

# Health Information Technology and Physicians' Perceptions of Healthcare Quality

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**Objectives:** To investigate the relationship between the use of health information technology (HIT) and physician perceptions of providing high-quality care and to determine whether this relationship has changed over time.

**Study Design:** We used 2 waves of longitudinal data from the Community Tracking Study Physician Surveys, 2000-2001 and 2004-2005.

**Methods:** Three measures of HIT were examined: a binary variable measuring the use of at least 1 type of HIT, a continuous variable measuring the total number of HIT types, and a binary variable measuring use of all 5 HIT types related to "meaningful use" of HIT as defined by Centers for Medicare & Medicaid Services. Three multivariate models were estimated to study the effect of each HIT measure on physicians' perception of providing high-quality care. Individual fixed-effects estimation also was used to control for individual time-invariant factors.

**Results:** Using at least 1 type of HIT significantly enhanced physicians' perception of providing high-quality care in 2000-2001, but not in 2004-2005. The marginal effect of adding 1 extra HIT type was positive and statistically significant in both periods. The association between using all 5 HIT types related to meaningful use and perceived quality was statistically significant in 2000-2001, but not in 2004-2005.

**Conclusions:** Health information technology has become a multifunctional system and appears to have enhanced physicians' perception of providing high-quality care. Physicians' perceptions of medical care quality improved as the number of HIT types used increased. This study supports more extensive use of HIT in physician practices.

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The Institute of Medicine has identified health information technology (HIT) as one of the most significant tools to improve healthcare quality in the United States.<sup>1</sup> Health information technology is defined as the use of information and communication functions to support the delivery of patient care and patient self-management.<sup>2</sup> Health information technology has become an integrated and multifunctional system<sup>3</sup> that includes personal electronic health records (EHRs), e-mail communication between providers and patients, clinical alerts and reminders, computerized decision support systems, handheld devices, and other technologies that store, protect, retrieve, and transfer clinical and administrative information electronically within the healthcare setting.<sup>2</sup> Since physicians play a critical role in the delivery of healthcare services, HIT has been touted as having the potential to enhance their ability to provide high-quality care to patients.<sup>4</sup>

The determinants of physicians' adoption of HIT have been studied extensively.<sup>5-16</sup> Previous studies have shown that HIT adoption rates vary considerably by physician specialty,<sup>5</sup> practice types,<sup>8,9</sup> practice revenues,<sup>7</sup> patients' characteristics,<sup>11</sup> regional location of the practice,<sup>6</sup> and other factors.<sup>8,10,12-16</sup> A number of programs have been implemented to help bridge gaps in HIT adoption rates.<sup>17-29</sup>

Although the benefits of HIT are significant in theory, empirical evidence of its effects on healthcare outcomes is rather limited.<sup>30-32</sup> This study seeks to understand the relationship between the adoption of HIT in medical practices and physicians' perceptions of their ability to provide quality care to their patients.

## METHODS

### Data and Sample

We used data from the Community Tracking Study (CTS) Physician Surveys maintained at the Center for Studying Health System Change.<sup>33</sup> The survey sample includes 11,963 physicians in 2000-2001 and 6306 physicians in 2004-2005. Due to cost considerations, the 2004-2005 CTS survey sampled 50% fewer physicians than the 2000-2001 survey. The response rate of CTS Physician Surveys ranged from approximately 50% to 60%.<sup>34</sup>

The CTS survey comprises a nationally representative sample

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of physicians in the United States.<sup>35</sup> Physicians were selected from 51 metropolitan areas and 9 nonmetropolitan areas, using a probabilistic stratified sampling strategy and including physicians who engaged in direct patient care for at least 20 hours per week. The survey questions asked about use of HIT in physicians' practices, perception of the physician's ability to provide quality care to patients, and a variety of physician and practice characteristics.

### Variables

**Perception of Providing High-Quality Care.** This measure is based on physicians' response to questions about their perceptions of providing quality care. Each physician was asked his or her opinion regarding the following statement: "It is possible to provide high-quality care to all of my patients." Physician responses were based on a 5-point scale of (1) agree strongly, (2) agree somewhat, (3) neither agree nor disagree, (4) disagree somewhat, and (5) disagree strongly. We constructed a binary measure of being able to provide high-quality care equal to 1 if the physician responded either 1 or 2 on the scale and equal to 0 otherwise.

**Health Information Technology Variables.** Physicians from both waves were queried about the use of 7 HIT types. Specifically, physicians were asked if they used HIT to (1) obtain information about treatment alternatives or recommended guidelines; (2) exchange clinical data and images with other providers; (3) access patient progress notes, medication lists, or problem lists; (4) obtain information on formularies; (5) write prescriptions; (6) generate reminders about preventive services; and (7) communicate about clinical issues with patients by e-mail.

In order to promote the adoption of HIT in physician practices, the Centers for Medicare & Medicaid Services recently offered Medicare and Medicaid EHR Incentive Programs, which specify 3 main components of Meaningful Use Requirements: the use of a certified EHR in a meaningful manner (eg, e-prescribing); the use of certified EHR technology for electronic exchange of health information to improve quality of healthcare; and the use of certified EHR technology to submit clinical quality and other measures.<sup>21</sup> Among the 7 HIT types we studied, the first 5 types described above appear to align most closely with these Meaningful Use Requirements. This study examines the effects of HIT implementation by testing the following hypotheses: (1) whether using at least 1 type of HIT enhances physicians' perceived ability to provide high-quality care; (2) whether the addition of 1 extra HIT type improves physicians' perception of quality care; and (3) whether using all 5 HIT types related to

### Take-Away Points

Data from the CommunityTracking Study Physician Surveys were used to examine the relationship between use of health information technology (HIT) and physician perceptions of providing high-quality care.

- Using at least 1 type of HIT enhanced physicians' perceived ability to provide high-quality care in 2000-2001, but not in 2004-2005.
- The more types of HIT that were adopted, the more likely physicians were to perceive the ability to provide high-quality care in both periods.
- Although most US physicians did not use HIT extensively in their practices, it appeared to promote quality of care.

the Meaningful Use Requirements enhances physicians' perceived ability to provide high-quality care. In addition, we investigated whether these relationships changed over time by comparing the estimated marginal effects of HIT between the 2 time periods considered.

**Other Explanatory Variables.** We also controlled for physician and practice characteristics that may affect the physician's perception of healthcare quality. These characteristics included sex; race (white or nonwhite); the physician's specialty (internal medicine, family/general practice, pediatrics, medical specialties, surgical specialties, psychiatry, and obstetrics and gynecology); board certification status; foreign medical graduate status; years of practice experience; yearly practice income; practice ownership (not an owner, part owner, or full owner); practice type (solo or 2 physicians, group with 3 or more physicians, health maintenance organizations (HMOs), medical school, hospital, or other practice type); percentage of practice revenues from Medicare, Medicaid, and managed care; and the competitive status of the physicians' market area (not competitive, somewhat competitive, or very competitive). In addition, we included geographic indicators (60 CTS survey sites) to account for potentially relevant but unobserved geographic characteristics that could influence the adoption of HIT and/or physician perceptions about quality of care.<sup>7</sup>

### Statistical Analysis

Bivariate analysis began with a student *t* test for continuous variables and a  $\chi^2$  test for categorical variables to examine the use of HIT and physicians' perceived ability to provide high-quality care. Multivariate probit regression was used to examine the effects of HIT types, using Stata version 11 (StatCorp LP, College Station, TX) for statistical analyses.

The adoption of HIT is potentially endogenous, as some unobserved factors may lead physicians to choose some specific HIT types. Just using HIT may lead physicians to think that they provide high-quality care when in fact they do not. Reverse causality is another potential reason for endogeneity. Endogeneity may bias the coefficient estimates for the HIT types upward. But given the number of different information

■ **Table 1.** Descriptive Statistics by Survey Year<sup>a</sup>

Variable	2000-2001 (n = 11,963) <sup>a,b</sup>	2004-2005 (n = 6306) <sup>a,b</sup>	Minimum	Maximum	P <sup>b</sup>
<b>Able to provide high-quality care to patients</b>	78	79	0	1	.15
<b>Use at least 1 HIT type (binary)</b>	75	85	0	1	<.01
<b>HIT types used, No. (SD)</b>	2.11 (1.85)	2.85 (1.99)	0	7	<.01
<b>Use HIT type to:</b>					
Obtain information about treatment alternatives or recommended guidelines	52	66	0	1	<.01
Exchange clinical data and image	38	49	0	1	<.01
Access patient notes, medication lists, or problem lists	34	48	0	1	<.01
Obtain information on formularies	30	46	0	1	<.01
Write prescriptions	12	23	0	1	<.01
Generate reminders about preventive services	25	29	0	1	<.01
Communicate about clinical issues with patients by e-mail	20	24	0	1	<.01
<b>Use all 5 HIT types related to the Meaningful Use Requirements (binary)<sup>c</sup></b>	4	11	0	1	<.01

HIT indicates health information technology.

<sup>a</sup>Values are percentages unless indicated otherwise. Data source: references 34 and 35.

<sup>b</sup>Student *t* test for continuous variables and  $\chi^2$  test for categorical variables between 2000-2001 and 2004-2005.

<sup>c</sup>The HIT types related to the Meaningful Use Requirements: obtain information about treatment alternatives or recommended guidelines; exchange clinical data and image; access patient notes, medication lists, or problem lists; obtain information on formularies; and write prescriptions.

technology measures and the lack of available instruments, instrumental variables estimation was not feasible. Instead, we estimated additional models that attempt to control for confounders adequately so that endogeneity concerns might be mitigated. First, we pooled 2 waves together as a panel, because we could identify the same physicians in 2 waves (6194 physicians in both 2000-2001 and 2004-2005 as the panel sample). Then we estimated all models described above by fixed-effects estimation. Probit estimation is not available for fixed effects, so we use the fixed-effects linear probability estimation as an alternative. The fixed-effects estimation helped us control for unobserved time-invariant physician characteristics and estimate the within-physician impact of HIT adoption on perceived quality with a linear probability model.<sup>36</sup>

## RESULTS

**Table 1** compares the 2 waves in the CTS Physician Surveys with respect to sample characteristics. The percentage of physicians who were able to provide high-quality care to all patients did not differ significantly between the 2 time periods (78% in 2000-2001 and 79% in 2004-2005). The proportion of physicians using at least 1 type of HIT in their

practice increased significantly, from 75% in 2000-2001 to 85% in 2004-2005 ( $P < .01$ ). The average number of HIT types used in 2000-2001 was 2.11. This number increased to 2.85 in 2004-2005 ( $P < .01$ ). In 2000-2001, only about 4% of physicians used all 5 HIT types related to the Meaningful Use Requirements, but this percentage increased to 11% in 2004-2005.

**Table 2** shows selected results of adopting at least 1 HIT type, using a binary measure. In 2000-2001, the use of at least 1 HIT type significantly increased the probability of physicians' perceptions of providing high-quality care by 1.85% ( $P = .04$ ). However, in 2004-2005, this marginal effect was reduced to 0.21% ( $P = .88$ ). The effect of having at least 1 type of HIT was not statistically significant in the fixed-effects model ( $P = .36$ ).

Adding an extra HIT type increased this probability by 0.71% ( $P < .01$ ) in 2000-2001 and by 0.62% ( $P = .03$ ) in 2004-2005. The marginal effect of HIT on perceived quality of care only diminished slightly from 2000-2001 to 2004-2005, even though physicians substantially increased the use of HIT in their practices. The fixed-effects estimation produced a larger effect: 0.86% ( $P < .01$ ).

**Table 2** also shows selected results from using all 5 HIT types related to the Meaningful Use Requirements. In 2000-

■ **Table 2.** Selected Results of Multivariate Estimation by Survey Year

Variable	Probit Estimation, %						Fixed-Effects Estimation, %		
	2000-2001			2004-2005			2000-2001 and 2004-2005		
	Marginal Effect	SE	P	Marginal Effect	SE	P	Coefficient	SE	P
<b>Model 1</b>									
Use at least 1 HIT type (binary)	1.85	0.91	.04	0.21	1.48	.88	1.35	1.46	.36
<b>Model 2</b>									
Number of HIT types used (continuous)	0.71	0.22	<.01	0.62	0.28	.03	0.86	0.31	<.01
<b>Model 3</b>									
Use all HIT functions related to Meaningful Use Requirements (binary)	4.41	1.77	.02	1.96	1.72	.27	0.94	1.88	.62

HIT indicates health information technology.

2001, the marginal effect was 4.41% ( $P = .02$ ) if physicians used all of these 5 HIT types, but it was not statistically significant in 2004-2005. The results from fixed-effects estimation were also not statistically significant.

Due to multicollinearity issues, we were unable to include 7 dummy variables for each HIT type in 1 equation. However, in an attempt to ascertain which HIT types might be included within the same regression model, we also performed stepwise regression (forward selection) by adding each HIT type into the estimation and requiring a 0.2 significance level for retaining an independent variable. In 2000-2001, only 2 HIT types were chosen by the forward selection: exchange clinical data and image ( $P < .01$ ) and communicate about clinical issues with patients by e-mail ( $P = .11$ ). In 2004-2005, only the HIT types of communicating about clinical issues with patients by e-mail ( $P < .01$ ) and accessing patient notes, medication lists, or problem lists ( $P = .11$ ) were selected. Due to space considerations, the stepwise regression results are not reported here, but are available from the authors upon request.

Health information technology is used much less in private practice settings than it is in hospitals, HMOs, and medical schools; hence, the effects of HIT may vary across settings. To investigate this issue, we reestimated our empirical models individually for 3 types of physician practice settings: solo or 2-physician private group practice (4126 physicians in 2000-2001 and 2116 physicians in 2004-2005); private group practice with 3 or more physicians (3503 physicians in 2000-2001 and 1834 physicians in 2004-2005); and practice in HMOs, medical schools, hospitals, or other settings (4334 physicians in 2000-2001 and 2356 physicians in 2004-2005). We found that HIT did not enhance physicians' perceptions of healthcare quality in the first 2 types of pri-

vate practices under any of the estimation strategies reported in Table 2, but significantly improved quality perceptions in HMOs, medical schools, hospitals, or other settings ( $P < .05$  in every case). Adoption of HIT in private practices is very limited in the United States, but considerably higher in other settings, which are more heavily subsidized for adopting these technologies. These differential adoption rates may help to explain the above results.

## DISCUSSION

Health information technology is considered a potentially important way to improve the efficiency and quality of healthcare in the United States.<sup>5-16</sup> However, there remain wide variations in HIT adoption rates among physicians.<sup>26-29</sup> Few empirical studies have directly examined the relationship between the adoption of HIT and healthcare quality.<sup>32</sup> Using a nationally representative longitudinal data set, we found that HIT appears to promote quality of care.

Our results must be interpreted with caution, however. First, this study was limited by having only physicians' perceptions of providing high-quality care. We cannot measure the actual quality provided to patients. Second, this study did not completely address the endogeneity of HIT adoption. Third, unobserved heterogeneity across physician practice settings may have affected the relationship between HIT and perceived quality of care. Finally, the significance levels in our results may have reflected the large sample size; thus, the practical significance should be evaluated carefully.

This study is a first attempt at investigating the relationship between the adoption of HIT and physicians' perceptions of healthcare quality. Further research is needed to determine whether this relationship is truly a causal one.

Future work should also focus on which HIT type has the greatest effect on quality of care and how quality of care itself can be measured more accurately.

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