

1 The Relationship between External Environment and Physician' E-mail Communication: The  
2 Mediating Role of Health Information Technology (HIT) Availability

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ABSTRACT

299 words

**Background:** Physician e-mail communication, with patients and other providers, is one of the cornerstones of effective care coordination, but varies significantly across physicians. A physician’s external environment may contribute to such variations by enabling or constraining a physician’s ability to adopt innovations, such as health information technology (HIT) that can be used to support e-mail communication.

**Purpose:** To examine whether the relationship external environment and physician’ e-mail communication with patients and other providers is mediated by practice’s health information technology (HIT) availability.

**Methodology:** The data were obtained from the Health Tracking Physician Survey (HTPS) (2008) and the Area Resource File (2008). Cross-sectional multivariable subgroup path analysis was used to investigate the mediating role of HIT availability across 2,850 U.S. physicians.

**Findings:** Solo physicians’ perceptions about malpractice were associated with 0.97 lower odds ( $p<0.05$ ) of e-mail communication with patients and other providers, as compared to group and hospital practices, even when mediated by HIT availability. Subgroup analyses indicated that different types of practices are responsive to different dimensions of the external environment. Specifically, solo practitioners were more responsive to the availability of resources in their environment, with per capita income associated with lower likelihood of physician e-mail communication ( $OR=0.99$ ,  $p<0.01$ ). In contrast, physicians working in the group practices were more responsive to the complexity of their environment, with a physician’s perception of practicing in environments with higher malpractice risks associated with greater IT availability,

1 which in turn was associated with a greater likelihood of communicating via e-mail with patients  
2 (OR; 1.02, p<0.05) and other physicians (OR; 1.03, p< 0.001).

3 **Practical Applications:** The association between physician' e-mail communication and external  
4 environment is mediated by practice's health information technology (HIT) availability. Efforts  
5 to improve physicians' e-mail communication and HIT adoption may need to reflect the varied  
6 perceptions of different types of practices.

7 **Keywords:** physician' communication, health information technology, mediation analysis,  
8 external environment

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### INTRODUCTION

Physician e-mail communication, with patients and other providers, is an important component of effective care coordination (Mettner, 2009) as it is shown to improve patient and physician outcomes (Forrest et al. 2000; Schoen et al. 2006). Approximately 20% of physicians use e-mail to communicate with patients and about 65% with their peers (Menachemi, Prickett, & Brooks, 2011; Houston, Sands, Nash, & Ford, 2003), but this practice varies greatly throughout the country (O'Malley & Reschovsky, 2011; Pham, O'Malley, Bach, Saiontz-Martinez, & Schrag, 2009). According to resource-dependency theory, which highlights the importance of availability of external resources, this variation may be partially attributed to characteristics of a physician practices' external environment, such as practice location (Gupta, O'Connor, & Quezada-Gomez, 2004) or socio-demographic characteristics of the surrounding community (Rodriguez, von Glahn, Rogers, & Safran, 2009).

Policy makers have increasingly promoted the use of health information technology (HIT; e.g., the passage of Health Information Technology for Economic and Clinical Health Act (HITECH)), in part to improve physician e-mail communication with patients and other clinicians (Blumenthal, 2010). This interest has resulted in an unprecedented number of financial resources being devoted to development of HIT availability in physician practices (Blumenthal, 2009). Importantly, however, these resources are not evenly distributed across markets (Center for Medicaid and Medicare Services 2012; Rao et al. 2011), which may influence practice's HIT availability and in turn, the amount of e-mail communication engaged in by these practices.



1 Resource dependence theory (RDT) is an open system theory that stipulates that an  
2 organization's external environment provides resources needed to successfully engage in key  
3 strategic and operational activities (Dess & Beard, 1984). However, because organizations  
4 operate in different environments, they often adopt different structures and strategies to align  
5 themselves with their external environment (Thompson, 1967; Venkatraman & Camillus, 1984).  
6 Previous research has identified three primary dimensions of the external environment:  
7 complexity, munificence, and dynamism (Dess & Beard, 1984; Zinn, Proenca, & Rosko, 1997).  
8 Environmental complexity reflects the number of different actors/elements that need to be taken  
9 into consideration when making strategic decisions. Environmental munificence reflects the  
10 abundance of resources in the environment. Environmental dynamism reflects the rate of change  
11 and thus uncertainty in the environment.

#### 12 **External Environment and Communication: The Mediating Role of HIT Availability**

13 One means by which the external environment may influence physician e-mail  
14 communication is by promoting or hindering HIT availability. Research suggests that more  
15 complex and dynamic environments are associated with EMR adoption due to the uncertainty  
16 that these environments can create for organizations (e.g., unclear return on investment; Kazley  
17 & Ozcan, 2007). In contrast, more munificent environments help reduce a practice's dependence  
18 on other entities for resources (e.g., financial, technical, information) and can be used to facilitate  
19 electronic health record (EHR) adoption.

20 Other research has found that HIT availability is associated with improved  
21 communication (Milne et al., 2014; Shachak, & Reis, 2009). For example, HIT availability is  
22 associated with enhanced information exchange about active medications among providers and  
23 facilitated discussion about pharmacy procedures between providers and the patients (Arar, Wen,

1 McGrath, Steinbach & Pugh, 2005). Together, this research suggests that the relationship  
2 between the external environment and communication may be mediated by HIT availability.  
3 *Hypothesis 1: Physician practices in more munificent environments will be associated with*  
4 *greater HIT availability, which in turn will be associated with more time allocated to e-mail*  
5 *communication.*

6 *Hypothesis 2: Physician practices in more dynamic environments will be associated with lower*  
7 *HIT availability, which in turn will be associated with less time allocated to e-mail*  
8 *communication*

9 *Hypothesis 3: Physician practices in more complex environments will be associated with lower*  
10 *HIT availability, which in turn will be associated with less time allocated to e-mail*  
11 *communication.*

## 12 **Moderating Influence of Practice Type**

13 In this study, we also consider the moderating role of practice type (solo practitioners,  
14 group practices, or hospital-based physicians). Different types of organizations often have  
15 variable access to internal (e.g. managerial expertise and staff) and external (e.g., affiliation with  
16 hospital) resources needed to manage the adoption process of new innovations such as HIT  
17 (Castle 2001; Zinn, Proenca, & Rosko, 1998). We expect these differences to moderate the  
18 influence of the external environment on HIT availability, and in turn, the amount of e-mail  
19 communication engaged in by a physician practice.

## 20 **METHODS**

21 The study uses a cross-sectional design to analyze the mediating role of HIT availability  
22 in the relationship between the external environment and physician e-mail communication. The  
23 data were obtained from the Health Tracking Physician Survey (HTPS) (2008) conducted by the

1 Center for Studying Health System Change and the Area Resource File (2008) (Health Tracking  
2 Physician Survey Methodology Report, 2008). The HTPS consisted of nationally representative  
3 sample of U.S. physicians. The response rate of among eligible participants was 61.9 %.  
4 Observations with item specific missing values were discarded from the sample (N=1,870),  
5 leaving a final analytic sample of 2,850 physicians. We compared individual level characteristics  
6 (specialty, years in practice, gender) of those included in the analysis with those excluded using  
7 chi-square and one-way analysis of variance tests and did not detect any statistically significant  
8 differences between the groups.

### 9 **Outcome Variable**

10 *Amount of e-mail communication with patients and other providers.* E-mail  
11 communication with patients and other providers was measured with 2 items that were modeled  
12 individually in the analysis. The items were: 1) Amount of time allocated for e-mail  
13 communications with patients and their families; 2) Amount of time allocated for e-mail  
14 communication with physicians and other clinicians. The responses were provided on a 4-point  
15 scale ranging from 0 (*none*) to 4 (*more than 2 hours*) plus the “*not ascertained*” category. “Not  
16 ascertained” responses were coded as missing and excluded from final analysis. Our initial  
17 attempts to model time allocated to email communication as an ordinal variable were  
18 unsuccessful, however, with the Score test indicating that the variable did not meet the  
19 proportional odds assumption. Therefore, the response categories were recoded into binary  
20 variables, with none and less than a half hour categories coded as “0” and the remaining  
21 categories coded as “1”.

### 22 **Explanatory Variables**



1 Environmental munificence was represented by community income level and  
2 reimbursement. Community income level was operationalized as the average per capita income,  
3 measured in \$1,000 units (income divided by population, multiplied by \$1,000). Reimbursement  
4 was based on the physician's response to the following question: "Is your practice reimbursed by  
5 any health insurance plans for these activities: 1. Email communications with family; 2.  
6 Telephone communications with family; 3. Email communications with physicians and other  
7 clinicians; and 4. Telephone communications with physicians and other clinicians." The  
8 response categories were: "Reimbursed", "Not Reimbursed", and "Unsure if reimbursed".  
9 "Reimbursed" responses were coded as 1, "Not reimbursed" responses were coded as 0, and  
10 "Unsure if reimbursed" responses were coded as missing and removed from further analysis. A  
11 single reimbursement variable was then created by summing across the responses related to these  
12 four activities (range 0 to 4). Environmental dynamism was measured as the change in the  
13 unemployment and poverty rates from 2002 to 2007 (the five-year period preceding our study  
14 data. Environmental complexity was measured as the degree of competition and the level of  
15 malpractice concern perceived by physicians. Previous research indicates that medical practices  
16 located in more complex environments, characterized by the presence of a malpractice crisis in  
17 the state where the medical practice is located, were less likely to pursue a strategic initiative,  
18 such as adoption of an electronic medical record (EMR) (Menachemi, Shin et al. 2011;  
19 Menachemi, Mazurenko et al. 2012). The degree of competition was assessed with a single  
20 question that asked respondents "Thinking about your practice specifically, how would you  
21 describe the competitive situation your practice faces?" Responses options were "Not at all  
22 competitive", "Somewhat competitive", and "Very competitive", which were subsequently  
23 coded as 1, 2, and 3, respectively with higher values indicate perceptions of a more competitive

1 environment. Finally, the level of malpractice concern was constructed as the average across four  
2 items that asked physicians to what degree they agreed with the following statements: 1. Will be  
3 involved in a malpractice case sometime in the next 10 years; 2. Pressured in my day-to-day  
4 practice by the threat of malpractice litigation; 3. Order tests or consultations simply to avoid the  
5 appearance of malpractice; and 4. Ask for consultant opinions primarily to reduce my risk of  
6 being sued. Responses to all four items were recorded on five point scales ranging from  
7 “Strongly Disagree” (1) to “Not Sure” (3) to “Agree Strongly (5); thus, higher scores indicated  
8 greater concerns about malpractice.

### 9 **Mediating Variable**

10 *HIT availability.* The HTPS included seventeen questions about the availability of  
11 electronic health records (EHR) and various HIT applications, such as ordering laboratory tests,  
12 exchanging clinical data with other physicians, hospitals or laboratories, and electronically  
13 transmitting prescriptions to pharmacies (See Appendix 1 for the list of HIT applications). The  
14 response categories were: “yes, application is available”, or “no, application is not available”. A  
15 summated scale was developed from these 17 questions to obtain a single variable (range 0 to  
16 17) reflecting the health information technology (HIT) availability in a physician’s practice.

### 17 **Moderating Variable**

18 *Practice type.* Practice type was included as a moderating variable and was measured  
19 through a series of dummy variables: solo/2physicians ; group with 3 physicians or more; and  
20 hospital-based practices.

### 21 **Control Variables**

22 We also included the following control variables: physician demographic characteristics  
23 (gender, race), professional characteristics (specialty, years in practice) and practice

1 characteristics (practice type). Gender was operationalized as a binary variable, where male was  
2 coded as one and female coded as zero. Race was specified as a binary variable representing  
3 non-Hispanic white coded as one and others coded as zero. Specialty was coded as a binary  
4 variable, where primary care provider (PCP) is coded as one and the rest are coded as zero.

## 5 **Analytic Strategy**

6         The unit of analysis was the physician practice. This was driven by the fact that HTPS  
7 survey asks respondents both physician level (e.g. specialty, years in practice) and practice level  
8 attributes (e.g. HIT availability) and the primary items of interest for this paper were practice  
9 level attributes. A multivariable subgroup path analysis was used to analyze the mediating role of  
10 HIT availability in the relationship between the external environment and amount of e-mail  
11 communication. A multivariable path analysis is an extension of multiple regression that enables  
12 researchers to test a theory of causal ordering among a set of variables (e.g., X causes Y and Y  
13 causes Z) by treating these relationships as a system of regression models whose parameters and  
14 standard errors are estimated simultaneously (MacKinnon, 2008). A multivariable path analysis  
15 has several advantages over the causal steps approach (e.g. Baron & Kenny, 1986). First,  
16 simulation studies have shown that the causal steps approach has low power relative to other  
17 methods for testing indirect effects (Fritz & MacKinnon, 2008). Second, studies have shown that  
18 it is possible to detect significant indirect effects in the absence of direct effects between the  
19 constituent paths, a precondition in the causal steps approach (Hayes, 2009; Zhao, Lynch, &  
20 Chen, 2010). Finally, the causal steps approach typically entails using the Sobel test to make  
21 inferences about the statistical significance of indirect effects, which requires an assumption that  
22 the sampling distribution of the indirect effect is normal but is often not the case (Bollen & Stine,  
23 1992). Newer methods such as bootstrapping provide tests that do not require such assumptions.

1 Thus, multivariable path analysis provides a more parsimonious yet comprehensive approach to  
2 analyzing both direct and indirect effects of exogenous variables. Results are presented as  
3 standardized regression coefficients and odds ratios to facilitate comparisons across variables.

#### 4 **FINDINGS**

5 Physician, practice and environmental characteristics are presented in Table 1.  
6 Respondents were predominately male (71.9%), White (74.7%), and board certified in their  
7 practice specialty (91%). More than half of the responding physicians were working in a practice  
8 with more than three physicians (55.8%) and nearly half (47.3%) were primary care physicians  
9 (PCPs). The mean community income across markets was \$41,129.

10 **INSERT TABLE 1 ABOUT HERE**

11 Less than 5% of physician respondents reported spending more than 30 minutes e-  
12 mailing patients. In comparison, 21.2% of all physician respondents reported spending more than  
13 30 minutes e-mailing other providers. Solo/2-person practices were more likely to report no e-  
14 mail communication with patients (79.1%) compared to group practices (73.6%) and hospital-  
15 based practices (71.2%;  $\chi^2=23.5$ ,  $p<0.01$ ; Table 2). Similarly, solo/2-person practices were more  
16 likely to report no e-mail communication with other providers (67.8%) compared to group  
17 practices (39.6%) and hospital-based physicians (21.0%;  $\chi^2=381.5$ ,  $p<0.001$ ). On average,  
18 physician practices reported 7.1 HIT capabilities available (SD=4.0, range=0-14). A one-way  
19 analysis of variance (ANOVA) indicates that solo/2-person practices had significantly fewer IT  
20 capabilities available (M=5.8, SD=4.0) compared to group (M=7.71, SD=3.9) and hospital-based  
21 (M=7.9, SD=3.7) practices (F=77.6,  $p<0.001$ ).

22 **INSERT TABLE 2 ABOUT HERE**

1 Overall, the analysis suggests that environmental characteristics are indirectly associated  
2 with e-mail communication via HIT availability, although the indirect relationships are more  
3 pronounced for certain environmental dimensions and practice types. Detailed results for each  
4 dimension and practice type are presented below.

5 *Munificence.* Hypothesis 1 was not supported by our analysis. Higher levels of  
6 community income were negatively associated email communication with patients (OR= 0.99,  
7  $p<0.001$ ) and providers (OR= 0.99,  $p<0.001$ ) when mediated by HIT availability of the practice.  
8 This was because higher levels of community income were associated with lower HIT  
9 availability (OR=0.95,  $p<0.001$ ). Similarly, solo physicians practicing in more munificent  
10 environments, when measured as receiving financial incentives for engaging in communication  
11 activities, were more likely to report e-mail with other physicians (OR= 1.14,  $p<0.005$ ), but the  
12 indirect relationships between reimbursement and e-mail communication were not statistically  
13 significant.

14 *Dynamism.* Hypothesis 2 was partially supported by our analysis. Specifically, an  
15 increase in the unemployment rates decreased e-mail communication with patients (OR=0.98,  
16  $p<0.5$ ) and other providers (OR=0.99,  $p<0.5$ ), when mediated by HIT availability, but only for  
17 group practice physicians. Contrary to our prediction, an increase in the poverty rates increased  
18 e-mail communication with patients (OR=1.20,  $p<0.05$ ) and other providers (OR=1.01,  $p<0.05$ ),  
19 when mediated by HIT availability, but again only for group practice physicians.

20 *Complexity.* Our analysis found the strongest support for Hypothesis 3. Solo and hospital-  
21 based physicians who expressed greater concerns about the malpractice environment reported  
22 lower HIT availability, which in turn, was associated with lower likelihood of e-mail  
23 communication with patients (solo: OR=0.97,  $p<0.05$ ) and other providers (solo: OR=0.97,

1 p<0.05; hospital-based: OR=0.75, p<0.001). Contrary to our predictions, group-based physicians  
2 who expressed greater concerns about the malpractice environment reported more robust HIT  
3 availability, which was associated with a greater likelihood of e-mail communication with  
4 patients (OR=1.03, p<0.05) and other providers (OR=1.02, p<0.01).

5 INSERT TABLE 3 ABOUT HERE

6 **DISCUSSION**

7 One important finding of our study was that measures of environmental complexity were  
8 most consistently associated with physician e-mail communication, even when mediated by HIT  
9 availability. We found that solo and hospital-based physicians who expressed greater concerns  
10 about the malpractice environment reported lower HIT availability, which in turn, was associated  
11 with lower likelihood of e-mail communication with patients and other providers. This finding is  
12 congruent with previous research (Bertram, Hershey, Opila, & Quirin, 1990; Menachemi et al.,  
13 2012) that suggests more complex environments can create “distractions”, such as fear of  
14 potential lawsuits, and adversely impact decision-making processes and daily activities.  
15 Although HIT, and electronic health records (EHR) in particular, can facilitate legal and  
16 regulatory compliance (Agrawal, 2002) by confidentially storing patient records, our results  
17 indicate that solo and hospital-based physicians practicing in more complex markets either are  
18 not be aware of these benefits or have yet to take advantage of them.

19 Our findings with respect to other environmental dimensions were more mixed.  
20 Specifically, measures of environmental munificence exhibited significant indirect relationships  
21 with e-mail communication, but in the opposite direction of what was predicted. One potential  
22 explanation for this finding is that physicians who are located in higher income communities  
23 may care for healthier patients with lower demands to for engaging in extensive communication

1 and care coordination. Consequently, these practices may invest fewer resources into building  
2 robust HIT systems used for e-mail communication with patients and other providers.

3 Finally, our findings suggest that certain practice types are more sensitive to their  
4 external environment than others. Specifically, solo practices appeared to be the most responsive  
5 to changes in their environment in ways that affected their e-mail communication with patients  
6 and other providers, even when mediated by HIT availability. This could be due to fewer  
7 resources available to this practice type. Although the HITECH Act is intended to address certain  
8 financial barriers to HIT adoption, the impact of this legislation may be attenuated because of  
9 certain market factors that play a particularly important role for practices with fewer resources.

10 Several limitations should be considered when interpreting our findings. First, although  
11 resource-dependency theory is widely used in the strategic management literature, it may not be  
12 exhaustive in capturing a physician practice's environment (Yeager et al., 2014). Second, the  
13 data presented are cross-sectional, thus we are not able to comment on the causality of the  
14 relationships. Third, our study used "self-reported" measures of communication, which have  
15 notable limitations such as desirability bias. Future studies should consider using more objective  
16 measures of communication. Likewise, our measure of HIT availability was based on a sum of  
17 dichotomous items indicating the presence or absence of HIT capabilities and does not reflect the  
18 level of use or how long these capabilities have been used by a practice. Finally, we were not  
19 able to control for the patient population served by a given physician practice (e.g. demographic  
20 characteristics).

## 21 **PRACTICE IMPLICATIONS**

22 Our study revealed generally low levels of e-mail communication among physicians, with  
23 both patients and other physicians. Although more recent research is needed to assess whether

1 this is still the case, it seems plausible that circumstances have not changed so dramatically that  
2 electronic communication is commonly occurring among physicians. Such low levels suggest  
3 that, despite developments in HIT and increased policy attention toward promoting the use of  
4 HIT, more efforts, including non-technological ones, may be needed to promote e-mail  
5 communication by physicians. For example, renewed interest in new models of care such as the  
6 PCMH that emphasize care coordination and shared decision making with patients may remedy  
7 this problem. Likewise, reimbursement models that compensate physicians for e-mail  
8 consultations may also encourage greater use of electronic communication.

9       Regardless of the specific effort, our findings also indicate that “one size fits all”  
10 approaches to foster communication may not be as effective as desired. More specifically, our  
11 findings indicate that the mediational role of HIT availability varies by environmental  
12 dimension, with physicians who practice in more complex environments associated with less  
13 robust HIT availability, which, in turn, was associated with lower likelihood of e-mail  
14 communication. Such findings suggest that resource availability may not be the sole or even  
15 primary driver of HIT adoption and use and subsequent use of this technology to engage in  
16 electronic communication. Thus, policy makers and other sponsors and advocates of HIT may  
17 want to consider how the allocation of existing resources may influence decisions regarding HIT  
18 adoption and use. In particular, our analysis suggests that the malpractice environment may play  
19 a significant role in such decisions. Similarly, we found that solo practitioners’ e-mail  
20 communication patterns are most responsive to their external environment, even after the  
21 mediational role of HIT availability is taken into consideration. Thus, despite the efforts of the  
22 HITECH Act, payers and policy makers may want to reconsider how resources are allocated to  
23 this group of practitioners. Given the well-known barriers to HIT adoption, including high up-



1 front investment, payers and policy makers may want to consider more targeted, group specific  
2 policies that could influence providers' behaviors and communication patterns. This could  
3 include, but is not limited to, education and on-going support for HIT adoption and  
4 implementation or potential partnership with larger groups that are more successful in this realm.

## References

- Abdolrasulnia, M., Menachemi, N., Shewchuk, R. M., Ginter, P. M., Duncan, W. J., & Brooks, R. G. (2008). "Market effects on electronic health record adoption by physicians". *Health Care Management Review, 33*(3): 243-252.
- Agrawal, A. (2002). Return on investment analysis for a computer-based patient record in the outpatient clinic setting. *Journal of the Association for Academic Minority Physicians: the official publication of the Association for Academic Minority Physicians, 13*(3), 61-65.
- Arar, N., Wen, L., McGrath, J., Steinbach, R. & Pugh, J. (2005). Communicating about medications during primary care outpatient visits: the role of electronic medical records. *Informatics in Primary Care, 13* (1), 13–22.
- Area Resource File. 2008. <http://datawarehouse.hrsa.gov/arf.aspx>. Accessed December 2013
- Baron, R.M. and Kenny, D.A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173-1182.
- Bertram, D. A., Hershey, C. O., Opila, D. A., & Quirin, O. (1990). A measure of physician mental work load in internal medicine ambulatory care clinics. *Medical care, 11, (23)*, 458-467.
- Blumenthal, D. (2009). "Stimulating the adoption of health information technology." *New England Journal of Medicine, 360*(15): 1477-1479.
- Blumenthal, D. (2010). Launching HiteCH. *New England Journal of Medicine, 362*(5), 382-385
- Bollen, K.A. and R.A. Stine. (1992). Bootstrapping goodness-of-fit measures in structural equation models. *Sociological Methods & Research, 21*(2), 205-229.
- Centers for Medicare & Medicaid Services. (2012). EMR Incentive programs

Doi:[http://www.cms.gov/RegulationsandGuidance/Legislation/EMRIncentivePrograms/index.html?redirect=/EMRIncentivePrograms/01\\_Overview.asp](http://www.cms.gov/RegulationsandGuidance/Legislation/EMRIncentivePrograms/index.html?redirect=/EMRIncentivePrograms/01_Overview.asp). Accessed: December 2013

Castle, N. (2001). "Innovation in nursing homes: which facilities are the early adopters?" *The Gerontologist*, 41(2): 161-172.

Damschroder, L.J., Aron, D., Keith, R., Kirsh, S., Alexander, J.A., Lowerly, J.C. (2009). "Fostering implementation of health services research findings into practice: A consolidated framework for advancing implementation." *Implementation Science*, 4(50): 1-15.

Dess, G. G., & Beard, D. W. (1984). "Dimensions of organizational task environments." *Administrative Science Quarterly*, 29 (1): 52-73.

Forrest, C. B., Glade, G. B., Baker, A. E., Bocian, A., von Schrader, S., & Starfield, B. (2000). "Coordination of specialty referrals and physician satisfaction with referral care." *Archives of Pediatrics and Adolescent Medicine*, 154(5): 499-512.

Fritz, M.S. and MacKinnon, D.P. (2007). Required sample size to detect the mediated effect. *Psychological Science*, 18(3): 233-239.

Gupta, V. B., O'Connor, K. G., & Quezada-Gomez, C. (2004). "Care coordination services in pediatric practices." *Pediatrics*, 113:1517-1529.

Hayes, A.F. (2009). Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Communication Monographs*, 76(4): 408-420.

Health Tracking Physician Survey Methodology Report. (2008). Technical Publication No.77, doi:<http://www.hschange.org/CONTENT/1085/>. Accessed December 2013.

Houston TK, Sands DZ, Nash BR, Ford DE. Experiences of physicians who frequently use e-mail with patients. *Health Commun.* 2003;15(4):515-2

Hsieh, H. M., Clement, D. G., & Bazzoli, G. J. (2010). "Impacts of market and organizational characteristics on hospital efficiency and uncompensated care." *Health Care Management Review, 35(1): 77-87.*

Kazley, A. S., & Ozcan, Y. A. (2007). "Organizational and environmental determinants of hospital EMR adoption: A national study." *Journal of Medical Systems, 31(5): 375-384.*

Mazurenko, O., Hearld, L. (2015) "Environmental factors associated with physician' engagement in communication activities". *Health Care Management Review, 40(1), 79-89.*

MacKinnon, D. (2008). *Introduction to statistical mediation analysis.* Lawrence Erlbaum Associates: New York, NY.

Menachemi, N., Mazurenko, O., Kazley, A. S., Diana, M. L., & Ford, E. W. (2012). "Market factors and electronic medical record adoption in medical practices." *Health Care Management Review, 37 (1), 14-22.*

Menachemi, N., Shin, D. Y., Ford, E. W., & Yu, F. (2011). "Environmental factors and health information technology management strategy." *Health Care Management Review, 36(2), 1-12.*

Menachemi, N., Prickett, C. T., & Brooks, R. G. (2011). The use of physician-patient email: a follow-up examination of adoption and best-practice adherence 2005-2008. *Journal of medical Internet research, 13(1).*

Mettner J. The doctor is in (your inbox) *Minn Med.* 2009 Jan;92(1):10–1.

Meyer, J. W., & Scott, W. R. (1983). *Organizational environments: ritual and rationality.* Beverly Hills.

Milne, H., Huby, G., Buckingham, S., Hayward, J., Sheikh, A., Cresswell, K., & Pinnock, H. (2014). Does sharing the electronic health record in the consultation enhance patient

involvement? A mixed-methods study using multichannel video recording and in-depth interviews in primary care. *Health Expectations*, 12 (1), 23-34.

O'Malley, A.S., & Reschovsky, J. D. (2011). "Referral and consultation communication between primary care and specialist physicians: finding common ground." *Archives of Internal Medicine*, 171(1), 56-70.

Pham, H. H., O'Malley, A. S., Bach, P. B., Saiontz-Martinez, C., & Schrag, D. (2009). "Primary care physicians' links to other physicians through Medicare patients: the scope of care coordination." *Annals of Internal Medicine*, 150(4), 236-242.

Rao SR, Desroches CM, Donelan K, Campbell EG, Miralles PD, Jha AK. (2011). "Electronic health records in small physician practices: availability, use, and perceived benefits." *Journal of American Medical Association*, 118 (3), 271–275.

Rodriguez, H., von Glahn, T., Rogers, W., & Safran, D. (2009). "Organizational and Market Influences on Physician Performance on Patient Experience Measures." *Health Services Research*, 44(3), 880-892.

Schoen, C., Osborn, R., Huynh, P. T., Doty, M., Peugh, J., & Zapert, K. (2006). "On the front lines of care: primary care doctors' office systems, experiences, and views in seven countries." *Health Affairs*, 25(6), 555-571.

Shachak, A., & Reis, S. (2009). The impact of electronic medical records on patient–doctor communication during consultation: a narrative literature review. *Journal of evaluation in clinical practice*, 15(4), 641-649.

Thompson, J. (1967). *Organizations in action*. New York: McGraw-Hill.

Venkatraman, N., & Camillus, J. C. (1984). "Exploring the concept of " fit" in strategic management." *Academy of Management Review*, 9(3), 513-525.

Yeager, V., Menachemi, N., Savage, G., Ginter, P., Sen, B., Beitsch, L. (2014) Using Resource Dependency Theory to Measure the Environment in Health Care Organizational Studies: A Systematic Review of the Literature. *Health Care Management Review, 39(1)*, 50-65.

Zhao, X., Lynch, J.G. and Chen, Q. (2010). Reconsidering Baron and Kenny: Myths and truths about mediation analysis. *Journal of Consumer Research, 37(2)*: 197-206.

Zinn, J. S., Proenca, J., & Rosko, M. D. (1997). "Organizational and environmental factors in hospital alliance membership and contract management: a resource-dependence perspective." *Hospital Health Services Administration, 42(1)*, 67-86.

Zinn, J.S., Weech, R.J., Brannon, D. (1998). "Resource dependence and institutional elements in nursing home TQM adoption." *Health Services Research, 33(2)*, 261-273.

Table 1. Physician and environmental characteristics of the sample (N=2,850)

	<i>All practices</i>
<i>Amount of communication with patients and other providers</i>	
E-mail communications with patients	<i>Frequency (%)</i>
< 30 minutes	2,722 (95.5%)
> 30 minutes	128 (4.5%)
E-mail communication with physicians	
< 30 minutes	2,246 (78.8%)
> 30 minutes	604 (21.2%)
	<i>Mean (S.D.)</i>
<i>IT availability</i>	7.2 (4.0)
<i>Environmental Characteristics</i>	
	<i>Mean (S.D.)</i>
Per Capita Income in 2006	41,129 (11,853)
Number of activities reimbursed	1.12 (0.63)
Perceived competition	2.10 (0.73)
Perceived malpractice	3.67 (1.00)
Change in % of people below federal poverty (2002 to 2007)	-0.77 (1.89)
Change in unemployment rate (2002 to 2007)	1.12 (1.30)
<i>Physician Characteristics</i>	
	<i>Frequency (%)</i>
<i>Gender</i>	
Male	2,048 (71.9%)
Female	802 (28.1%)
Mean years in practice (SD)	16.5 (9.6)
<i>Specialty</i>	
Primary Care Provider	1,348 (47.3%)
Other	1,502 (52.7%)
Board Certified	2,593 (91.0%)
<i>Practice Type</i>	
Solo/2 physicians	887 (31.1%)
Group>=3 physicians	1,591 (55.8%)
Hospital-owned	372 (13.1%)
<i>Race</i>	
White	2,128 (74.7%)
Other	722 (25.3%)

Table 2. Comparison of communication and IT availability by practice type (N=2,850)

	Solo/2 person practices	Group practices	Hospital-based practices	Test statistic
IT availability (M / SD)	5.8 (4.0) <sup>2,3</sup>	7.7 (3.9) <sup>1</sup>	7.9 (3.7) <sup>1</sup>	F=77.6, p<0.001
E-mail with patients (N / %)				$\chi^2 = 23.5, p<0.01$
0 (none)	702 (79.1%)	1,171 (73.6%)	265 (71.2%)	
1 (<30 minutes)	138 (15.6%)	358 (22.5%)	88 (23.7%)	
2 (30-60 minutes)	35 (4.0%)	51 (3.2%)	14 (3.8%)	
3 (1-2 hours)	8 (0.9%)	7 (0.4%)	4 (1.1%)	
4 (> 2 hours)	4 (0.5%)	4 (0.3%)	1 (0.3%)	
E-mail with physicians (N / %)				$\chi^2 = 381.5, p<0.001$
0 (none)	601 (67.8%)	630 (39.6%)	78 (21.0%)	
1 (<30 minutes)	199 (22.4%)	612 (38.5%)	126 (33.9%)	
2 (30-60 minutes)	56 (6.3%)	229 (14.4%)	87 (23.4%)	
3 (1-2 hours)	30 (3.4%)	77 (4.8%)	52 (14.0%)	
4 (> 2 hours)	1 (0.1%)	43 (2.7%)	29 (7.8%)	

<sup>1</sup> Significantly different than solo/2-person practices at p<0.05.

<sup>2</sup> Significantly different than group practices at p<0.05.

<sup>3</sup> Significantly different than hospital-based practices at p<0.05.



Table 3. Multivariable subgroup path analysis: mediating role of HIT availability (N=2,850)

	<i>Solo Practitioner B (OR)</i>	<i>Group Practice B (OR)</i>	<i>Hospital-based B (OR)</i>
<b><i>Environmental Munificence</i></b>			
Per capita income → Time emailing patient	0.028*** (1.03)	0.007 (1.01)	0.021 (1.02)
Per capita income → IT Cap → Time emailing patient	-0.005** (0.99) <sup>2,3</sup>	0.001 (1.00) <sup>1</sup>	0.001 (1.00) <sup>1</sup>
<i>Total effect of per capita income on time emailing patient</i>	0.023 (1.02)	0.009 (1.01)	0.022 (1.02)
Per capita income → Time emailing other physicians	0.019** (1.02) <sup>2</sup>	-0.001 (0.99) <sup>1</sup>	0.005 (1.01)
Per capita income → IT Cap → Time emailing other physicians	-0.005*** (0.99) <sup>2,3</sup>	0.001 (1.00) <sup>1</sup>	-0.001 (0.99) <sup>1</sup>
<i>Total effect of per capita income on time emailing other physicians</i>	0.014 (1.01)	-0.001 (0.99)	0.004 (1.01)
Reimbursement → Time emailing patient	-0.177 (0.84)	0.310 (1.36)	-0.135 (0.87)
Reimbursement → IT Cap → Time emailing patient	0.043 (1.04)	-0.014 (0.99)	0.001 (1.00)
<i>Total effect of per capita income on time emailing patient</i>	-0.134 (0.87)	0.297 (1.35)	-0.134 (0.87)
Reimbursement → Time emailing other physicians	0.132** (1.14)	0.186 (1.20)	0.063 (1.07)
Reimbursement → IT Cap → Time emailing other physicians	0.044 (1.04)	-0.011 (0.99)	0.008 (1.01)
<i>Total effect of per capita income on time emailing other physicians</i>	0.176 (1.19)	0.175 (1.19)	0.071 (1.07)
<b><i>Environmental Dynamism</i></b>			
Change in unemployment → Time emailing patient	0.124 (1.13) <sup>2,3</sup>	0.115 (1.12) <sup>1</sup>	0.129 (1.14) <sup>1</sup>
Change in unemployment → IT Cap → Time emailing patient	-0.014 (0.99)	-0.017* (0.98)	0.003 (1.00)
<i>Total effect of change in unemployment on time emailing patient</i>	0.111 (1.12)	0.097 (1.10)	0.132 (1.14)
Change in unemployment → Time emailing other physicians	0.047 (1.05)	-0.036 (0.96) <sup>3</sup>	0.138* (1.15) <sup>2</sup>
Change in unemployment → IT Cap → Time emailing other physicians	-0.014 (0.99) <sup>3</sup>	-0.013* (0.99) <sup>3</sup>	0.020 (1.02) <sup>1,2</sup>
<i>Total effect of change in unemployment on time emailing other physicians</i>	0.033 (1.03)	-0.049 (0.95)	0.158** (1.17)
Change in poverty → Time emailing patient	-0.029 (0.97)	-0.078 (0.92)	0.003 (1.00)
Change in poverty → IT Cap → Time emailing patient	-0.006 (0.99) <sup>2</sup>	0.018** (1.20) <sup>1,3</sup>	-0.002 (0.99) <sup>2</sup>

<i>Total effect of change in poverty on time emailing patient</i>	-0.035 (0.97)	-0.060 (0.94)	0.001 (1.00)
Change in poverty → Time emailing other physicians	-0.040 (0.96) <sup>2</sup>	-0.181*** (0.83) <sup>1,3</sup>	-0.049 (0.95) <sup>2</sup>
Change in poverty → IT Cap → Time emailing other physicians	-0.006 (0.99) <sup>2</sup>	0.014** (1.01) <sup>1,3</sup>	-0.014 (0.99) <sup>2</sup>
<i>Total effect of change in poverty on time emailing other physicians</i>	-0.046 (0.96)	-0.167*** (0.85)	-0.063 (0.94)
<b>Environmental Complexity</b>			
Malpractice → Time emailing patient	0.011 (1.01)	-0.165** (0.85) <sup>3</sup>	0.094 (1.10) <sup>2</sup>
Malpractice → IT Cap → Time emailing patient	-0.026* (0.97) <sup>2,3</sup>	0.031** (1.03) <sup>1,3</sup>	0.001 (1.00) <sup>1,2</sup>
<i>Total effect of malpractice on time emailing patient</i>	-0.015 (0.99)	-0.134* (0.87)	0.095 (1.10)
Malpractice → Time emailing other physicians	-0.018 (0.98)	-0.134*** (0.87) <sup>3</sup>	-0.296*** (0.74) <sup>2</sup>
Malpractice → IT Cap → Time emailing other physicians	-0.027* (0.97) <sup>2</sup>	0.024*** (1.02) <sup>1</sup>	0.007 (1.01)
<i>Total effect of malpractice on time emailing other physicians</i>	0.045 (1.05)	-0.110** (0.90)	-0.290*** (0.75)
Competition → Time emailing patient	0.036 (1.04)	-0.005 (0.99)	0.206 (1.23)
Competition → IT Cap → Time emailing patient	-0.013 (0.99)	-0.003 (0.99)	0.005 (1.01)
<i>Total effect of competition on time emailing patient</i>	0.414 (1.51)	-0.008 (0.99)	0.211 (1.23)
Competition → Time emailing other physicians	0.144 (1.15)	0.124* (1.13)	0.053 (1.05)
Competition → IT Cap → Time emailing other physicians	-0.013 (0.99)	-0.002 (0.99)	0.029 (1.03)
<i>Total effect of competition on time emailing other physicians</i>	0.131 (1.14)	0.122 (1.13)	0.082 (1.09)
Specialists per capita → Time emailing patient	-0.992*** (0.37) <sup>2,3</sup>	0.047 (1.05) <sup>1</sup>	-0.251 (0.78) <sup>1</sup>
Specialists per capita → IT Cap → Time emailing patient	0.032 (1.03)	-0.021 (0.98)	0.003 (1.00)
<i>Total effect of specialists per capita on time emailing patient</i>	-0.960*** (0.38)	0.025 (1.03)	-0.248 (0.78)
Specialists per capita → Time emailing other physicians	-0.121 (0.89)	-0.193* (0.82) <sup>3</sup>	0.121 (1.13) <sup>2</sup>
Specialists per capita → IT Cap → Time emailing other physicians	0.034 (1.03)	-0.017 (0.98)	0.019 (1.02)
<i>Total effect of specialists per capita on time emailing other physicians</i>	-0.088 (0.92)	-0.210* (0.81)	0.140* (1.15)
<sup>1</sup> Significantly different than solo practices.			
<sup>2</sup> Significantly different than group practices.			
<sup>3</sup> Significantly different than hospital-based practices *p<0.05; **p<0.01; ***p<0.01			

**Figure 1.** Relationship between external environment, HIT availability and communication:

