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Computerization of Primary Care in the United States

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ABSTRACT

The objective of this study was to assess the current level of information technology use by primary care physicians in the U.S. Primary care physicians listed by the American Medical Association were contacted by e-mail and asked to complete a Web-based questionnaire. A total of 2,145 physicians responded. Overall, between 20% and 25% of primary care physicians reported using electronic medical records, e-prescribing, point-of-care decision support tools, and electronic communication with patients. This indicates a slow rate of adoption since 2000. Differences in adoption rates suggest that future surveys need to differentiate primary care and office-based physicians by specialty. An important finding is that one-third of the physicians surveyed expressed no interest in the four IT applications. Overcoming this barrier may require efforts by medical specialty societies to educate their members in the benefits of IT in practice. The majority of physicians perceived benefits of IT, but they cited costs, vendor inability to deliver acceptable products, and concerns about privacy and confidentiality as major barriers to implementation of IT applications. Overcoming the cost barrier may require that payers and the federal government share the costs of implementing these IT applications.

Keywords: *decision support systems; electronic health record; electronic prescription system; physicians*

INTRODUCTION

The adoption of information technology (IT) to support the delivery of healthcare is recognized increasingly in many countries as an essential tool to improve patient care (Dick & Steen, 1997; Leaning, 1993; President's Information Technology Advisory Committee, 2004). Until recently, IT products available for healthcare providers mostly were designed for large organizations, were business-oriented, complex to implement, and costly. Recent advances in technology have made IT applications more available to primary care physicians in smaller practices. Products are available that are modular; able to be integrated with different systems, and designed to fit the physician's practice pattern without substantial investments in hardware, software, and maintenance (McDonald & Metzger, 2002).

As a result, the introduction of computers and IT applications into primary care in countries with favorable government policies

and financial incentives has been rapid (Kidd, 2000; Mount, Kelman, Smith, & Douglas, 2000; Purves, Sugden, Booth, & Sowerby, 1999; Thakurdas, Coster, Guirr, & Arroll, 1996). A number of English-speaking countries has experienced widespread implementation of information technology. The Harvard School of Public Health and the Commonwealth Fund's International Symposium survey of primary care physicians found the following proportions of primary care physicians in the following countries who were using electronic medical records: U.S. (17%); Canada (14%); Australia (25%); New Zealand (52%); and the U.K. (59%). The survey also found the following use of electronic prescribing by primary care physicians: U.S. (9%); Canada (8%); Australia (44%); New Zealand (52%); and the U.K. (87%) (Harris Interactive, 2001a).

The U.S. trails European countries in the use of information technology in patient care. Overall, 29% of general practitioners in the European Union use electronic medical records compared to only 11% in the U.S. Only three countries from the Organization for Economic Cooperation and Development (OECD)—Portugal, France, and Spain—lag behind the U.S. (Harris Interactive, 2002b). Despite its potential to improve efficiency and quality of care, use of information technology in healthcare lags behind other sectors of the economy in the U.S. In 2001, most of the $20 million invested in healthcare information technology was used to computerize financial systems (Goldsmith, Blumenthal, & Rishel, 2003). Less than 10% of U.S. hospitals had adopted electronic medical record systems and less than 5% had implemented computerized physician order entry by 2001.

Given the increasing public attention to the importance of health information technology, the rate of IT adoption among primary care providers is important (Hillestad, et al., 2005). Accurate estimates of the adoption rate for information technology form the basis for policy regarding how to stimulate its use by physicians. The overall aim of this study was to determine primary care physicians' use of information technology in patient care. The specific objectives included the following:

1. Estimating the proportion of primary care physicians who have adopted information technology applications in their practices.
2. Determining physician perceptions of the benefits of these IT applications.
3. Determining physician perceptions of the barriers to the adoption of IT applications in their practices.

Primary care in the U.S. is delivered by physicians who comprise several specialties; namely, family practice (FP), internal medicine (IM), pediatrics (PEDS), and obstetricians and gynecologists (OBGYN). One other group of physicians was included in the survey comprising medical specialties such as geriatrics and occupational medicine.

Four IT applications were selected for investigation. First, electronic medical records (EMRs) are promoted as more comprehensive and accessible to healthcare providers. Studies have shown that EMRs have the potential to reduce medical errors, especially when integrated with other applications such as decision support (Bates et al., 1998). Electronic prescribing involves the use of computers or hand-held devices to submit prescriptions to pharmacies electronically. E-prescribing has the potential to improve efficiency, to reduce prescription errors, and to improve compliance with managed-care formularies (Miller, Gardner, Johnson & Hripcsak, 2005; Schiff & Rucker, 1998). Third, point-of-care decision support tools can improve the quality of patient care; for example, an antibiotic decision support system (Evans et al., 1998) and automated decision support alerts for contraindicated medications (Galanter, Didomenico & Polikaitis, 2005). Fourth, patients consistently have expressed a strong desire for online communication with physicians (Harris Interactive, 2005). This may involve e-mail queries as well as online consultations.

Electronic communication allows physicians to deliver better care and patients to assume greater responsibility for their own care.

METHODS

Survey Method

A Web-based survey was developed to investigate primary care physicians' use of the four IT applications described previously. These applications were selected because healthcare providers in the U.S. and the EU find them helpful and effective (Harris Interactive, 2003, 2005). Comparative data also exist from earlier surveys on the use, perceived benefits, and barriers to these applications. At the same time, earlier studies failed to differentiate primary care physicians by specialty.

We describe the design and administration of the survey. A Web-based survey method was chosen, because it permitted us to survey a national sample of primary care physicians with a reasonable budget (Eysenbach, 2005; Lazar & Preece, 1999; Wyatt 2000). Also, we wanted to sample an Internet-literate population that is most likely to be early adopters in their practices (Rogers, 1983).

Survey Design

The study was sponsored by the Quality Improvement Working Group of the American Medical Informatics Association and the School of Public Health at St. Louis University. The e-mail that was sent out inviting primary care physicians to participate in the study contained a link to the Web-based survey (see Appendix).

In order to facilitate comparisons to earlier surveys, items were adapted from other widely cited surveys; in particular, the annual Health Care Information and Management Systems Society (HIMSS) Leadership Survey (HIMSS, 2002) and the Harris Interactive polls that were conducted in the U.S. and the EU (Harris Interactive, 2002b, 2003).

The questionnaire was divided into seven sections. The first section included information about the physician's specialty and practice. The second section asked physicians to rate the priority of a number of Internet technologies. The next three sections listed specific financially focused, clinically focused, and patient-focused IT applications. The physician was asked to indicate for each IT application if he or she (1) had implemented, (2) planned to implement within one year, (3) had no plans to implement but was interested in learning more, or (4) had no interest. Physicians also could respond by indicating that they didn't know or that they chose not to answer that question. The sixth section asked physicians to rate the benefits of using IT applications on a Likert scale. Responses ranged from (1) high benefit to (4) not a benefit. The final section asked about barriers to implementing IT applications. Responses ranged from (1) not a barrier to (5) insurmountable barrier. A copy of the survey is included in the Appendix.

Factor analyses were performed on the items that measured perceived benefits of the IT application and on the perceived barriers to implementation. A single factor accounted for 63% of the variance in the benefits items. The reliability based on Chronbach's Alpha was 0.93. For the barriers items, a single factor accounted for 48% of the variance. The reliability was 0.86 based on Chronbach's Alpha.

Sample

We contracted with SK&A Information Services to broadcast an e-mail invitation to primary care physicians to participate in the study. This company maintains a comprehensive list of physicians based on the AMA Physician Masterfile. The list is updated weekly through the use of surveys, publication mailings, and the U.S. Postal Services Address Correction Services. E-mail invitations to participate in the study were sent out to 31,743 primary care physicians. Of these e-mails, 1,101 were rejected due to invalid e-mail addresses. A total of 2,145 physicians responded, representing a 7.3% response rate to the survey. The software prevented respondents from completing the

survey more than one time. Questionnaires from physicians who were not currently practicing or who were not currently engaged in primary care were eliminated as were questionnaires with significant missing data. This resulted in a final sample of 1,665 that was used in the analysis.

Table 1 presents demographic data and practice information about the study sample. Sixty percent of the physicians were between 41 and 60 years of age, while 29% were younger. Three-fourths of the responding physicians were male. Almost 75% practiced family medicine, internal medicine, or pediatrics, while 15% practiced obstetrics and gynecology and 9% other medical specialties. More than 88% of the respondents were primarily clinicians. The other 12% held primarily administrative positions in their practices and were excluded from the final analysis.

About 14% of the respondents were hospital-based. Almost 18% of the physicians were in group practices of 10 or more; more than one-third of the respondents were in small group practices with less than 10 physicians, and 20% of the physicians were in solo practice. The remaining 12% were in integrated health delivery service organizations, managed care organizations, and so forth.

RESULTS

Use of Information Technology

Table 2 shows the extent to which physicians in each specialty have implemented each of the four IT applications. Overall, only one out of four has implemented electronic medical records and report using point-of-care decision support tools. About 23% communicate electronically with patients. Only one out of five primary care physicians utilizes electronic prescribing. A surprisingly high number of physicians indicated no interest in all of the IT applications. Thirty-six percent indicated no interest in decision support tools, while 31.3% and 23.5% evidenced no interest in electronic prescribing and electronic medical records, respectively. Almost 30% stated that they were not interested in electronic communication with patients.

A greater proportion of internists report having implemented all four of the IT applications in practice ($p<0.05$). Thirty-one percent have implemented electronic medical records; about 26% have implemented electronic prescribing, decision support tools, and e-mail communication with patients. In general, OBGYNs are the least likely to have implemented any of the IT tools with the exception of electronic communication with patients ($p<0.05$). Less than one out of six of these physicians have implemented electronic medical records or electronic prescribing or decision support tools, and only one out of five have implemented electronic communication with patients. OBGYNs also expressed the least interest in IT applications ($p<0.05$). More than 30% indicated no interest in electronic medical records, electronic prescribing, and e-mail communication with patients. More than 40% indicated no interest in implementing decision support tools. There may be several major reasons for this low use of IT and lack of interest by OBGYNs. Most of the IT applications are general and may not meet the specific needs of this specialty. Also, there appear to be few published studies involving the use of IT by OBGYNs.

Perceived Benefits and Barriers

Overall, the majority of primary care physicians surveyed perceived benefits from implementing IT applications (see Table 3). Almost 75% indicated that these applications could reduce errors; 70% perceived IT as potentially increasing their productivity; more than 60% indicated that IT tools have the potential to reduce costs and to help patients assume more responsibility. Physicians are less certain about some of the other potential benefits of IT applications. About half of the physicians surveyed evidenced skepticism that IT applications would shorten consultations and reduce the number of patients who seek unnecessary healthcare. More than 40% felt that IT is unlikely to reduce unnecessary tests and treatments.

Table 1. Physician characteristics of the study sample

Characteristic	N	%
Age		
30 or less	16	1.1%
31–40	259	17.9%
41–50	537	27.0%
51–60	484	33.4%
61–70	108	7.4%
70 or above	46	3.2%
Gender		
Male	1134	74.5%
Female	388	25.5%
Specialties		
Family Practice	448	29.8%
Internal Medicine	368	24.5%
Pediatrics	324	21.5%
Obstetrics and Gynecology	225	15.0%
Other Medical Specialties	138	9.2%
Role		
Physician	1972	88.4%
Administrative	176	11.6%
Type of Organization		
Hospital	232	13.9%
Group: 10 or more	298	17.9%
Group: Less than 10	607	36.5%
Solo	327	19.6%
Other Settings	201	12.1%

More than 80% of primary care physicians report the lack of financial support for IT applications as a major barrier to adoption. This is followed by their perceptions that vendors fail to deliver acceptable products as primary barriers to implementing these tools (79.3%) (see Table 4). In general, physicians perceive these barriers as difficult to overcome. Almost two-thirds of the physicians surveyed also cited the lack of a strategic plan for implementing applications and difficulty in recruiting experienced IT personnel as major barriers, while more than one-half cited lack of sufficient knowledge of IT as a barrier to implementation. At the same time, physicians indicated that these last three barriers easily could be overcome.

Predictors of IT Implementation

Table 5 provides the logistic regression models and predictors for implementing each of the IT applications. Demographic factors, specifically age and gender, were not associated significantly with the implementation of the four IT applications. In only one instance was there a significant difference between male and female physicians. Males were almost twice as likely to implement e-prescribing as females.

Physicians' specialties did predict whether or not they had implemented certain IT applications. Pediatricians and obstetricians and gynecologists were significantly less likely to have implemented electronic medical records. In contrast, family practitioners were almost three times more likely to have implemented point-of-care decision support tools. Specialty was not a significant predictor of implementation of electronic prescribing and communication with patients.

Perceived benefits and barriers appear to be consistent predictors of whether or not primary care physicians implemented three of the

Table 2. Use of information technology by primary care specialty (%)

Application	FP	IM	PEDS	OB/ GYN	Other	Total
Electronic Medical Records						
Implemented	23.2	31.2	23.0	16.4	40.6	25.8
Plan to implement	16.9	13.9	12.5	16.0	12.8	14.4
Interested in	26.7	23.7	33.4	23.7	19.5	26.4
No interest	24.8	21.2	19.7	31.5	21.8	23.5
NA	8.4	10.0	11.5	12.3	5.3	9.5
Electronic Prescribing						
Implemented	17.7	26.4	20.4	13.3	24.0	20.1
Plan to implement	18.2	16.7	13.0	14.3	15.2	16.2
Interested in	21.5	15.5	21.8	17.6	12.0	18.6
No interest	31.1	30.2	30.6	35.2	34.4	31.3
NA	11.6	11.2	14.1	19.5	14.4	13.8
Decision Support Tools						
Implemented	27.6	25.7	24.0	15.6	30.8	25.1
Plan to implement	16.6	11.1	9.4	10.1	8.7	12.0
Interested in	11.2	11.5	9.4	15.6	11.5	12.2
No interest	33.9	35.9	35.6	43.6	35.6	35.9
NA	10.7	15.8	21.5	15.1	13.5	14.8
Electronic Communication						
Implemented	25.5	26.6	20.4	21.2	26.2	23.2
Plan to implement	11.4	7.1	8.2	10.1	1.6	8.7
Interested in	9.3	6.5	12.1	11.1	9.5	9.9
No interest	29.0	28.1	28.9	31.7	29.4	28.9
NA	24.8	31.7	30.4	26.0	33.3	29.4

NA=don't know or I choose not to answer

four IT applications. Physicians who perceived that IT can reduce medical errors were one and one-half times more likely to have implemented electronic medical record, e-prescribing, and decision support tools. In contrast, physicians who cited lack of financial support and the considerable investment required to implement these applications as significant barriers were less likely to have implemented all three of these IT applications. Physicians who perceived vendors as failing to deliver useful and acceptable products were significantly less likely to have implemented decision support tools. The decision to implement electronic communication with patients did not appear to be affected by demographic characteristics, specialty, or perceptions of benefits or barriers.

DISCUSSION

Adoption of electronic medical records has been the most widely surveyed IT application. A review of 22 studies of outpatient electronic medical record (EMR) adoption from 1998 to 2002 suggested a utilization rate of 20% to 25% at the time of the surveys (Brailer & Terasawa, 2003). However, data from the U.S. National Ambulatory Medical Care Survey (NAMCS) indicated that in 2001, only 17% of office-based

Table 3. Perceived benefits of implementing IT applications (%)

Benefit	High	Medium	Low	None
Patients assume responsibility for monitoring symptoms/disease	23.6	38.7	22.1	15.6
Shorter consultations	17.0	29.1	20.9	32.9
Patients not seeking medical care when it was not needed	22.5	28.2	24.4	25.0
Patients coming in sooner for necessary treatment	33.8	29.6	18.4	18.3
Fewer unnecessary tests	29.4	27.9	16.1	26.5
Fewer unnecessary treatments	32.8	24.9	16.9	25.4
Fewer errors	53.4	21.4	10.5	14.7
Increased productivity	39.2	30.3	14.2	16.3
Reduced costs	37.5	25.5	15.4	21.6

Table 4. Perceived barriers to implementing IT applications (%)

Barriers	No Barrier	Easily Overcome	Overcome some effort	Overcome great effort	Insurmountable
Lack of financial support	7.6	5.0	35.3	41.3	10.7
Vendors' inability to deliver acceptable products	12.4	8.3	34.8	36.3	8.2
Acceptance by staff	17.8	23.9	41.6	15.3	1.3
Difficulty proving quantifiable benefits	14.8	18.0	38.7	24.6	3.9
Lack of strategic plan for implementing	19.7	15.2	35.7	25.3	4.1
Recruiting experienced IT personnel	22.0	17.6	31.7	24.0	4.8
Retaining experienced personnel	24.6	17.9	36.6	18.1	2.8
Insufficient knowledge of IT applications	15.0	22.5	41.4	19.3	1.7
Considerable investment in IT applications	6.1	6.9	28.8	47.6	10.6

Table 5. Predictors of the implementation of IT applications (odds ratios)

Characteristic	EMR	E-Prescribing	Decision Support	E-Communication
Age				
30 or less	1.000	1.000	1.000	1.000
31–40	0.668	1.474	0.761	1.360
41–50	0.421	0.401	0.760	1.614
51–60	0.568	0.392	0.660	1.157
61–70	0.530	0.503	0.606	1.393
70 or above	0.503	0.706	0.499	1.393
Gender				
Male	1.175	1.942**	1.094	1.066
Female	1.000	1.000	1.000	1.000
Specialties				
FP	1.420	1.433	0.591**	0.924
IM	0.712	1.125	0.957	0.851
Pediatrics	0.513**	0.622	1.206	0.616
OBGYN	0.406**	0.957	1.180	0.586
Other	1.000	1.000	1.000	1.000
Benefits				
Fewer Errors	1.541**	1.574**	1.238*	1.086
Increased Productivity	1.023	1.282*	1.157	0.919
Reduced Costs	0.804*	0.724**	0.788*	0.868
Barriers				
Lack of Financial Support	1.591**	1.452**	1.296*	0.960
Vendors' Failure to Deliver	1.169	1.211*	1.309**	1.108
Considerable Investment	1.207	1.271*	1.221	1.278

***p<0.01 *p<0.05*

physicians used electronic medical records (Burt & Hing, 2005).

These studies vary considerably in terms of how respondents were selected and their generalizability to a physician population. Many of the studies are unscientific and utilized surveys of meeting attendees. Only three of the 22 studies reviewed were rated as generalizable. Also, most of these studies do not differentiate among physicians by specialty. Consequently, there is only limited data on adoption of EMRs by specialty. The 2002 Health Care Information and Management Systems Society (HIMSS, 2002) survey administered to attendees and exhibitors at the annual conference found that 42% of internal medicine practices and 30% of family medicine practices reported using EMRs. These rates show little change from the HIMSS survey in 2001. However, since only meeting attendees were surveyed, it is impossible to extrapolate these results to the U.S. primary care physician population as a whole.

There are fewer studies of the adoption of other IT applications such as electronic prescribing and online communication between physicians and patients. The National Ambulatory Medical Care Survey (NAMCS) indicated that only 8% of office-based physicians in 2001 ordered prescriptions electronically (Burt & Hing, 2005). The Harris Interactive study that compared use of IT by U.S. general practitioners to European physicians found that 17% of physicians in primary care practices reported that they used EMRs, and 9% reported using electronic

prescribing (Harris Interactive, 2002a). This survey also dates back to 2000-2001. Neither study differentiates physicians by specialty.

More recent information is needed about the extent to which primary care physicians use information technology for patient care, patterns of use, and perceived barriers to use of IT. Many of the surveys discussed earlier were undertaken before the year 2000. The NAMCS statistics on uses of computerized clinical support systems in medical settings are based on office-based physician practices rather than only on primary care physicians (Burt & Hing, 2005). The Harris Interactive study reports aggregate statistics for primary care physicians and specialists. Our survey examined IT applications that appear to offer the greatest potential to primary care physicians in providing high-quality patient care. It also differentiates primary care physicians by specialty.

This study provides evidence from a large sample of U.S. primary care physicians that there is limited implementation of clinical and patient care IT applications. Overall, only about 25% of primary care physicians have implemented electronic medical records, e-prescribing, point-of-care decision support tools, or electronic communication with patients. These results are similar to those from a Harris Interactive survey of 400 U.S. physicians conducted in 2001 and other earlier studies indicating a slow rate of adoption However, the proportion of physicians who have implemented e-prescribing has almost doubled from 11% to 20% since 2001. This may be due in part to improvements in the technology, such as the use of wireless devices.

Of concern is the finding that almost one out of three primary care physicians surveyed expressed little or no interest in the four IT applications. This may indicate that while two-thirds of primary care physicians perceive that implementation of IT can reduce costs and errors and help patients assume more responsibility for their medical conditions, a significant number of these physicians does not perceive the advantages of implementing IT technologies to provide patient care. One way of overcoming this barrier may be for medical specialty societies to offer seminars, short courses, and/or Web seminars on IT for CME credit with a focus on those features that are most useful to physicians in that specialty.

Age and gender on the whole do not appear to predict implementation of these four IT applications. However, there are significant differences in implementation among the specialties. A greater proportion of internists report having implemented all four IT applications. Pediatricians and obstetricians and gynecologists are less likely to have implemented EMRs, while family practitioners are more likely to have implemented decision support tools. OBGYNs, in particular, have been slow to adopt IT in practice. Only 16% have implemented EMRs and decision support tools. Even less, 13%, have implemented electronic prescribing. The slow adoption of IT applications by this specialty group may be due to the fact that these tools fail to address the special needs of this group of physicians. Also, OBGYNs may need to see more studies that demonstrate how these tools can help them to improve their practices.

This finding suggests that future surveys that assess adoption of IT applications by physicians need to differentiate by specialty rather than to treat primary care physicians or office-based physicians as homogeneous groups. Efforts to encourage IT adoption by physicians need to be tailored to specific specialty groups by emphasizing features of the technology that are particularly useful to that specialty.

Perceptions of benefits and barriers are significant predictors of implementation of three of the four applications. Physicians who perceive that EMRs, e-prescribing, and decision support tools can help them to reduce medical errors are significantly more likely to have implemented these technologies. At the same time, perception of barriers is a significant impediment to implementation (Anderson, 1997, 1999). Those physicians who perceived lack of financial support and high investment cost required were much less likely to have implemented these three IT applications. Also, physicians cited lack of experience and knowledge of IT as barriers. This may indicate that physicians

may feel that learning to use IT applications in practice may require too much time and energy by them and their staff in order to achieve the perceived benefits. Consequently, a key to increased use of patient care IT applications by primary care physicians may be to convince them that the benefits significantly outweigh the barriers, primarily cost. Also, physicians do not perceive vendors as delivering acceptable IT products that meet their needs. More than 70% of physicians who responded to the survey perceived vendors' unresponsiveness as a barrier to implementation of IT. It may be necessary for vendors to examine more thoroughly the needs of primary care physicians and how their IT applications fit into clinical practice in order to convince physicians to adopt them.

Other studies have indicated that lack of funding and costs are the largest barriers to the adoption of EMRs. Surveys have found that 50% or more of respondents cited lack of adequate funding as the major barrier to implementation (HIMSS, 2002; Medical Group Management Association, 2001; Medical Records Institute, 2002; Miller & Sims, 2004). This perception is based on the fact that implementation of some IT applications such as EMRs requires large up-front investment and ongoing maintenance costs. A study by the California Health Care Foundation (2003) estimated that the cost of implementing a computerized physician order entry (CPOE) system in an ambulatory care practice ranges from $15,000 to $50,000 per physician with a median cost of $30,000 per physician.

Overcoming the cost barrier will be difficult and may require incentives by payers and the government. An example is New Zealand, Australia, and the U.K., which have introduced government funding programs to stimulate adoption and use of EMRs (Bates, Ebell, Gotlier, Zapp & Mullins, 2003). Professional associations also can facilitate adoption of IT. The American Academy of Family Physicians, through a nonprofit foundation, is developing low-cost, open-source EMR software that will be available to physicians with no licensing fee.

Decisions to implement electronic communication with patients appear to be independent of perceptions of benefits and barriers. Barriers to electronic communication with patients may be different than barriers to the other IT applications. Physicians generally express concerns about the legal status of these communications and concern about the security of patient information sent over the Internet.

One of the limitations of this study is the low response rate (7.3%). Low response rates are one of the major limitations of Web-based surveys in general (Eysenbach, 2005). A systematic review of 17 Internet-based surveys of health professionals found that reported response rates ranged from 9% to 94% (Braithwaite, Emery, de Lusignan & Sutton, 2003). Most of these studies utilized professional e-directories. Some used commercial organizations' e-mail directories or recruited volunteers via Web sites of electronic discussion groups. Six of the 17 studies reviewed did not report response rates. A meta-analysis of response rates in Web- and Internet-based surveys found that the mean response rate for 68 surveys was 39.6% with a standard deviation of 15.7% (Cook, Heath & Thompson, 2000). Other researchers have reported similarly low response rates of 18% for a study of physicians in Hong Kong (Leung, Johnston, Ho, Wong & Cameo, 2001).

One study of general practitioners' use of decision support for management of familial cancer sent five separate e-mail reminders and achieved a response rate of 52.4% (Braithwaite, Sutton, Smithson & Emery, 2002). In the case of our study, the high cost of sending additional reminders to physicians precluded our doing so.

Since our survey was administered online and did not include an alternative mail survey, there is a risk of over-sampling respondents who are more likely to utilize computers in their practices. Our sample was drawn from physicians with e-mail addresses listed by the American Medical Association (AMA). These physicians may be knowledgeable about IT applications and more likely to implement them in patient care. This sample design was adopted

since we wanted to sample an Internet- and computer-literate population of primary care physicians. These physicians are most likely to be early adopters of IT applications in their practices. Consequently, estimates of implementation reported in this study are likely to be higher than for the entire population of primary care physicians.

At the same time, limitations on the generalizability of the results apply to many of the earlier reported studies of IT adoption by physicians (Brailer & Terasawa, 2003). The HIMSS surveys were voluntary surveys administered to conference attendees (HIMSS, 2002). The MediNetwork 2002 Medical Group Office Management Systems Survey was voluntary and reported a 7.52% response rate. The AHA Most Wired Survey 2002 and the Medical Records Institute Survey of Electronic Health Record Trends and Usage sponsored by SNOMED were online voluntary surveys and did not report response rates. Comparative data for the U.S. and the E.U. reported by Harris Interactive did not report response rates. Data on the E.U. countries were based on the EuroBarometer 104 conducted in June/July 2001. U.S data were collected by Harris Interactive. Our study is an improvement over a number of these earlier studies in which there are serious questions about the reliability and the generalizability of results due to flawed study design or industry sponsorship (e.g., the HIMSS Leadership Survey). Also, earlier studies with few exceptions failed to differentiate primary care physicians or office-based physicians by specialty.

In this study, no attempt was made to specify specific features of each of the four IT applications. Physicians simply were asked if they had implemented or intended to implement each application. However, features of each application vary considerably from practice to practice. For example, an EMR in addition to patient problem lists, medications, allergies, tests, and personal information and medical history may be linked to an electronic prescribing system and evidence-based decision support tools.

CONCLUSION

The present study has documented the extent to which primary care physicians use IT in providing patient care. Variation among different primary care specialty groups is an important finding as is the finding that one out of three primary care physicians expressed no interest in using any of the four IT applications for patient care. Moreover, the finding that perceived that benefits and barriers are the most significant predictors of IT implementation has implications for strategies to promote implementation of IT in clinical practice. Primary care physicians will need to be convinced that the benefits of these tools outweigh their costs. Also, vendors will need to be more responsive to the needs of primary care physicians. Finally, overcoming the costs barrier will require incentives and/or cost sharing by payers and the federal government.

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APPENDIX

Dr. <name>

The Quality Improvement Working Group of the American Medical Informatics Association in conjunction with the School of Public Health at St. Louis University is undertaking a survey of physician experience with information technology at the point of care. The survey is being performed under contract with the Social Research Institute at Purdue University and funded by the Center for Education and Research in Information Assurance and Security.

To participate, simply click on the link below and you will be directed to the Social Research Institute Web site at Purdue University. Please complete the short survey. Your responses will be kept strictly confidential and will be used solely for academic research purposes. We are grateful for your willingness to provide your valuable perspective on the real implementation experience of a physician using information technology at the point of care.

If you have any questions, please contact:

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CLICK HERE <Web site Address>

(continued on the following pages)

Which of the following best describes your role within your Organization:

1. Physician
2. Director
3. Scientist
4. President
5. Chief of Executive officer
6. Medical Director
7. Chief Medical Officer
8. Vice President of Medical Services
9. Other

a. don't know
b. I choose not to answer

Which of the following best describes the environment where you spend most of your workday:

1. Hospital
2. Medium or large group practice or clinic (10 or more physicians)
3. Small group practice or clinic (less than 10 practicing physicians)
4. Solo Practice
5. Integrated Health Delivery Service Organization
6. Long Term Care
7. Managed Care Organization (MCO)
8. Mental and Behavioral Services
9. Other

a. don't know
b. I choose not to answer

Which of the following Internet Technologies are priorities during the next year:

Upgrading Security of medical information for HIPAA compliance
1. High Priority
2. Medium Priority
3. Low Priority
4. Not a Priority

a. don't know
b. I choose not to answer

Reducing Medical Errors
1. High Priority
2. Medium Priority
3. Low Priority
4. Not a Priority

a. don't know
b. I choose not to answer

Promoting Patient Safety
1. High Priority
2. Medium Priority
3. Low Priority
4. Not a Priority

a. don't know
b. I choose not to answer

Reducing Costs
1. High Priority
2. Medium Priority
3. Low Priority
4. Not a Priority

a. don't know
b. I choose not to answer

Increasing Productivity
1. High Priority
2. Medium Priority
3. Low Priority
4. Not a Priority

a. don't know
b. I choose not to answer

Internet Tools

Which of the following financial-focused Internet Technology tools have/ do you plan to implement:

Connectivity to payers
1. Have implemented
2. Plan to implement within 1 year
3. No plans to implement but interested in learning more
4. No interest

a. don't know
b. I choose not to answer

Assistance in coding patient visits
1. Have implemented
2. Plan to implement within 1 year
3. No plans to implement but interested in learning more
4. No interest

a. don't know
b. I choose not to answer

Electronic charge capture
1. Have implemented
2. Plan to implement within 1 year

3. No plans to implement but interested in learning more
4. No interest

a. don't know
b. I choose not to answer

Which of the following clinically focused Internet tool have or do you plan to implement:

Document scanning/imaging
1. Have implemented
2. Plan to implement within 1 year
3. No plans to implement but interested in learning more
4. No interest

a. don't know
b. I choose not to answer

Transcription/voice recognition
1. Have implemented
2. Plan to implement within 1 year
3. No plans to implement but interested in learning more
4. No interest

a. don't know
b. I choose not to answer

Electronic team messaging between clinic staff
1. Have implemented
2. Plan to implement within 1 year
3. No plans to implement but interested in learning more
4. No interest

a. don't know
b. I choose not to answer

Electronic lab order entry
1. Have implemented
2. Plan to implement within 1 year
3. No plans to implement but interested in learning more
4. No interest

a. don't know
b. I choose not to answer

Electronic routing of test results
1. Have implemented
2. Plan to implement within 1 year
3. No plans to implement but interested in learning more
4. No interest

a. don't know
b. I choose not to answer

Electronic medical record
1. Have implemented
2. Plan to implement within 1 year
3. No plans to implement but interested in learning more
4. No interest

a. don't know
b. I choose not to answer

Electronic Prescribing
1. Have implemented
2. Plan to implement within 1 year
3. No plans to implement but interested in learning more
4. No interest

a. don't know
b. I choose not to answer

Point–of-Care decisions support tools
1. Have implemented
2. Plan to implement within 1 year
3. No plans to implement but interested in learning more
4. No interest

a. don't know
b. I choose not to answer

Which of the following patient-focused Internet Tools do you have or plan to implement:

Incoming telephone call management
1. Have implemented
2. Plan to implement within 1 year
3. No plans to implement but interested in learning more
4. No interest

a. don't know
b. I choose not to answer

Automated telephone appointment reminders
1. Have implemented
2. Plan to implement within 1 year
3. No plans to implement but interested in learning more
4. No interest

a. don't know
b. I choose not to answer

Automated patient notification of test results
1. Have implemented
2. Plan to implement within 1 year
3. No plans to implement but interested in learning more
4. No interest

a. don't know
b. I choose not to answer

Automated telephone patient reminders for health prevention
1. Have implemented
2. Plan to implement within 1 year
3. No plans to implement but interested in learning more
4. No interest

a. don't know
b. I choose not to answer

Electronic communication between physicians and patients
1. Have implemented
2. Plan to implement within 1 year
3. No plans to implement but interested in learning more
4. No interest

a. don't know
b. I choose not to answer

Internet site with health information links for patients
1. Have implemented
2. Plan to implement within 1 year
3. No plans to implement but interested in learning more
4. No interest

a. don't know
b. I choose not to answer

In general, what have been the benefits for the health service of your patients using IT applications?

Patients assuming more responsibility for monitoring their symptoms/disease?
1. High Benefit
2. Medium Benefit
3. Low Benefit
4. Not a Benefit

a. don't know
b. I choose not to answer

Shorter consultations
1. High Benefit
2. Medium Benefit
3. Low Benefit
4. Not a Benefit

a. don't know
b. I choose not to answer

Patients not seeking medical help when it was not needed
1. High Benefit
2. Medium Benefit
3. Low Benefit
4. Not a Benefit

a. don't know
b. I choose not to answer

Patients coming in sooner for necessary treatment
1. High Benefit
2. Medium Benefit
3. Low Benefit
4. Not a Benefit

a. don't know
b. I choose not to answer

Fewer unnecessary tests
1. High Benefit
2. Medium Benefit
3. Low Benefit
4. Not a Benefit

a. don't know
b. I choose not to answer

Fewer unnecessary treatments
1. High Benefit
2. Medium Benefit
3. Low Benefit
4. Not a Benefit

a. don't know
b. I choose not to answer

Fewer errors
1. High Benefit
2. Medium Benefit
3. Low Benefit
4. Not a Benefit

a. don't know
b. I choose not to answer

Increased productivity
1. High Benefit
2. Medium Benefit
3. Low Benefit
4. Not a Benefit

a. don't know
b. I choose not to answer

Reduced costs
1. High Benefit
2. Medium Benefit
3. Low Benefit
4. Not a Benefit

a. don't know
b. I choose not to answer

Barriers to Implementation

To what extent are the following barriers to implementing IT applications:

Lack of Financial Support
1. Not a barrier
2. Barrier easily overcome
3. Barrier overcome with some effort
4. Barrier overcome with great effort
5. Insurmountable barrier

a. don't know
b. I choose not to answer

Vendors inability to effectively deliver an acceptable product
1. Not a barrier
2. Barrier easily overcome
3. Barrier overcome with some effort
4. Barrier overcome with great effort
5. Insurmountable barrier

a. don't know
b. I choose not to answer

Acceptance by the staff
1. Not a barrier
2. Barrier easily overcome
3. Barrier overcome with some effort
4. Barrier overcome with great effort
5. Insurmountable barrier

a. don't know
b. I choose not to answer

Difficulty proving quantifiable benefits
1. Not a barrier
2. Barrier easily overcome
3. Barrier overcome with some effort
4. Barrier overcome with great effort
5. Insurmountable barrier

a. don't know
b. I choose not to answer

Lack of a strategic plan for introducing application
1. Not a barrier
2. Barrier easily overcome
3. Barrier overcome with some effort
4. Barrier overcome with great effort
5. Insurmountable barrier

a. don't know
b. I choose not to answer

Recruiting experience IT personnel
1. Not a barrier
2. Barrier easily overcome
3. Barrier overcome with some effort
4. Barrier overcome with great effort
5. Insurmountable barrier

a. don't know
b. I choose not to answer

Retaining experience personnel
1. Not a barrier
2. Barrier easily overcome
3. Barrier overcome with some effort
4. Barrier overcome with great effort
5. Insurmountable barrier

a. don't know
b. I choose not to answer

Insufficient knowledge of IT applications
1. Not a barrier
2. Barrier easily overcome
3. Barrier overcome with some effort
4. Barrier overcome with great effort
5. Insurmountable barrier

a. don't know
b. I choose not to answer

Requirement of a considerable investment in IT applications
1. Not a barrier
2. Barrier easily overcome
3. Barrier overcome with some effort
4. Barrier overcome with great effort
5. Insurmountable barrier

a. don't know
b. I choose not to answer

James Anderson is currently a professor of medical sociology and health communication at Purdue University. He is a fellow of the American College of Medical Informatics. He earned a BES in chemical engineering and an MSE in operations research and industrial engineering, MAT in chemistry and mathematics, and a PhD in education and sociology from the Johns Hopkins University. He has served as director of the Social Research Institute (1995-1998), and co-director of the Rural Center for AIDS/STD Prevention (1994-Present). Dr. Anderson is the author/co-author of five books including Evaluating the Organizational Impact of Health Care Information Systems*, Springer, 2005;* Ethics and Information Technology: A Case-Based Approach to a Health Care System in Transition*, Springer, 2002; and* Evaluating Health Care Information Systems: Methods and Applications*, Sage, 1994. His work has been recognized by outstanding research awards by the American Association for Medical Systems and Informatics (1983), the Association of American Medical Colleges (1988), the Alliance for Continuing Medical Education (1995), and the American Medical Informatics Association (1997). He currently serves on the editorial board of the American Medical Informatics Association; as the chair of the Quality Improvement Working Group and past chair of the Ethical, Legal, and Social Issues Working Group of the American Medical Informatics Association; associate vice-president for Simulation in Health Care of the Society for Computer Simulation International; and past chair of the Section on Communication and Information Technologies of the American Sociological Association.*

Andrew Balas serves as the dean of the College of Health Sciences and professor of community health at Old Dominion University in Norfolk, Virginia. His areas of expertise include development of policy priorities for the production of new scientific knowledge responsive to public health needs, and application of advanced information technologies to improve health outcomes. He is a member of the Healthcare Information Technology Advisory Panel of JCAHO and the board of directors of the American Medical Informatics Association. He is an elected member of the European Academy of Sciences and Arts and the American College of Medical Informatics. As a Congressional Fellow, Andrew Balas worked on health care legislation for the Public Health and Safety Subcommittee and his contribution has been acknowledged in the Records of the United States Senate. His credentials include more than 100 publications, including reviews and editorials in the Journal of the American Medical Association (JAMA)*,* British Medical Journal*,* Archives of Internal Medicine*, and other periodicals. During the last 10 years, he has been responsible for over 10 million dollars of externally funded research as principal investigator/project director. Prior to his current position, he served as dean of School of Public Health at Saint Louis University, director of the Missouri European Union Center and Weil Distinguished Professor of Health Policy at the University of Missouri-Columbia. He obtained degrees in medicine (MD), medical informatics (PhD), and applied mathematics.*