

Refereed paper

Adoption and use of health information technology in physician practice organisations: systematic review

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ABSTRACT

Background Health information technology (HIT) has the potential to improve clinical outcomes, increase health provider productivity and reduce healthcare costs. Over half of all patient care is delivered in physician practice organisations, yet adoption and utilisation of HIT in these groups lags behind inpatient facilities.

Objective To better understand current utilisation rates along with benefits and barriers to HIT adoption in physician practice organisations.

Methods Published literature on the adoption and use of HIT in physician practice organisations within the USA between 12 January 2004 and 12 January 2009 and indexed in MEDLINE and EMBASE was included in the systematic review. Grey literature was also searched. Studies related to the adoption and use of HIT in hospitals and community health centres were excluded.

Results A total of 119 articles were eligible for inclusion in the review. Adoption rates across physician groups remain low, with between 9% and 29%

of practices having implemented electronic medical records. HIT improves clinical outcomes, increases the use of vaccinations and improves medication adherence. Furthermore, HIT adoption leads to cost savings for physician groups, improves staff productivity and enriches patient–provider interactions. The largest barrier to HIT adoption in physician groups is the high initial and ongoing costs of electronic systems. Lack of sufficient training, a disorganised or non-receptive practice culture and technological problems such as inadequate connectivity appear to impede effective HIT use.

Conclusions HIT has the potential to positively impact on physician practice organisations, although significant and diverse barriers block adoption. Research into these obstacles should be coupled with efforts to understand barriers to effective implementation after HIT adoption.

Keywords: computerised medical records systems, electronic health records, medical informatics

What this paper adds

- Evidence shows that HIT has the potential to benefit physician practice organisations by improving clinical and economic outcomes.
- Future research should be conducted on a larger scale to test interventions to overcome implementation obstacles in physician groups of varied size, specialty and affiliation.

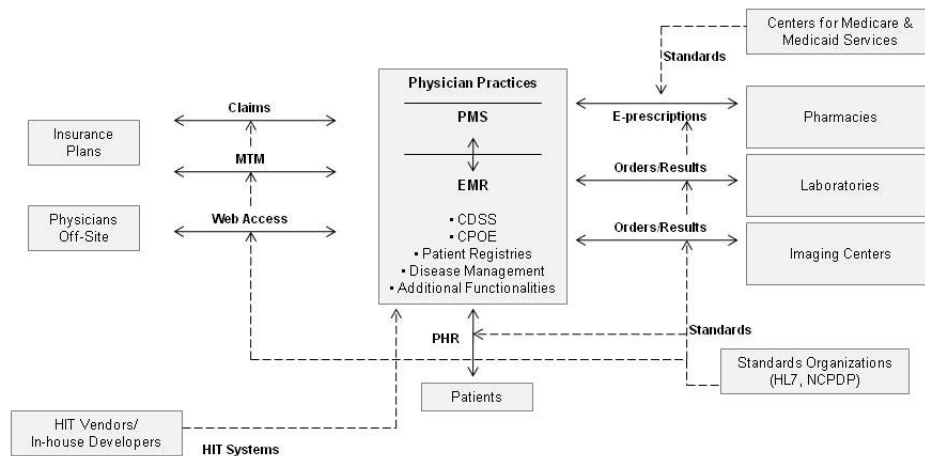
Introduction

Health information technology (HIT) encompasses a broad range of hardware, software and networking technologies whose primary purpose is to collect, store and transmit health data among the different stakeholders of the healthcare system (Figure 1).¹ The potential of HIT to improve healthcare delivery in the USA has been recognised by the National Committee for Quality Assurance (NCQA), the Agency for Healthcare Research and Quality (AHRQ) and the Government Accountability Office (GAO), but Americans continue to lag behind much of Europe and Asia in the implementation of HIT within primary care. The NCQA's Physician Practice Connection programme was established to recognise physician groups that use HIT to improve patient care, and the GAO has issued a series of strategic recommendations on how to improve HIT adoption. In addition, under the 2009 Health Information Technology for Economic and Clinical Health (HITECH) Act, physician groups are eligible to receive financial incentives for implementing and utilising electronic medical records (EMRs).

As evidenced by the support of US clinical and policy organisations, HIT is viewed as a potential solution for a variety of significant problems believed to result from insufficient communication about patient information among healthcare providers. Among the

applications with the greatest potential for improving patient care and for saving healthcare costs is the use of HIT in outpatient care. The focus of this paper was physician groups and not integrated care organisations such as the US Department of Veterans Affairs (VA). Outpatient physician groups, primary or specialty care groups that are either independently owned by providers or affiliated with an academic medical centre or integrated care delivery network, play a vital role in the US healthcare system. In fact, small physician practices represent the primary source of healthcare delivery in the USA.² However, these practices lag behind integrated medical centre and community hospitals in their level of HIT adoption. Failure to adopt and efficiently utilise HIT eschews any potential clinical or financial benefits to physician group practices. Therefore, it is important to understand what is inhibiting their adoption of HIT, and identify any factors that might predict or thwart the successful utilisation of HIT in the physician group environment.

In this study, a systematic review was conducted of the recent literature related to the adoption and utilisation of HIT in physician practice organisations. Current levels of HIT adoption by physician groups and the potential benefits of HIT applications for outpatient physician groups were reviewed, along with current barriers and potential approaches to overcoming those barriers and improving adoption rates. Rigorous evaluation of the literature will allow us to identify



Abbreviations:

- CDSS Clinical decision support systems
- CPOE Computerised physician order entry
- EMR Electronic medical record
- HIT Health information technology
- HL7 Health Level Seven
- MTM Medical treatment management
- NCPDP National Council for Prescription Drug Programmes
- PHR Patient health record
- PMS Practice management system

Figure 1 HIT landscape for physician practices

knowledge gaps and make recommendations on the future direction of research.

Methods

Clinical and scientific databases utilised for this systematic review included the US National Library of Medicine's (MEDLINE) system, and the Excerpta Medica Database (EMBASE). A search of the 'grey' literature, citable material not indexed in MEDLINE or EMBASE, was also conducted. We systematically reviewed MEDLINE and EMBASE-indexed, English-language literature between 12 January 2004 and 12 January 2009 on human research related to the adoption and use of HIT in US physician practice organisations. Articles were required to have abstracts related to full-length publications. To obtain articles on HIT implementation and utilisation, we required that one or more of the following keywords or phrases appear in the article title: 'information technolog*', 'information system*', 'informatic*', 'pharmacoinformatic*', 'electronic medical record*', 'EMR' or 'smartphone*'. The search also was constructed to eliminate any articles with the phrases 'EMR technique', 'endoscopic mucosal resection', 'translational research' and 'in-vehicle', or the words 'geographic', 'military', 'veterans' or 'cybernetics' in the article title. Articles were not limited by study type. The search excluded review articles published in 2004 and 2005 as well as studies published outside the USA. Figure 2 presents these details of the search strategy, along with other exclusion criteria.

The search strategy identified 681 unique MEDLINE-indexed articles and 919 EMBASE-indexed publications for inclusion, although there was significant overlap. All of the abstracts were examined manually to identify whether the publications should be retrieved in full text for further review. For the purposes of this research, 'physician practice organisations' were defined as primary or specialty care groups that are either independently owned by providers or affiliated with an academic medical centre or integrated care delivery network. We excluded 118 MEDLINE-indexed articles because they pertained to the adoption or use of HIT in a hospital or other inpatient care setting, and 109 unrelated to the use of HIT. From the remaining MEDLINE-indexed articles, we excluded an additional 214 articles pertaining to a variety of other topics. Among the EMBASE-indexed articles, we excluded 528 articles that overlapped with the MEDLINE search as well as an additional 360 articles for reasons listed in Figure 2.

In total, 240 MEDLINE-indexed articles and 31 EMBASE-indexed articles were retrieved in full text. Upon further examination of these publications, we excluded 153 from MEDLINE and 26 from EMBASE. Ultimately, 90 MEDLINE-indexed and five EMBASE-indexed publications from these searches were identified as eligible for inclusion.

As our full-text review did not yield sufficient information on the use of electronic prescribing technology in physician practice organisations, we conducted a subsequent search of MEDLINE-indexed, English language-literature on human research published in the past five years using the key words 'electronic prescribing', 'e-prescribing', 'ambulatory', 'outpatient' and 'physician practice'. The search yielded approximately 21 articles. After excluding nine articles unrelated to the use of e-prescribing in physician practice groups, we identified 12 articles eligible for inclusion.

We also conducted a 'grey' literature search for non-MEDLINE or non-EMBASE-indexed material meeting our search criteria. We searched the websites of clinical informatics, information technology and healthcare quality organisations including, but not limited to, the Institute of Medicine, the Agency for Healthcare Research and Quality and the Commonwealth Fund, for articles, pilot programmes or issue briefs containing the keywords 'health technology', 'HIT' or 'medical technology'. We also searched these websites for general information on health technology utilisation or initiatives related to HIT adoption in outpatient settings (see Figure 2).

Results

In total, we identified 119 literature sources for inclusion in this systematic review. Overall, our findings indicate an especially active pace of research on this topic. Recent studies focus on current utilisation rates, benefits to adopting HIT in the practice environment and barriers to both implementing and effectively using various technological systems. While much of the literature focuses on EMR components, some also discuss the impact of additional systems, including electronic prescribing software and CPOE, on improving care delivery in physician organisations. A summary of articles related to the current use of HIT is presented in Table 1. Table 2 lists the studies that evaluate EMR applications used in improving patient care delivery, while Table 3 lists studies on EMR applications being evaluated for use in providing quality assessments and improvements.

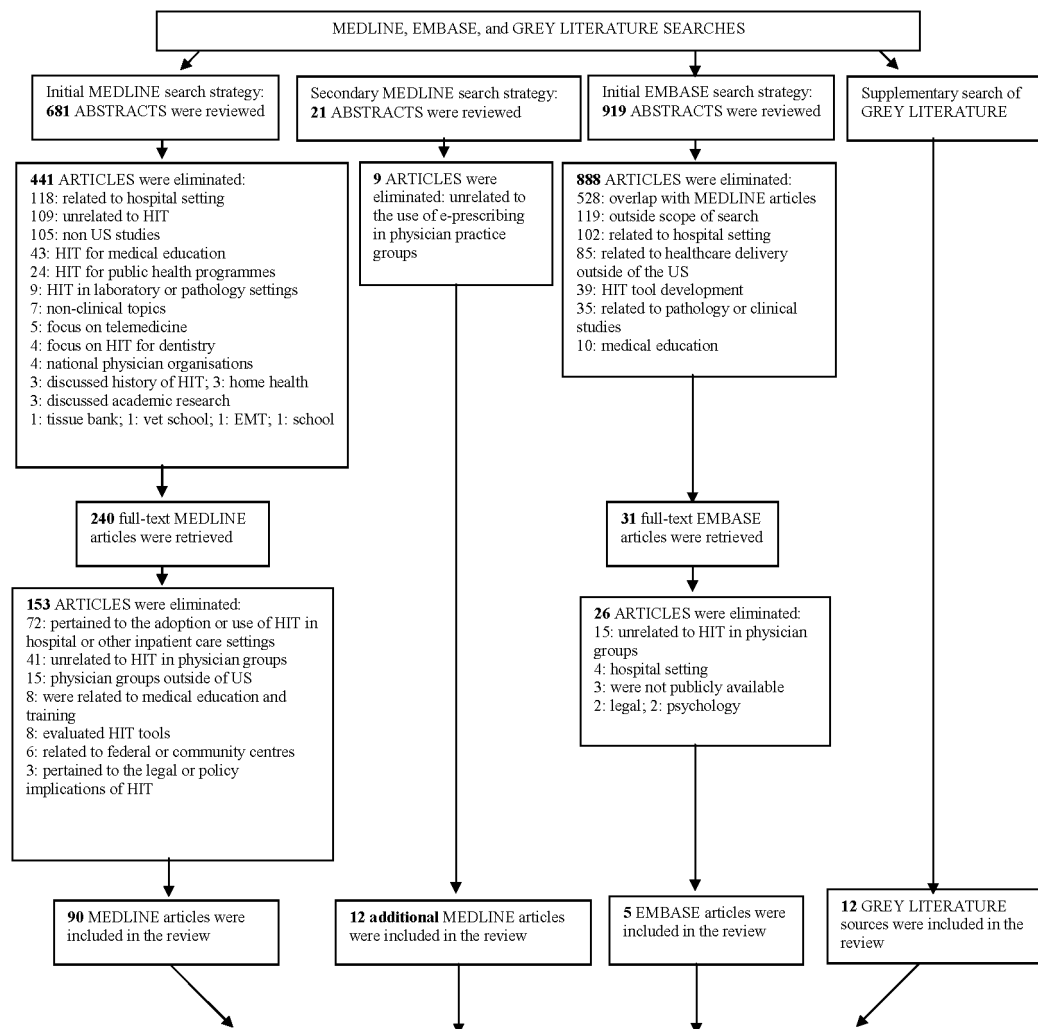


Figure 2 Description of search strategy

Predictors and barriers to HIT adoption

Although recent analyses have documented the diverse benefits of HIT, adoption rates remain low among physician practice organisations. The high cost of implementation, potential loss of productivity, size and location of physician practice, influence of stakeholders and the transition from a paper-based to an electronic system represent significant challenges to widespread adoption.

Much of the literature discusses barriers to HIT integration, with a smaller portion focusing on strategies to encourage adoption by physician groups. Within this body of literature, ten primary studies focus on financial barriers to adoption, including eight physician surveys, one time-and-motion study and one cross-sectional study. Three of the practitioner surveys that discuss financial barriers to HIT adoption also focus on practice-related predictors and barriers. Four

survey studies discuss various organisational or policy-related barriers to adopting HIT in physician practice groups, while one survey and one physician focus group focus on issues of technology and medical privacy that hinder HIT implementation. The literature on staff-related barriers is limited to systematic and narrative reviews.

Financial barriers

According to two recent studies, the initial and ongoing cost of HIT remains the single largest barrier to widespread adoption among physician practice organisations.^{3,4} With the upfront cost of purchasing and installing an electronic system ranging from \$15 000 to \$50 000 per physician, it is not surprising that 55% of physicians surveyed by the Medical Records Institute cited lack of adequate funding as the primary barrier to adopting HIT in their practices.^{1,5} Supporting this statistic are findings from seven recent physician

Table 1 Current levels of HIT adoption and use

Author, year	Years of study	Sample	HIT adoption level	Factor associated with difference
Poon <i>et al</i> 2006 ²	NR	NR	Adoption rates for clinical applications of HIT are extremely low compared with adoption rates for PMS	NA
Schöen <i>et al</i> 2006 ⁶	NR	NR	Access to comprehensive HIT is lower for US physicians compared with those in western Europe, Australia and New Zealand	Geographic
Linder <i>et al</i> 2007 ⁷	2003–2004	50 000 ^a	Only 18% of ~1.8 billion ambulatory visits in the US involved use of EMRs	NA
Hing <i>et al</i> 2007 ⁸	2006	1311 ^b	29.2% of office-based physicians used some form of EMR; of these, 12.4% used comprehensive EMR systems	NA
Des Roches <i>et al</i> 2008 ⁹	2007–2008	2758 ^b	13% of physicians had basic EMR systems; 4% used fully functional EMR systems	NA
Simon <i>et al</i> 2007 ¹⁰	2005	1345 ^b	23% of practices in Massachusetts adopted EMR systems; 52% of practices with ≥ 7 physicians and 14% of solo practices had an EMR	Practice size
Grossman <i>et al</i> 2006 ¹¹	2000–2001; 2004–2005	18 600 ^b	Gaps in HIT adoption between practices with ≤ 9 physicians and those with ≥ 50 physicians grew from 27% in 2001 to 38% in 2005	Practice size
Grant <i>et al</i> 2006 ¹²	NR	NR	Practices with 1–2 physicians are less likely to use simple HIT technologies compared with larger practices	Practice size
Menachemi <i>et al</i> 2007 ¹³	NR	4203 ^b	Differences exist in EMR use between urban and rural physician groups	Practice size; practice type
Corey <i>et al</i> 2007 ¹⁴	2004–2005	NR ^b	Adoption rates for many HIT functionalities are lower for surgeons than for medical specialists and primary care physicians	Physician specialty
Menachemi <i>et al</i> 2006 ¹⁵	NR	4203 ^b	EMR use was lower among general paediatricians (13.7%) compared with family physicians (26.1%) and paediatric sub-specialists (29.6%)	Physician specialty

NR Not reported; NA Not applicable; ^a Patient records; ^b Physician surveys

surveys on the adoption and utilisation of HIT within physician practices; between 60% and 85% of these physicians cited the initial and ongoing costs of technology purchase and implementation as the single most important barrier to adoption.^{9–11, 15–18} The hesi-

tation to financially commit to HIT stems from uncertainty about eventual returns on investment.¹⁹ In a survey of 2758 practicing physicians, 50% expressed concern that their practice would not see returns on investing in an EMR.^{2,9,20,21} Physicians

Table 2 Studies of EMR-based applications for improved patient care delivery

Patient indications	EMR applications	Objectives	Study
Screening Cancer	Patient portals	Evaluation of the impact of patient corrections to their own EMR data via a patient portal on the rate of cancer screening and immunisation compliance	Staroselsky <i>et al</i> 2005 ²²
Cancer	<ul style="list-style-type: none"> • Patient outreach • Automated reminders 	Case study of the impact of EMR applications in a small physician practice on mammography rates	Baron <i>et al</i> 2007 ²³
Developmental delays	EMR documentation of screening	Review of EMR documentation of screening for developmental delay in six healthcare organisations	Jensen <i>et al</i> 2009 ²⁴
Immunisation Influenza	Patient rosters	Evaluation of monitoring of high-risk asthma patients requiring immunisation	Martin <i>et al</i> 2006 ²⁵
	Physician alerts	Identification of asthma patients who should be vaccinated	Fiks <i>et al</i> 2009 ²⁶
Routine paediatric immunisation	Physician alerts	Evaluation of the impact of EMR-associated alerts on paediatric immunisation rates for inner-city children	Fiks <i>et al</i> 2007 ²⁷
Chronic disease management Cardiac risk	Automated EMR-based assessment of cardiac risk	Comparison of the accuracy of an automated EMR-based cardiac risk classification of patients and treatment recommendations versus physician determinations of patient treatment based on manual chart reviews	Persell <i>et al</i> 2009 ²⁸
Diabetes	<ul style="list-style-type: none"> • EMR-associated electronic messaging • EMR documentation of patient care 	Comparison of diabetes healthcare team coordination in four different care team models using EMR systems for team communication	MacPhail <i>et al</i> 2009 ²⁹
Diabetes	EMR system	Comparison of practice compliance with diabetes guidelines and patient outcomes as a function of EMR use	Orzano <i>et al</i> 2007 ³⁰
Diabetes	<ul style="list-style-type: none"> • CDSS • Prompts and reminders 	Comparison of practice compliance with diabetes guidelines and patient outcomes as a function of EMR use	O'Connor <i>et al</i> 2005 ³¹
Multiple chronic diseases	<ul style="list-style-type: none"> • EMR with CDSS and e-prescribing • Patient web portal • Web-based immunisation registry 	Case study of EMR strategies implemented by Marshfield Clinic to improve preventive care and the management of chronic diseases	McCarthy <i>et al</i> 2009 ³²

Table 2 Continued

Patient indications	EMR applications	Objectives	Study
Obesity	<ul style="list-style-type: none"> • Patient intervention lists • Telehealth services Documentation in EMR	Evaluation of the impact of EMR implementation on the documentation of patient obesity and decision to provide medical treatment	Bordowitz <i>et al</i> 2007 ³³
Other patient care Osteoporosis	Automated reminders	Evaluation of the impact of reminders on guideline compliance for patient testing and treatment	Feldstein <i>et al</i> 2006 ³⁴
Tobacco use	<ul style="list-style-type: none"> • Smoking status icons • Automated reminders • Smart form 	Evaluation of the impact of HIT prompts and reminders on the level of patient interventional care by healthcare providers	Linder <i>et al</i> 2009 ³⁵
Patient safety Risk of falls in the elderly	Electronic messaging through the EMR	Evaluation of the impact of EMR-based intervention to notify physicians of risk for falls based on age and medication use	Weber <i>et al</i> 2007 ³⁶

bear the entire financial brunt of investing in practice-wide HIT, while clinical benefits accrue to patients and payers of healthcare services.^{1,2,45}

The loss of revenue that could occur if HIT implementation were to disrupt access to patient data, or interfere with staff productivity, constitutes another barrier to adoption.¹³ Pre-adoption discussions on whether to automate an existing paper database, or entirely rethink practice workflow, can prompt physician apprehension over how introducing HIT could impact efficiency and productivity.⁴⁶ Three recent provider surveys indicate that many physicians cited the upfront, and possibly continued, loss of productivity associated with the transition from a paper-based to electronic system of data management as a barrier to HIT adoption.^{2,15,17} In cases where practice revenue depends on productivity rather than outcomes, resistance to the adoption of EMR is particularly challenging.² There is also evidence to suggest that there is a perception that the HIT integration process results in diminished productivity, despite data to the contrary; although a recent time and motion study found that the overall time spent per patient during office visits decreased after a physician group implemented an EMR, only 25% of surveyed practitioners reported time savings.⁴⁷

Differences in the type and source of physician group revenue and participation in quality initiatives or incentive programmes also are associated with differences in the adoption of HIT. One recent study of 25 primary care clinicians found that a practice group's decision to adopt e-prescribing technology primarily depended on the presence of financial incentives from insurers.¹⁸ According to a recent study, physician groups with higher Medicaid and capitation-based revenue were more likely to implement HIT and use electronic systems for developing treatment guidelines.⁴⁸ An integrated EMR facilitates the exchange of information among providers and may be more valued among group practices that operate within a capitated reimbursement agreement. Additionally, Medicaid's value-based purchasing initiatives with managed care groups are usually based on quality performance initiatives; physician organisations with greater proportions of Medicaid patients may find it helpful to purchase HIT as a tool to monitor clinical performance.^{48,49} It has been suggested that healthcare payers and purchasers provide additional financial incentives, or front the capital required for HIT integration in order to increase the levels of adoption in physician practice groups.^{9,16,50} Some practitioners

Table 3 Studies of EMR-based quality applications

Patient indications	EMR applications	Objectives	Study
Asthma, behaviour and mental health, cancer screening, diabetes, well child and adolescent care, women's health	HEDIS performance metrics	Evaluation of performance based on HEDIS measurements as a function of EMR adoption	Zhou <i>et al</i> 2009 ³⁷
Cancer: breast	Performance metrics	Evaluation of the quality of breast cancer prevention based on process and outcome measures	Baldwin 2006 ³⁸
Chronic disease: asthma, adult diabetes, heart failure, hypertension, stable coronary artery disease (CAD) and major depressive disorder	<ul style="list-style-type: none"> • Disease registries • Central data warehousing • Performance metrics 	Feasibility studies for the application of clinical performance measures and tools	Keyser <i>et al</i> 2009 ³⁹
Diabetes	<ul style="list-style-type: none"> • Performance feedback • Reminders 	Evaluation of the impact of performance feedback and/or reminders on diabetes control	Zeimer <i>et al</i> 2006 ⁴⁰
Diabetes	<ul style="list-style-type: none"> • Audits • Performance feedback • Reminders 	Evaluation of the impact of audits, performance feedback, reminders and financial incentives on compliance with best practice measurements and diabetes control	Weber <i>et al</i> 2007 ⁴¹
Neuromuscular disorders	Patient outcome reporting	Evaluation of the implementation of functional status outcome reporting for clinical practice improvement	Deutscher 2008 ⁴²
Pharyngitis	Performance metric	Assessment of compliance with diagnostic testing for streptococcal pharyngitis in accordance with Health Plan Employer Data and Information Set (HEDIS)	Benin <i>et al</i> 2005 ⁴³
Unspecified	Quality reports	Evaluation of the utility of clinical quality reports	Jung 2006 ⁴⁴

also have suggested that US government organisations facilitate HIT implementation by assisting physician groups with the initial capital costs.^{21,51} A survey of Massachusetts physician groups indicated that organisations with access to financial incentives were between 21% and 31% more likely to implement an EMR.¹⁰

Staff-related barriers

Physician and staff perceptions and attitudes about technology adoption represent another significant barrier to HIT implementation. Evidence suggests that the positive attitudes of practitioners can significantly predict the acceptance and eventual implementation of HIT into practice organisations.⁵²⁻⁵⁴ The perception

that switching to an electronic system would disrupt the delivery of care indicates a greater unwillingness to change prevalent in the physician community.⁵⁵ Strategies to combat this resistance include fostering a culture of communication and cooperation and involving the eventual users of HIT in the implementation process; studies have indicated that providers invested in long-term practice success and adaptation are more likely to successfully adopt HIT.^{53,55–57}

Practice-based predictors and barriers

Practice size, type and affiliation also impact the likelihood of implementing HIT. Large physician practices appear far more likely than small practices to adopt HIT systems, primarily due to the substantial purchase and integration costs.⁵⁸ Three recent surveys note that physicians practising in larger groups of more than four are more likely to use all components of an EMR system and supporting technologies.^{6,10,11} In a survey of Massachusetts medical practice groups measuring predictors of HIT implementation, practice size was the strongest independent correlate of EMR adoption; compared with solo practices, groups with four to six physicians were almost twice as likely (OR 1.66) and those with over seven physicians were nearly four times as likely (OR 3.66) to have an EMR.¹⁰ The same survey also identified teaching or hospital affiliation as a predictor of EMR adoption. Poon *et al* also note that practice groups affiliated with integrated delivery networks have greater access to the funding needed to adopt comprehensive versions of an electronic system.²

External policies and organisational barriers

The influence of external stakeholders and internal organisational policies also affects HIT adoption. Quality improvement and pay-for-performance initiatives instituted by US health insurers can help accelerate the adoption of HIT in physician practice groups.^{55,59–61} A 2007 nationwide survey of physician groups with 20 or more practitioners found that HIT adoption was higher in groups motivated and evaluated by external pay-for-performance initiatives ($P=0.042$) or that participated in a quality improvement programme ($P<0.01$).^{55,61} A second survey of 1014 paediatricians indicated that direct pay-for-performance incentives were associated with implementation of an EMR system in practice organisations.⁶² Results from a survey of Massachusetts medical groups also indicate that external stakeholders play an important role in organisational HIT implementation. According to the survey, practice groups that had not yet adopted an EMR were more likely to report influence by outside sources, and 19% reported that the state

medical society and other committees played a role in their adoption decisions.¹⁰ Internal policies can also have an impact on the choice to adopt HIT; 50% of respondents to the survey of Massachusetts medical providers identified political and structural issues within their practice groups as the most important factors influencing EMR adoption.^{1,10,63}

Technological barriers

Finally, issues surrounding the security, appropriateness and feasibility of HIT represent significant barriers to adoption among physician practice organisations. Concerns about the privacy and confidentiality of patient information stored and accessed within an electronic system remain obstacles to EMR implementation.^{1,3,17,50,56,64} A 2006 survey of paediatricians noted that practitioners were apprehensive about maintaining patient privacy within an EMR system, and expressed reluctance to share the possibility of HIT utilisation with patients in their practices.¹⁵ Findings from ten physician focus groups also highlight concerns about the technical capabilities and overall 'fit' of HIT to physician group environments.⁶⁵ Some authors have speculated that the significant variability in HIT adoption across practice specialties may stem from the fact that existing EMR systems do not meet the clinical needs of certain physician organisations.^{11,14,15} There are also issues with the lack of standards for how patient data should be managed, coded and represented within an electronic record.^{4,15,56} To mitigate this, studies suggest that customisation of any EMR system be slow and incremental to account for the preferences of practice environments.^{66,67} Development of a non-profit government organisation tasked with creating standards for healthcare data organisation could also facilitate the HIT adoption process.⁴

Predictors and barriers to effective HIT utilisation

Although most of the recent literature describes barriers to adopting HIT, some also addresses the issues physician groups encounter in actually using HIT effectively after it has been fully implemented. A lack of sufficient staff education and training on new systems, resistance to change and technology that fails to deliver anticipated benefits are all obstacles to effective utilisation of HIT. Three primary prospective studies focus on educational barriers to effectively utilising HIT in physician organisations, while one staff survey discusses the impact of practice culture on utilisation rates. Additionally, one cross-sectional survey and two case studies highlight technological barriers to effective utilisation.

Educational barriers

Five recent studies indicate that adequately training all staff within a physician group to utilise new technologies is essential to the clinical success of HIT.^{54,68–71} After implementing an electronic performance system at a cardiovascular physician group, practitioners reported that the time required to train staff constituted a substantial barrier to utilising the new system. Additionally, a study of 14 solo or small group practices using an EMR system reported that physicians worked longer hours for four months after implementation as they adjusted to the new technology.⁶⁰ A further study on five outpatient practices attempting to adopt and utilise e-prescribing systems noted that ‘unsuccessful’ facilities reported both a limited understanding of the software and of how the system could benefit their practices. In contrast, organisations successful in utilising e-prescribing software reported greater familiarity with the capabilities and purpose of the system.⁷² Research suggests that sufficient training time must be built into any HIT implementation schedule; early identification of physicians who may need extra time to learn the system will help improve use and minimise time burdens.^{47,73}

The impact of practice culture

Organisational and structural deficiencies within a practice culture also can derail effective utilisation of HIT. A lack of commitment to HIT integration and a structural organisation unwilling to adapt will impact technology utilisation regardless of practice size or specialty.^{11,57,74} A study of 27 hospital-affiliated physician practices identified practice culture as the most important factor influencing HIT use.¹¹ A similar analysis noted that ‘organisational trust’ and ‘adaptive practice culture’ are two factors that positively influence the utilisation of e-prescription technology within a physician organisation.⁷⁵

Technological barriers

Finally, systemic flaws with the technology itself prevent physician groups from realising the full benefits of HIT. Connectivity and interoperability problems were cited as barriers to effective utilisation in two recent studies.^{59,32} A cross-sectional survey of 225 primary care providers reported that 52% of physicians had connectivity issues with their EMR during patient visits.⁷⁶ Although it is optimal for HIT systems to be able to directly exchange information, true system interoperability has yet to be achieved. Full health information exchange (HIE), the exchange of electronic health information between organisations while maintaining data integrity, requires the development of a number of electronic and data standards,

including standards for message formats, nomenclature for drug databases and the documentation of patient medication histories.⁷⁷ Many of these standards are still currently under development through collaborations between CMS (Centers for Medicare and Medicaid Services) and HIT vendors and health-care providers.⁷⁷ The accessibility and usefulness of EMR data also is an issue; software must enable providers to visually access patient information in a manner that is intuitive and clinically meaningful.^{3,78}

Discussion

Principal findings

Our systematic review of literature on the adoption and utilisation of HIT in physician practice organisations indicates that this topic has been an active area for research over the past five years. The most thoroughly investigated technology has been EMR; it is likely that government and payer-driven quality initiatives are prompting interest in understanding the gaps in adoption of this system. Despite studies demonstrating the clinical, financial, staff and patient-related benefits of HIT, implementation rates remain low, particularly for fully comprehensive EMR systems. The literature has identified predictors of adoption including practice size, specialty and location and the influence of external stakeholders, but has recently focused on understanding the diverse barriers to HIT implementation which range from lack of adequate funding to fears of organisational change. There has been less emphasis in the recent literature on understanding obstacles to effectively utilising (as opposed to adopting) HIT.

Implications

There is a substantial body of evidence suggesting that HIT has the potential to benefit physician practice organisations. The recent literature has discussed how EMR systems are tied to clinical improvements such as increased screening efforts, medication adherence and more timely delivery interventions. By allowing physicians to document measurable patient outcomes, EMR systems also can help physicians evaluate the quality of their patient care. Practice organisations that participate in care improvement initiatives, or are evaluated by external quality organisations, are able to use EMR components to generate performance metrics. Additionally, HIT adoption has been associated with increased physician productivity and downstream cost savings for physician practices.

Comparison with the literature

The findings from this systematic review are consistent with previous publications. Recent studies have shown low adoption rates for HIT and have emphasised the important impact of these technologies on patient outcomes.^{79–81} Similar to our study, Kaushal *et al* found that physician characteristics and financial status were barriers to HIT adoption.

The literature identifies lack of upfront and continued organisational funding as the main barrier to physician groups' ability to implement. However, recent national policy decisions may impact on future research in this area. Under the 2009 Health Information Technology for Economic and Clinical Health (HITECH) Act, physician groups are eligible to receive up to \$44 000 in total incentives per provider from Medicare, and up to \$65 000 from Medicaid, for 'meaningful use' of a fully certified EMR starting in 2011. While the effects of this policy have yet to be realised, it is reasonable to assume that it will alter or diminish financial obstacles to EMR adoption. Despite this change in HIT financing, significant non-financial barriers still impede use of EMRs and should continue to be studied. Physician perceptions that EMR systems decrease clinical productivity, erode patient confidentiality, lack relevance to their specialty and damage the patient–provider relationship will continue to play a major role in the decision to adopt both EMR and other technical modalities.

Regarding the implementation of HIT within primary care, Americans continue to lag behind much of Europe and Asia. Unlike a study from the UK which found that almost all British practitioners use computers in their consulting rooms,⁸² our study found very low adoption rates across physician groups. It is clear from the UK study that incentives are helpful in overcoming large barriers to HIT adoption (i.e. high initial and ongoing costs); however, the USA has yet to find this same success.

Limitations

This systematic review of the current use of HIT by physician practice organisations has several limitations. First, our definition of 'physician practice organisations' was based on an arbitrary set of criteria (defined as primary or specialty care groups that are either independently owned by providers or affiliated with an academic medical centre or integrated care delivery network) and may have impacted on the selection of relevant literature for this review. In our search criteria, we only included these physician practice organisations and excluded any integrated care organisations such as the VA, which represents a limitation to our

conclusions. We encourage others to expand an analysis such as ours to these other types of organisations for a comprehensive assessment of the state of HIT across a variety of different healthcare delivery organisations in the US system. Second, observations about the pace of research and patterns identified in the literature are limited to the past five years (2004–2009) of published and non-published material, although this has been the primary timeframe for the widespread availability of HIT systems. Finally, the scope of our review did not permit a discussion of telemedicine, an area of new technology that merits further investigation as it relates to the use of HIT within physician groups.

Call for further research

The body of literature on HIT adoption in physician practices is robust, but there are important areas where current research should be expanded. The bulk of primary studies in recent years have focused on the benefits and associated barriers to EMR systems, with less emphasis on the implementation of computerised physician order entry systems (CPOE), e-prescribing technology, physician management systems (PMS) and clinical decision support systems (CDSS) in physician organisations. Like EMR, these HIT applications have the potential to substantially improve how care is delivered in physician organisations. PMS allow physician practices to easily handle billing and claims, while e-prescribing allows for automatic transfer of practitioner medication orders directly to the pharmacy. It is likely that these systems, along with other HIT components, present their own set of adoption barriers that must be explored to facilitate the introduction of these important technologies into practitioner organisations.

Research into obstacles to HIT adoption should be coupled with efforts to understand barriers to effective implementation after physician groups do adopt these systems. More than 75% of US healthcare is administered in an ambulatory setting, including care received after hospital discharge. After transfer from the hospital, any clinical improvements patients gain through hospital-wide HIT functionality may be attenuated by underinvestment in the appropriate use of technology in physician groups.² Several studies have highlighted the approaches to improving the effective use of HIT, including education and training of staff, creating a practice culture comfortable with change and receiving help with technical issues such as connectivity. Further research must be conducted on a larger scale to test interventions to overcome implementation obstacles in physician groups of varied size, specialty and affiliation.

Conclusions

HIT has the potential to positively impact physician practice organisations, although significant and diverse barriers block its adoption. Given recent mandates and recommendations from both government and private organisations, research into these obstacles should be coupled with efforts to understand barriers to effective implementation after physician groups have adopted these systems. Furthermore, future research should focus on efforts to improve the use of HIT in the USA via a comparison of successful implementation in Europe and Asia.

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CONFLICTS OF INTEREST

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