Prevalence of Basic Information Technology Use by U.S. Physicians

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BACKGROUND: Information technology (IT) has been advocated as an important means to improve the practice of clinical medicine.

OBJECTIVES: To determine current prevalence of non-electronic health record (EHR) IT use by a national sample of U.S. physicians, and to identify associated physician, practice, and patient panel characteristics.

DESIGN, SETTING, AND PARTICIPANTS: Survey conducted in early 2004 of 1,662 U.S. physicians engaged in direct patient care selected from 3 primary care specialties (family practice, internal medicine, pediatrics) and 3 nonprimary care specialties (anesthesiology, general surgery, cardiology).

MEASUREMENTS: Self-reported frequency of e-mail communication with patients or other clinicians, online access to continuing medical education or professional journals, and use of any computerized decision support (CDS) during clinical care. Survey results were weighted by specialty and linked via practice zip codes to measures of area income and urbanization.

RESULTS: Response rate was 52.5%. Respondents spent 49 (± 19) (mean [± standard deviation]) hours per week in direct patient care and graduated from medical school 23 (± 11) years earlier. "Frequent" use was highest for CDS (40.8%) and online professional journal access (39.0%), and lowest for e-mail communication with patients (3.4%). Ten percent of physicians never used any of the 5 IT tools. In separate logistic regression analyses predicting usage of each of the 5 IT tools, the strongest associations with IT use were primary care practice (adjusted odds ratios [aORs] ranging from 1.34 to 2.26) and academic practice setting (aORs 2.17 to 5.41). Years since medical school graduation (aOR 0.85 to 0.87 for every 5 years after graduation) and solo/2-person practice setting (aORs 0.21 to 0.55) were negatively associated with IT use. Practice location and patient panel characteristics were not independently associated with IT use.

CONCLUSIONS: In early 2004, the majority of physicians did not regularly use basic, inexpensive, and widely available IT tools in clinical practice. Efforts to increase the use of IT in medicine should focus on practice-level barriers to adoption.

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Information technology (IT) has been heralded as a solution to many of the current problems in health care.[1] Moreover, pressure to modernize the current practice of medicine will continue to increase as the population ages and as chronic disease care becomes more complex.[2,3] In response to these trends, the Institute of Medicine and the U.S. government have both advocated greater adoption of new IT by health care providers as a means to reduce medical errors, improve communication between clinicians, and reduce the ever-increasing costs of care nationwide.[4,5]

Prior studies of health IT adoption have focused almost exclusively on electronic health records (EHRs) and have found low rates of EHR adoption (17% to 22%) nationwide.[6,7] While universal adoption of EHRs would require substantial capital investment,[8] relatively simple and inexpensive technologies such as e-mail and the internet are currently available to support clinical collaboration, communication with patients outside of clinical encounters, and access to information regarding the most recent advances in clinical medicine.[9,10]

Despite advocates' enthusiasm and the increasing availability of web-based clinical resources, there is evidence that the medical profession has been slow to adopt even the most basic IT tools.[11,12] Prior surveys of physician IT use have been limited to single practice settings (often academic centers) or single technologies (such as e-mail communication).[13–22] To more fully address the issue of basic IT adoption by physicians actively engaged in patient care, we surveyed a national sample of primary care and specialist physicians to determine frequency of e-mail communication with patients or with other providers, online access to continuing medical education (CME) programs or professional journal web sites, and "real-time" computerized decision support (CDS) during patient care. These 5 technologies are technically simple to use and substantially less expense to adopt than EHRs. We analyzed the relationships between such IT use and corresponding attributes of physicians, their patient panels, and their practice setting. We hypothesized that adoption of IT tools would be associated with more recent completion of medical training and with system-level factors such as the physician's practice environment.

METHODS

Survey Sample

From the master file of the American Medical Association, we selected all physicians in the 50 states in the 3 largest primary care specialties (family practice, internal medicine, pediatrics) and in 3 nonprimary care specialties (anesthesiology, general surgery, cardiology). We excluded all doctors of osteopathy, resident physicians, physicians in military hospitals, and any physicians with no address in the AMA database or who were retired or specifically requested that they not be contacted by mail using the AMA data.

From this list of 271,148 physicians, we randomly selected an equal number of physicians from each of the 6 special-

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ties to obtain a sample of 3,504 subjects (584 physicians per specialty). We then excluded 337 ineligible physicians (9.6% of the sample) who were no longer providing patient care, deceased, out of the country, practiced in a nonsampled specialty, not English speaking, or on maternity leave. Of the remaining 3,167 eligible sampled physicians, 1,662 returned a completed questionnaire yielding an overall weighted response rate of 57.8%. The response rate differed by subject specialty from a low of 42.6% among cardiologists to a high of 65.8% among pediatricians.

Survey Design and Administration

The Institute of Medicine as a Profession Survey (IMAP Survey) consisted of 41 questions focused primarily on medical professionalism. Five questions were included that directly addressed IT use: "How often do you: (1) Communicate with your patients via e-mail? (2) Communicate with other clinicians via e-mail? (3) Use CDS tools in real-time management of patients? (4) Complete continuing medical education online? and, (5) Access professional journals online?" Examples of CDS tools provided in the survey included: "Up-to-Date, Harrison's, government web-sites, and professional society web-sites." The response categories for the question were: Frequently, Rarely, or Never. Of the respondents, 1,644 (98.9%) completed all 5 IT-related questions and are the subject of this analysis.

Sampled physicians were mailed a survey instrument, cover letter, fact sheet describing the study, postage-paid return post card, postage-paid return envelope, and prepaid incentive check for $20 between November 2003 and June 2004. The sampled physicians were asked to complete the survey and mail back the postcard separately from the completed survey instrument. This procedure enabled tracking of nonrespondents while ensuring the respondents' complete anonymity. Nonrespondents were contacted by mail and telephone and were encouraged to participate.

Characteristics of Physicians and Their Practices

We characterized physicians by their gender, hours of direct patient care/week, medical school training (U.S. or Canadian medical school vs other) and years since medical school graduation. Based on survey responses, all physicians were assigned to 1 of 4 mutually exclusive primary practice types in the following order: academic practice, health maintenance organization (HMO), solo/2-person practice, or multispecialty/group practice.

Physicians provided estimates of the proportion of their patients who were English-speaking, and the proportion insured by Medicare, Medicaid, or uninsured. Zip codes for each physician's primary practice were used to identify U.S. census region (Northeast, Mid-West, West, South) and to classify practice sites according to 2003 Rural-Urban Continuity (RUC) codes.[23] Rural-Urban Continuity codes distinguish metropolitan counties by population size and nonmetropolitan counties by population and adjacency to metropolitan areas.[24] Codes 1 to 3 correspond to metropolitan areas with populations of: 1 million or greater; 250,000 to 1 million; and, less than 250,000. Codes 4 to 9 correspond to nonmetropolitan areas. Nationwide, there were 1,089 metropolitan and 2,052 nonmetropolitan counties in 2003. Practice zip codes were also linked to federal government county census data for 2002 to provide an estimate of the percentage of county residents meeting the government definition for poverty.[25]

Statistical Methods

We created subject survey weights for each specialty based on the total number of AMA-listed physicians in that specialty and the overall survey response rates for each specialty. Total numbers of AMA-listed physicians for the 3 sampled primary care specialties were 64,517 (family practice), 84,983 (internal medicine), and 46,145 (pediatrics). Totals for the 3 nonprimary care specialties were 32,216 (anesthesiology), 24,246 (general surgery), and 19,041 (cardiology). Including sample weights in our analyses allowed us to provide population-level estimates of IT use for over one-quarter million U.S. physicians from 6 representative specialties.

Normally distributed continuous data were compared using t tests, nonnormally distributed continuous data using Wilcoxon rank sum, and categorical data using χ^2 tests. For each IT tool we constructed separate multivariate logistic regression models with survey weights (PROC SURVEYLOGISTIC) to calculate adjusted odds ratios (aORs) for independently significant physician, practice, and patient panel factors associated with IT use. We created a similar model for aggregate IT use, which we defined as frequent use of at least 3 of the 5 IT tools. The final models included physician gender, years since graduation, site of medical school graduation, primary care versus specialist practice, practice type (solo/2-person, multispecialty/group, HMO, or academic), RUC code, proportion of Medicaid-insured patients, and county poverty rate. Weights and sample strata were included to allow accurate standard error determinations. All analyses were performed using SAS software v 9.1 (SAS Institute Inc., Cary, NC). This study was approved by the Massachusetts General Hospital Institutional Review Board.

RESULTS

Survey Sample

Characteristics of survey respondents and corresponding weighted values for the sampled physician population are provided in Table 1. Respondents represented 195,759 AMA-listed primary care physicians (family practice, internal medicine, and pediatrics) and 73,510 specialists (anesthesiology, cardiology, general surgery). Physicians graduated from medical school a mean of 22 ($\pm$ 13) years earlier and engaged in 48 ($\pm$ 20) hours of direct patient care per week. The majority of physicians practiced in multispecialty/group practice settings (56%) and in large metropolitan areas (56% in areas with 1 million or more residents). Only 15% practiced in nonmetropolitan counties.

Overall Prevalence of IT Use

Of the 5 IT tools surveyed, "Frequent" use was most prevalent for real-time CDS (40.8%) and online access to professional journals (39.0%, see Table 2). Online CME was frequently completed by 24.1% of physicians. Physicians were much more likely to communicate frequently via e-mail with other clinicians (30.2%) than with their patients (3.6%). Less than

Table 1. Physician and Practice Characteristics

	Respondents, $n=1644$	Weighted, $N=269,270$
Men, %	75.6	77.2
Non-white, %	27.9	25.9
U.S. or Canadian medical school graduate, %	75.7	78.6
Years since medical school graduation	23 (± 11)	22 (± 13)
Direct patient care, hours/week	49 (± 19)	48 (± 20)
Specialty, %		
Family practice	18.0	24.0
Internal medicine	15.4	31.6
Pediatrics	19.4	17.1
Anesthesia	17.8	11.9
Cardiology	13.7	7.0
Surgery	16.1	8.3
Practice type, %		
Solo/2-person practice	24.6	20.3
Multi-specialty/group practice	59.1	56.1
Health maintenance organization	4.6	8.6
Academic medical center	11.7	15.0
Proportion of patient panel insured by:		
Medicare	31 (± 23)	31 (± 27)
Medicaid	19 (± 20)	18 (± 22)
Uninsured	10 (± 14)	10 (± 19)
Proportion of patient panel whose primary language is not English, %	15 (± 21)	15 (± 24)
RUC for practice county, %		
Urban county, population ≥ 1 million	55.4	56.1
Urban county, 250,000 to 1 million	20.7	20.3
Urban county, <250,000	8.5	8.6
Nonmetropolitan county	15.3	15.0

Numbers are proportions or means and standard deviations. Weighting is calculated from ratio of respondents to total number of AMA-listed physicians for each of the 6 surveyed specialties to provide representative estimates for practicing U.S. physicians in those specialties.
RUC, 2003 Rural-Urban Continuity (RUC) classification 21.

1% of physicians frequently used all 5 of the IT tools in clinical practice, whereas 10% never used any of the 5 tools.

Predictors of IT Use

Fewer years since medical school graduation was strongly associated with greater IT use (Table 2). The majority of physicians practicing within their first decade since medical school graduation used real-time CDS (59.7%) and accessed professional journals online (55.1%), compared with 33.8% and 35.0%, respectively, of physicians in their third decade of practice. Primary care specialty was associated with greater use of all tools except e-mail with other clinicians. Graduates of U.S. or Canadian medical school were more likely to communicate with patients and other clinicians via e-mail than foreign medical graduates.

Use of each of the 5 IT tools varied greatly by practice type. Physicians in solo/2-person practices were markedly less likely to use IT tools (only 12.4% frequently used at least 3 of the 5 surveyed tools), whereas physicians in academic or HMO practices were more often IT frequent users (over 40% frequently used 3 of 5 tools, Table 2). Factors associated with the geographic location of practices (U.S. census region, urban/rural classification, county poverty rate) and physicians' patient panel characteristics (prevalence of non-English speakers, insurance status) were less correlated with physician use of IT tools.

Multivariate Analyses

In separate multivariate logistic regression models for each IT tool, years since medical school graduation, practice specialty (primary care vs specialist), and practice setting remained most strongly associated with IT use (Table 3). With the exception of online CME, physicians practicing in academic environments were 2- to 4-fold more likely to use the various IT tools compared with physicians in the referent practice (multispecialty/group practices, the most common practice type) with adjusted odds ratios (aORs) and 95% confidence intervals ranging from 2.17 (1.42 to 3.31) for real-time CDS use to 5.41 (3.52 to 8.32) for e-mail with patients. In contrast, physicians in solo/2-person practice were markedly less likely to use these tools after adjusting for physician, other practice, and patient panel characteristics. Solo/2-person practice aORs ranged from 0.21 (0.13 to 0.34) for e-mail with other clinicians to 0.55 (0.40 to 0.77) for real-time CDS use.

Frequent users of at least 3 of the 5 IT tools were more likely to be primary care physicians (aOR 1.69 [1.26 to 2.27]) and practice in an academic setting (2.29 [1.47 to 3.56]), whereas increasing number of years since medical school graduation (0.67 [0.44 to 1.04]) and solo-2-person practice setting (0.42 [0.28 to 0.64]) were associated with decreased odds of aggregate IT use (see Fig. 1).

DISCUSSION

We evaluated the current use of basic computer-based information technologies by a representative sample of U.S. primary care and specialist physicians. Our goals were to characterize current rates of basic IT use and to determine the role of physician, practice, and patient panel characteristics in IT adoption. We chose 5 activities that require little capital investment, do not depend on an existing electronic health record system, and have been widely adopted by other industries and by the general population. Recent consumer- and patient-focused studies, for example, have found that 70% of Americans report online access and between 40% and 75% of internet users use the internet to look for health-related advice or information.[26,27] In contrast, we found that a minority of physicians have incorporated IT tools into everyday patient care, that very few physicians (1%) use all 5 tools, and that 1 in 10 never use any of the 5 basic IT tools assessed in the survey. By focusing on IT tools that can be used to support clinical care even in the absence of an electronic health record, our findings extend the results of other recent surveys that found low prevalence of EHR adoption[6,28,29] to provide a fuller inventory of current IT-related clinical practices.

We identified wide variation in IT use both by IT tool and according to physician and practice characteristics. Of the 5 tools surveyed, real-time CDS and online journal access were the most frequently used, whereas e-mail communication—particularly with patients—was less prevalent. Thus, many physicians appear comfortable with IT for information retrieval but are less inclined to use IT for patient communication. Our results are consistent with prior reports that have found generally low rates

Table 2. Prevalence of "Frequent" Information Technology Use by Physician, Patient Panel, and Practice Characteristics

	E-mail with Patients	E-mail with Clinicians	Online CME	Online Journals	Real-time CDS	4 of 5	3 of 5
All physicians	3.6	30.2	24.1	39.0	40.8	8.1	24.3
Gender							
Men	3.7	29.3	24.2	38.4	40.5	8.4	24.4
Women	3.4	32.0	24.0	41.0	41.9	7.4	23.9
Years in practice							
0 to 10	5.0	42.5*	30.7*	55.1*	59.7*	12.4*	32.3*
11 to 20	3.0	33.8	29.7	40.1	42.3	9.4	26.6
>20	3.5	24.3	18.6	33.0	33.8	5.9	20.2
MD training							
U.S./Canada	4.3†	32.9*	23.2	40.3†	42.1†	8.0	24.1
Other	1.8	22.8	26.7	35.0	36.9	8.3	24.6
Specialization							
Primary care	4.2†	29.7	25.8†	40.8	44.5*	9.3†	26.6†
Specialist	2.2	31.4	19.6	34.5	30.8	4.8	18.0
Practice type							
Solo/2-person	2.1*	6.8*	20.2*	23.3*	28.1*	2.0*	12.4*
Multispecialty/group	2.7	28.9	28.4	37.9	40.3	9.0	23.5
HMO	8.0	70.8	20.5	42.2	54.3	13.0	41.5
Academic	7.3	65.9	12.3	72.1	60.1	14.6	43.5
Medicaid insured, % patient panel							
<10%	3.3	27.1	24.8	35.5	40.6	6.9	23.3
10% to 20%	3.5	33.3	25.6	43.7	36.4	9.1	24.6
>20%	2.7	30.9	22.8	43.6	44.1	7.2	25.6

P-values are for comparison with first category for ordinal variables and for group comparison for nonordinal variables. Data are weighted proportions. Primary care specialties surveyed=family practice, internal medicine, pediatrics; specialty practices surveyed=anesthesia, cardiology, general surgery; results weighted to the total number of AMA-registered physicians in each specialty.

*P<.001.

†P<.05.

CME, continuing medical education, CDS, computerized clinical decision support.

Table 3. Physician and Practice Characteristics Associated with Information Technology Use: Multivariate Logistic Regressions

Physician/Practice Characteristic	Adjusted Odds Ratio (95% Confidence Interval)*				
	E-mail with Patients	E-mail with Clinicians	Online CME	Online Journals	Real-time CDS Use
Years since medical school graduation					
0 to 10	1.00	1.00	1.00	1.00	1.00
11 to 20	0.97 (0.62 to 1.52)	0.77 (0.50 to 1.20)	0.98 (0.64 to 1.48)	**0.54 (0.37 to 0.79)**	**0.51 (0.35 to 0.75)**
>20	1.17 (0.76 to 1.81)	**0.60 (0.39 to 0.92)**	**0.48 (0.32 to 0.74)**	**0.43 (0.30 to 0.63)**	**0.40 (0.27 to 0.58)**
Medical school					
U.S. or Canadian	1.00	1.00	1.00	1.00	1.00
Other	**0.57 (0.39 to 0.83)**	0.74 (0.51 to 1.08)	1.31 (0.92 to 1.87)	1.00 (0.73 to 1.36)	0.98 (0.73 to 1.33)
Hours patient care/week					
<40	1.00	1.00	1.00	1.00	1.00
40 to 60	0.82 (0.60 to 1.12)	0.75 (0.54 to 1.03)	1.05 (0.76 to 1.46)	**0.72 (0.54 to 0.95)**	0.87 (0.66 to 1.51)
>60	0.91 (0.58 to 1.43)	0.70 (0.45 to 1.09)	0.95 (0.60 to 1.52)	0.80 (0.53 to 1.19)	0.77 (0.51 to 1.18)
Practice					
Specialty	1.00	1.00	1.00	1.00	1.00
Primary care	**2.26 (1.70 to 3.00)**	0.84 (0.63 to 1.11)	**1.39 (1.04 to 1.86)**	**1.34 (1.03 to 1.73)**	**1.74 (1.34 to 2.25)**
Practice type					
Multispecialty/group	1.00	1.00	1.00	1.00	1.00
Solo/2-person	0.79 (0.55 to 1.15)	**0.21 (0.13 to 0.34)**	0.70 (0.48 to 1.01)	**0.50 (0.36 to 0.70)**	**0.55 (0.40 to 0.77)**
HMO	1.81 (0.95 to 3.44)	**4.20 (2.18 to 8.09)**	0.48 (0.21 to 1.07)	0.81 (0.43 to 1.53)	1.16 (0.61–2.19)
Academic	**5.41 (3.52 to 8.32)**	**3.83 (2.44 to 6.03)**	**0.38 (0.21 to 0.70)**	**3.23 (2.07 to 5.02)**	**2.17 (1.42 to 3.31)**

**Adjusted for physician gender, years since medical school graduation, hours in direct patient care per week, and site of medical school graduation; practice type, poverty level and degree of urbanization of practice county; and percentage of patients insured by Medicaid or primary language not English.*

Boldface indicates statistical significance.

Specialty practices surveyed=anesthesia, cardiology, general surgery; primary care specialties surveyed=family practice, internal medicine, pediatrics.

CME, continuing medical education; CDS, computerized decision support.

of CDS adoption in clinical practice.[30,31] One recent study found that physicians have 2 unanswered questions for every 3 patients, yet access electronic information retrieval only 0.3 to 9 times per month.[32] More effective integration of IT clinical information retrieval systems into clinical work-flow may be required to reduce this apparent gap in knowledge acquisition.

E-mail communication, with patients or between clinicians, raises concerns about patient confidentiality and profes-

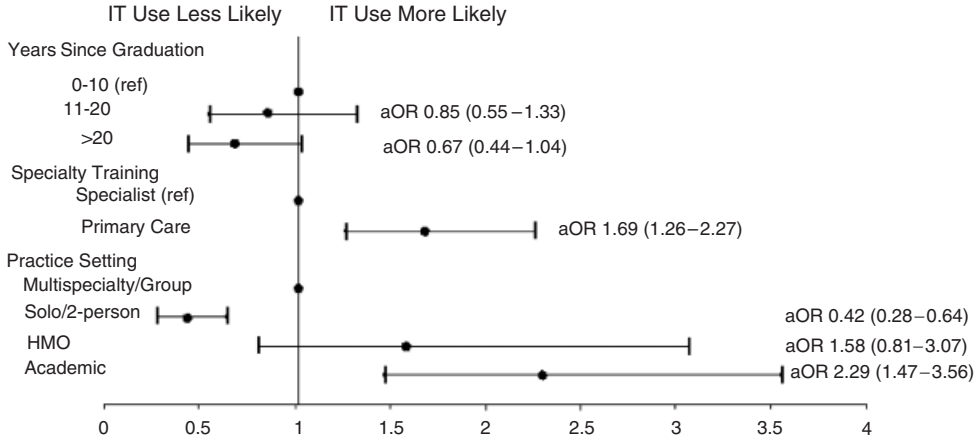

FIGURE 1. Odds ratios for frequent use of at least 3 of 5 information technology (IT) tools (e-mail with patients, e-mail with other clinicians, online continuing medical education, online professional journal access, and real-time use of computerized clinical decision support). Odds adjusted for physician gender, years since medical school graduation, hours in direct patient care/week, and site of medical school graduation; practice type, poverty level and degree of urbanization of practice county; and percentage of patients insured by Medicaid or primary language not English; specialty training, specialist (anesthesia, cardiology, general surgery) versus primary care specialties (family practice, internal medicine, pediatrics).

sional liability and generally lacks mechanisms for physician reimbursement.[33,34] Given that nearly three-quarters of U.S. adults currently report e-mail or internet access,[35] the low rate of physician-patient e-mail communication suggests a lack of appropriate clinical infrastructure rather than lack of patient access.[36,37] Low use may also reflect negative attitudes, resistance, and/or inertia among physicians. Consumer surveys have found that up to 70% of Internet users would engage in e-mail communication with their physicians if given the opportunity.[27] Realizing the full potential of patient-physician e-mail communication will require addressing reimbursement mechanisms and concerns about inappropriate message acuity and patient confidentiality.[38–41] Although e-mail communication was more frequent between clinicians, absolute rates remained low (30%), even for physicians practicing in rural communities (who presumably have greater barriers to collaborative care than their peers located at large urban-based medical centers). Our results indicate that the promise of IT for augmenting the practice rural medicine remains unfulfilled.[9]

The most substantial differences in IT use were found by practice setting. With the exception of online CME, adoption of IT was greatest among physicians working in academic or HMO practices (although the small absolute number of HMO physicians in our study limited our power to show statistically significant differences in the univariate analyses). Physicians in solo/2-person practice were least likely to use IT tools, even after adjusting for demographic and practice variables. In contrast, the geographic location and patient characteristics of the practices had little impact on prevalence of IT use in adjusted analyses. The crucial role of practice setting has also been seen in surveys of EHR use.[29] This pattern implies that system-level factors may play an important role in whether physicians use IT in clinical care.

Our findings suggest 2 specific lessons for IT adoption: (1) innovation—notably by academic clinical centers—has been slow to diffuse across other practice settings in medicine, and (2) system-level approaches to designing care—a method typical of HMOs—may be critical to facilitate IT adoption. Larger practices may also be more likely to adopt innovations because with more members they may be more likely to include an "early adopter" or innovator within the practice to influence the overall group.[42] The challenge remains how to identify and overcome barriers to use in more traditional private and community-based practices where most clinical care occurs.[43] Unlike electronic medical record systems, which require a substantial initial capital investment and effective linkage between data systems,[44] the technological barriers to e-mail communication and internet access are modest. Thus, the low rate of IT adoption found in this national survey reveals a marked reluctance by the majority of practicing U.S. physicians to embrace basic IT tools as part of usual care.

This study has several limitations. Although the primary focus of the survey was medical professionalism rather than IT use, responding physicians may have differed from nonrespondents in ways that correlate positively with IT adoption. In addition, "social desirability bias" might have lead respondents to overestimate IT use. These potential biases raise the possibility that the reported rates of technology adoption considerably overestimate the true estimates for the population of practicing physicians in the specialties surveyed. Also, we assessed only the most basic IT tools and thus cannot comment on adoption of integrated EHRs with advanced decision support—the current state-of-the-art in clinical information technology and medical informatics. In particular, our very basic definition of CDS allowed for the use of any computerized information resources rather than specifying the real-time, patient-linked automated decision support that is characteristic of more advanced CDS found in the EHR environment. Finally, this study was not designed to determine whether more frequent IT use was associated with better quality of care, one of the primary goals driving IT adoption.

The results of this large, nationally representative survey indicate that adoption of basic IT tools by practicing clinicians remains limited. Substantial systematic changes in the way medical practices are organized, such as secure e-mail systems linked to EHRs and reimbursement mechanisms for electronic consultation, may be necessary to increase e-mail communication.[45,46] Changes in physician training, underscored by the greater use of IT tools by more recent medical school graduates, offers another

means to fundamentally change the practice of medicine through more effective integration of information technology.

Dr. Grant had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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