on the quality and efficiency of health care. We also find the relationship between the meaningful use and quality of care is moderated by the length of use. In addition, using certified EMR could improve efficiency and quality of health care.

Background

EMR

The costs of health care in the United States have been rising dramatically in recently years, which has caused concerns about its affordability and quality. Information technology, especially Electronic Medical Records (EMR), are considered as one of the effective solutions to rein in costs and improve the quality of care. Electronic medical records are the electronic records of patient health information that includes patient demographics, progress notes, problems, medication, vital signs, past medical history, immunizations, laboratory data and radiology reports. It could be created, stored, and shared in information systems.

EMR systems could be classified into hospital EMR systems, which are intended to facilitate the sharing and storage of medical information across departments in a hospital, and ambulatory EMR systems,
which are designed to store patients' information in a physician practice, and exchange information with outside entities. These two types of EMR systems differ in their functionalities, primary users, and scope of implementation. Based on the functionalities, EMR systems could be further classified in different ways: basic functionalities vs. decision support functionalities or clinical functionalities vs. administrative functionalities.

Although the implementation of EMR is aimed to reduce the cost, improve the quality and efficiency of care, and prevent and manage diseases (Hillestad et al. 2005), the findings on the impact of EMR adoption has been mixed. Table 1 summarizes some of the findings from previous research on the effects of EMRs on health care outcomes. It shows that the effects of EMR on health care outcomes are not consistent and are contingent on various conditions.

The pace of EMR adoption in US has been slow. A recent study found only 7.6% US hospitals adopt basic EMR and 1.5% US hospitals adopt comprehensive EMR (Jha et al. 2009). In another study conducted in ambulatory settings, 13% physicians have basic EMR and only 4% used fully functional EMR (DesRoches et al. 2008). In addition, the EMR adoption is found unbalanced in locations (e.g. urban vs. rural areas), teaching status (teaching hospitals vs. non-teaching hospitals), and size (larger hospitals vs. small hospitals). The major barriers for EMR adoption include the costs and physician’s resistance to information technology.

**Meaningful use**

To increase EMR adoption rate, US government has initiated financial incentives through HITECH (The Health Information Technology for Economic and Clinical Health) Act to encourage health care providers to adopt EMR. Under this Act, out of a total of $38 billion ‘eHealth’ investment, $19 billion has been set aside and qualified doctors could receive up to $44,000 for adopting an EMR. Also, beginning in 2015, health care providers that do not use EMR will see reduction in their Medicare reimbursement as penalties.

The essential part of this incentive program is the ‘meaningful use' criteria. To qualify for the incentive payment, health providers (including both physicians and hospitals) must demonstrate meaningful use of EMR. According to Center for Medicare and Medicaid Services, ‘meaningful use’ refers to ‘providers’ need to show they’re using certified EMR technology in ways that can be measured significantly in quality and in quantity’. ‘Meaningful use’ has two core requirements: adopting certified EMRs and using them to achieve a set of objectives. The timeline of achieving the meaningful use of objects were broken into three stages. The final rules for the first stage have been officially published in 2010 and the rules for stage 2 and 3 are still in draft. The first stage, which is in the period of 2011-2012, identifies 25 objectives and divides them into two groups: the core group, which consists of 15 functionalities and all of them must be met by health care providers, and the menu group, which consists of additional 10 functionalities from which health care providers can choose any 5 to implement in the first stage. The functionalities in the core group include both the basic EMR functions such as record patient demographics, and decision support tools such as drug–drug and drug–allergy interaction checks (Blumenthal and Tavenner 2010). The detailed information on meaningful use could be found at https://www.cms.gov/EHRIncentivePrograms/. In this paper, we attempt to investigate whether the adoption of certified EMR and core functionalities required in the first stage of meaningful use will improve quality and efficiency of healthcare.
Table 1. Previous findings on EMR impact

<table>
<thead>
<tr>
<th>Studies</th>
<th>EMR functionalities</th>
<th>Health Care outcomes</th>
<th>Research Setting</th>
<th>Findings</th>
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<tr>
<td>Kaushal et al. (2003)</td>
<td>Computerized physician order entry (CPOE) and clinical decision support systems (CDSSs)</td>
<td>Patient Safety</td>
<td>mixed</td>
<td>Five trials assessing CPOE show it reduce errors and 7 trials assessing CDSSs show mixed results</td>
<td>Based on Literature review</td>
</tr>
<tr>
<td>Dorr et al. (2007)</td>
<td>different (Health Information Technology) HIT including EMR and PHR(personal health records)</td>
<td>care of chronic illness</td>
<td>Mixed</td>
<td>The majority of studies reports positive impact of HIT</td>
<td>Based on Literature review</td>
</tr>
<tr>
<td>Chaudhry et al. (2006)</td>
<td></td>
<td>Quality, Efficiency, cost</td>
<td>Mixed</td>
<td>Benchmark institutions have demonstrated the efficacy of health information technologies in improving quality and efficiency. But its effect on how other institutions are unclear.</td>
<td>Based on Literature review</td>
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<tr>
<td>Menachemi et al. (2006)</td>
<td>Administrative IT, clinical it, strategic IT</td>
<td>Financial performance</td>
<td>Hospitals</td>
<td>IT adoption is consistently related to improved financial outcomes</td>
<td>Empirical</td>
</tr>
<tr>
<td>Borzekowski (2009)</td>
<td>Financial/administrative, Clinical TI</td>
<td>Cost</td>
<td>Hospitals</td>
<td>hospitals are associated with declining costs three and five years after adoption.</td>
<td>Empirical</td>
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<tr>
<td>Himmelstein et al. (2010)</td>
<td>Clinical system, Administrative systems(patient related), Administrative systems(other)</td>
<td>administrati ve costs, overall cost and quality</td>
<td>Hospitals</td>
<td>Hospital computing might modestly improve process measures of quality but does not reduce administrative or overall costs.</td>
<td>Empirical</td>
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<tr>
<td>Setia et al. (2011)</td>
<td>clinical and business activity systems</td>
<td>Financial performance</td>
<td>Hospitals</td>
<td>Use of IT in clinical and business activity systems can have significantly distinct effects on financial performance in hospitals.</td>
<td>Empirical</td>
</tr>
<tr>
<td>Bhattacherjee et al. (2007)</td>
<td>Clinical HIT, Administrative HIT, Strategic HIT</td>
<td>operational and quality performance</td>
<td>Hospitals</td>
<td>Only clinical HIT investments were found to have a statistically significant positive effect on operational performance.</td>
<td>Empirical</td>
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<td>Devaraj and Kohli (2000)</td>
<td>Decision support systems</td>
<td>Profitability and Quality</td>
<td>Hospitals</td>
<td>IT-performance relationship is observed after certain time lags.</td>
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<td>Menon et al. (2009)</td>
<td>clinical IS and administrative IS</td>
<td>Hospital output and labor productivity</td>
<td>Hospitals</td>
<td>clinical IS improve hospital output in the short run. Administrative IS were negatively associated with organizational performance in the short run, but positively associated with these performance measures over the long run</td>
<td>Empirical</td>
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<tr>
<td>DesRoches et al. (2008)</td>
<td>Basic system and full functional systems</td>
<td>Quality of care and users’ satisfaction</td>
<td>Ambulatory Care</td>
<td>Physicians who use electronic health records believe such systems improve the quality of care and are generally satisfied with the systems</td>
<td>Empirical</td>
</tr>
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</table>
Hypothesis development

Extent of meaningful use

The “extent of meaningful use” refers to the degree to which the functionalities required by meaningful use criteria have been used. The pace of EMR adoption varies for different health care providers, ranging from the adoption of standalone single-module to comprehensive EMR. The more extensive adoption indicates more functionalities and higher integration, which is critical to efficiency and quality of health care delivery. A previous study shows that one of the major causes of low efficiency and high cost is the ‘decentralized and fragmented nature of the health care delivery’ (Kohn et al. 1999). More extensive usage facilitates the patients’ information flow within physicians’ practice as well as between outside entities including hospitals, labs, pharmacies, and other health care providers. More available information helps physicians to make more informed decisions and thus reduce unnecessary tests and medical errors. In contrast, less extensive usage usually limits to specific functionalities or certain group of users, which restrict physicians’ ability of information sharing and full utilization of EMR. This argument has been supported by Angst et al. (2011), who found that hospitals integrating fundamental technologies earlier tend to have better performance. Therefore, we propose that

H1A: More extensive meaningful use of EMR has more positive impacts on the quality of health care in ambulatory settings.

H1B: More extensive meaningful use of EMR has more positive impacts on the efficiency of health care in ambulatory settings.

Length of EMR Use

As the use of EMR systems become more extensive, it also increases the time to realize its desired benefit. In this paper, the length of use refers to the time since the adoption of current EMR and it captures the maturity of EMR adoption. EMR implementation is a complicated process and it takes time for users to get familiar with the systems. Therefore, users usually have a long learning curve to climb before materializing the benefit of EMRs, especially those used more extensively. Longer interaction with the systems will increase the knowledge of using EMR and familiarity with the EMR, which in turn could improve the utilization of functionalities as well as reduce the errors associated with misunderstanding or misuse of EMR. In addition, previous studies show that only a small proportion of physicians received sufficient training on EMR, and some physicians even do not know exactly about what functionalities their EMR system has (Morris et al. 2005). Longer use of EMR will make up the lack of training and increase physician’s knowledge of the systems, which in turn will improve the efficiency and effectiveness of the systems (Setia et al. 2011). Moreover, EMR adoption requires users to adjust their routines to adapt to new processes. A longer usage gives users sufficient time to make transitions from old systems to EMR systems. Furthermore, there may be some errors hidden in EMR systems or some physicians did not use the EMR systems correctly. A longer usage could expose those errors and allow users to find solutions, which in turn reduce the potential risks and minimize negative impacts. Furthermore, longer use could affect physician’s attitude toward IT, computer skills and self-efficacy, which can also positively affect their EMR adoption. Previous studies have shown that longer use of information systems have impacts on the outcomes. For example, Setia et al. (2011) found hospitals’ experiences with business activity systems are positively related to their financial performance. Devaraj and Kohli (2003) suggested frequency of use of decision support systems in hospitals help to reduce mortality rates. Therefore, we propose that length of use moderates the relationship between the extent of meaningful and health care outcomes. It may take longer for the more extensive EMRs to reap the benefit, which lead to the following hypotheses:

H2A: The extent of meaningful use has greater positive impacts on the quality of care in practices with longer EMR usage than in those with shorter EMR usage in ambulatory settings.

H2B: The extent of meaningful use has greater positive impacts on the efficiency of care in practices with longer EMR usage than in those with shorter EMR usage in ambulatory settings.
Certified EMR

Certified EMRs refers to the EMRs which receive certifications from authorized organizations such as ONC (Office of the National Coordinator for Health Information Technology) or CCHIT (the Certification Commission for Healthcare Information Technology) to ensure the quality of EMR systems. Certifications have been used in IT industry to signal the quality of products and indicate that certified products have met certain standards (Gao et al. 2010). To be certified, an EMR system has to go through rigorous testing processes on its functionality, usability, interoperability, privacy and security. Certified EMRs tend to have more features and thus are more likely to meet users’ requirements to improve care and reduce costs. In addition, although the certification process focuses on software packages, it is likely that the vendors of the certified EMRs have more experiences and qualification to implement the systems successfully.

Certification information could reduce information asymmetry for clients (Gao et al. 2010). EMR certification information has been used by health care providers to evaluate the EMR products and plays an important role in their software purchase decision. Also, as we discussed earlier, certified EMR is the central part of meaningful use legislation and is used as a standard to determine the qualifications for the incentive programs that control the outcomes of EMR adoption. Although certified EMRs are perceived reliable and high quality, there is no empirical study to date investigating the effect of EMR certification on health care outcomes. Other studies suggest that customized home-grown EMRs may better serve the customers due to their flexibility, fitness to customers’ unique requirements and users’ high involvement in the design process. In addition, compared with hospitals, most practices have smaller number of users and limited scope of implementation, thus the advantage of certified EMR systems may not be salient in ambulatory settings. In this study, we intend to investigate whether certified ambulatory EMRs outperform non-certified ambulatory EMRs in terms of health care outcomes. Therefore, we propose and test the following hypotheses.

\( H_3A: \) Certified EMRs have more positive impacts on the quality of care than non-certified EMRs in ambulatory settings.

\( H_3B: \) Certified EMRs have more positive impacts on the efficiency of care than non-certified EMRs in ambulatory settings.

Methods

Data

A national survey was conducted to collect the data. Since the focus of our research is ambulatory EMRs, our survey only targeted physician practices. The contact information of the practices was obtained from American Medical Information (AMI) database, which contained mail addresses of national physicians and medical offices. 5200 physician offices were selected from this database using stratified sampling method to ensure that our samples were balanced in terms of rural vs. urban. Surveys were mailed to all 5200 offices, and a reminder followed by a second mail was sent to the non-respondent offices. 1001 completed surveys were received during this process. Because this current study investigates the impact of actual EMR usage on health care outcomes, our data analysis only includes the physician offices which had already adopted EMR systems and whose data are complete for all variables included in our model, which lead to 222 observations in our final analysis.

Measurement

All measures used in the survey were either adapted from existing studies or developed based on extensive literature review and interviews with physicians. A panel of primary care physicians reviewed the survey to ensure its content validity and clarity.
Dependent variables

Efficiency of health care was measured by three items, using a 5-point likert scale with anchors from ‘much worse’ to ‘much better’, to assess how the time spent on the following tasks has changed: time chasing charts, phone/fax time dealing with and tracking labs and referrals, and time dealing with medication refills. The Cronbach’s alpha for this measure is 0.861, which indicates the reliability is satisfactory.

Quality of health care was measured by five items, using 5-point likert scale with anchors from ‘much worse’ to ‘much better’, to assess how the following service level change: accurate coding, level of services to patients per visit, ability to accurately capture services provided at each visit, capabilities for chronic disease management prompts, and turn-around time on claims from submission to payment. The Cronbach’s alpha for this measure is 0.864.

Independent variables

Length of use was measured by a single item which asked the respondents how long they have used current EMR in their offices.

Certified EMR is measured by a single item which asked the respondents whether the EMR they were using is certified. It was coded as 1 if the EMR is certified and 0 otherwise.

Extent of meaningful use was measured by the number of functionalities used and their corresponding use frequency. Respondents were asked to rate the use of 14 core functionalities identified by meaningful use criteria (our survey did not ask about the functionality of ‘record smoking status for patients’) using 5-point likert scale with anchors ‘used most of time’, ‘used some time’, and ‘did not use’. A function was coded as 1 if it was used most of time, 0.5 if used some time and 0 otherwise. Then we added all scores and used the total score of the 14 functionalities to measure the extent of meaningful use.

Control variables

We controlled for a couple of variables which could affect the health care outcomes. First, we included variables related to the size of practice, which has been found to have impact on EMR adoption (Angst et al. 2010). As the size of a physician’s practice increases, the amount of information to be processed and the difficulty in communication also increases. In addition, practices with different sizes will differ in the resources they can leverage, which in turn may affect their health care outcomes. The size-related variables include the number of patient visits, the number of clinicians, and the number of sites. Second, following previous studies (e.g., Menon et al. 2009), we also controlled for variables related to physician offices’ revenue including the percentage of Medicare and Medicaid billings.

Analysis and Preliminary Results

We used the following models to test our hypotheses. Ordinary least squares (OLS) were used to estimate the results. We first validated the assumptions associated with OLS regression. The plot of error terms indicated they follow normal distribution, which was further confirmed using Shapiro-Wilks test. Values of both variables in the moderation effect were mean-centered to reduce the multicollinearity. The variance inflation factors were all below 4 for every regression model, indicating that multicollinearity was not an issue. We then estimated the models in three steps: in the first step, only control variables were entered the model; in the second step, all independent variables were entered the model. In the third step, the interaction terms were entered the model. The results of the estimation are summarized in Table 2.

Quality of care (or efficiency of care)

\[
\beta_1 + \beta_2 (\text{ExtentUse}) + \beta_3 (\text{LengthUse}) + \beta_4 (\text{ExtentUse} \times \text{LengthUse}) + \beta_5 (\text{CertifiedEMR}) \\
+ \beta_6 (\text{PatientVisits}) + \beta_7 (\text{NumClinicians}) + \beta_8 (\text{NumSites}) + \beta_9 (\text{Medicare}) + \beta_{10} (\text{Medicaid}) + \varepsilon
\]
Hypothesis 1A and 1B propose that more extensive use of functionalities identified by meaningful use criteria leads to higher quality and efficiency. The results indicate that extent of meaningful use has significant positive relationship to health care outcomes (β=.167, p<0.05; β=.177, p<0.05). Thus H1A and H1B are supported.

Hypothesis 2A and 2B propose that the relationship between extent of meaningful use and health care outcomes is moderated by the length of EMR use. Our results show that while the length of EMR use moderates the relationship between meaningful use and quality of care (β=.121, p<0.1), its effect on the relationship between meaningful use and efficiency of care is not significant (β=.110, p=n.s.). Therefore, H2A is supported but H2B is not.

Hypothesis 3A and 3B propose that using certified EMR will achieve higher quality and efficiency of care. Our results show that the effect of certified EMR on quality and efficiency of care is positive and significant (β=.117, p<0.1; β=.173, p<0.01). Therefore H3A and H3B are supported.

**Implications**

This paper contributes to the literature on health IT. It suggests that the contradicting findings in previous research on the relationship between EMR adoption and healthcare outcome may be attributed to difference in the extent and length of EMR usage. Therefore, when investigating or comparing the outcomes of EMR, researchers need to take into account the factors including the number of functionalities used, length of use, and the quality of EMR products. First, our study finds that using more functionalities have a positive impact on both the quality and efficiency of health care. It suggests a comprehensive and integrated EMR may generate more benefit for healthcare providers. Second, our results are consistent with previous studies conducted in hospital settings which found the length of usage plays an important role in EMR adoption (Menon et al. 2009; Setia et al. 2011). Due to the learning curve and the complexity of EMR adoption, the benefit of EMR adoption may not appear until late stages of
adoption. Third, Our research implies that the EMR product quality and its vendor’s qualification matters when it comes to the realization of benefit of EMR adoption. Well-designed EMR and experienced vendors could increase the chances of success in EMR adoption.

Our research also has implications to policy makers and health care providers. First, our study is one of the first to test how meaningful use criteria would affect healthcare outcomes associated with EMR adoption. It shows the potential of the meaningful use criteria in improving the benefit of EMR adoption. Using certified EMR and the core functionalities defined by meaningful use will not only qualify its users for financial incentives of EMR adoption, but also may bring substantial benefit by improving the quality and efficiency of care. For healthcare providers, it is critical to choose the scope and products when making decisions on EMR adoption. In addition, the health care providers should manage their expectations regarding the length of time it will take to see the payback of their health IT investment, especially when using more comprehensive EMRs.

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