journal homepage: www.intl.elsevierhealth.com/journals/ijmi

The use of health information technology in seven nations

Ashish K. Jha[a,*], *David Doolan*[b], *Daniel Grandt*[c], *Tim Scott*[d], *David W. Bates*[e]

[a] *Department of Health Policy and Management, Harvard School of Public Health, 677 Huntington Avenue, Boston, MA 02115, USA*
[b] *Information Technology and Telecommunications, Hunter New England Area Health Service, Australia*
[c] *Hospital of Saarbrücken, Saarbrücken, Germany*
[d] *School of Management, University of St. Andrews, UK*
[e] *Brigham and Women's Hospital, USA*

ARTICLE INFO

Article history:
Received 11 March 2008
Received in revised form
20 May 2008
Accepted 2 June 2008

Keywords:
International
Electronic health record
Health information exchange
Interoperability

ABSTRACT

Objective: To assess the state of health information technology (HIT) adoption and use in seven industrialized nations.
Design: We used a combination of literature review, as well as interviews with experts in individual nations, to determine use of key information technologies.
Main outcome measures: We examined rates of electronic health record (EHR) use in ambulatory care and hospital settings, along with current activities in health information exchange (HIE) in seven countries: the United States (U.S.), Canada, United Kingdom (UK), Germany, Netherlands, Australia, and New Zealand (NZ).
Results: Four nations (the UK, Netherlands, Australia, and NZ) had nearly universal use of EHRs among general practitioners (each >90%) and Germany was far along (40–80%). The U.S. and Canada had a minority of ambulatory care physicians who used EHRs consistently (10–30%). While there are no high quality data for the hospital setting from any of the nations we examined, evidence suggests that only a small fraction of hospitals (<10%) in any single country had the key components of an EHR. HIE efforts were a high priority in all seven nations but the early efforts have had varying degrees of active clinical data exchange.
Conclusion: We examined HIT adoption in seven industrialized nations and found that many have achieved high levels of ambulatory EHR adoption but lagged with respect to inpatient EHR and HIE. These data suggest that increased efforts will be needed if interoperable EHRs are soon to become ubiquitous in these seven nations.

1. Introduction

The costs of health care are rising rapidly in most industrialized nations and there is concern that despite high levels of spending, the quality and efficiency of care are suboptimal [1,2]. Further, there is substantial variation in patients' experiences and outcomes, even among a group of high-income industrialized nations [3].

Health information technology (HIT) in general and electronic health records (EHRs) in particular are increasingly viewed as tools for improving the quality, safety and efficiency of health systems [4]. Their benefits include providing real-time decision support to clinicians, making critically important clinical information available, and reducing unnecessary testing [5]. Moreover, models suggest that health information exchange will have substantial financial benefits

* *Corresponding author*. Tel.: +1 617 432 5551; fax: +1 617 432 4494.
E-mail address: ajha@hsph.harvard.edu (A.K. Jha).
1386-5056/$ – see front matter. Published by Elsevier Ireland Ltd
doi:10.1016/j.ijmedinf.2008.06.007

[6,7]. Despite the challenges associated with EHR adoption [8], their potential benefits have lead to substantial interest on the part of policy makers to speed up adoption and use across the globe.

A recent literature review suggests that EHR adoption rates in the U.S. are still quite low [9] and a survey by the Commonwealth Fund (CMWF) of EHR use among primary care physicians found that the U.S. lags far behind many other industrialized nations in HIT use in ambulatory care [10]. While primary care is an important component of the healthcare sector, it represents one part of the larger healthcare system. How the U.S. fares with EHR use in other clinical settings or in health information exchange compared to other industrialized nations is not well known.

We hypothesized that by comparing domestic EHR and HIE use rates to those of other nations, it could be possible to gain insights into how the U.S. might improve its own adoption of these technologies. Therefore, we sought to answer three questions: First, how does the U.S. EHR rate of use in the ambulatory and hospital setting compare to those of six other industrialized nations? Second, how does the use of health information exchange (HIE) compare? Finally, what role has the public sector played in improving HIT use in each of the seven countries?

2. Methods

2.1. Overview

Although there is no consensus about the definition of an EHR, we began by considering the functionalities identified by the Institute of Medicine. We then refined the definition based on the recent work by an expert panel convened on behalf of the Office of the National Coordinator for Health Information Technology. This panel recommended that a electronic system should have four core functions in order to be considered an EHR: electronic documentation of providers' notes, results management, physician order entry, and decision support [11].

Health information exchange (HIE) was defined as the exchange of clinical data such as problem lists, clinicians' notes, or other critical medical information from one provider organization (e.g., doctor's office) to another (e.g., hospital). In order to access the current status of EHR use and HIE across these seven nations, we used a combination of literature review, examinations of recent surveys, and interviews with experts.

2.2. Data

We began with a review of the literature by searching Medline for terms such as "computerized records," "electronic health records," "electronic medical records," and "health information exchange" within each of the seven nations in our study. Because there was a recently completed review in the U.S. [9], we used data from that study for our results on the use of EHRs in the U.S. We identified surveys or other published reports from 2000 through 2006 in each of the six other nations.

We also searched data from non-peer-reviewed literature by searching Google, Google Scholar, and other search engines using similar search terms and limiting those results to each of the six other nations of interest.

Finally, we identified experts in HIT in each of the seven nations. We attempted, whenever possible, to reach both governmental and non-governmental experts. In five of the seven nations, we were able to contact the leading governmental expert overseeing HIT adoption policies for the nation. In all seven nations, we were able to identify country-level experts by using a combination of efforts: examining the literature, speaking to national representatives of the International Medical Informatics Association for those countries, and speaking to leaders of important HIT-related efforts that were known to us to ask about their national experts. Through these different sources, we were consistently able to identify a set of individuals who were most knowledgeable about HIT adoption in their respective countries. When we felt satisfied that we had identified the best experts through these multiple approaches, we contacted those experts to discuss our survey findings and ask for their best estimates about the state of EHR adoption and HIE, as well as important facilitators of adoption, in their respective nations. In all seven nations, we were able to identify and speak with at least two independent experts.

We synthesized the results from each of these data sources to create either point estimates or a range of estimates, which we asked our independent experts (described above) to verify. If there was any substantial disagreement between the two independent experts, we planned on finding a third who could arbitrate differences of opinion.

3. Results

We found very few data sources that could definitively demonstrate how many physicians and hospitals had systems that fulfilled all four criteria of a "true" EHR as defined by the Office of the National Coordinator for Health Information Technology. The Commonwealth survey of primary care physicians inquired about all four functionalities of an EHR. It found that nations with high rates of adoption of electronic clinical documentation generally also had high rates of physician order entry, results viewing and decision support. However, none of the surveys we found specifically determined the percentage of doctors and hospitals that used all four of these functionalities. Therefore, our ability to make comparisons was limited by the differing definitions of an EHR, as these systems vary within and among nations.

3.1. EHRs in ambulatory care

Until the results of the Commonwealth Fund survey became available in late 2006, we were able to find survey results of EHR use among ambulatory physicians in only four of the seven nations: the United States, Canada, Australia, and the United Kingdom. For the other nations, we relied primarily on estimates based on expert opinions. In the U.S., the combination of the CMWF survey and several other high-quality surveys have made possible reasonable estimates of EHR adoption in ambulatory care: it is likely that between 24% and 28% of ambulatory care physicians use some form

of an HER [10,12–14] and that approximately 10% use a system including computerized physician order entry [9,14], although some estimates suggest that the CPOE rate may be as high as 22% [10]. Rates of EHR use vary widely by practice size: physicians who are in solo or two-person practices have significantly lower rates of EHR use (approximately 10% use some sort of an EHR) than physicians in large practices, where as many as half use some sort of an HER [14].

The rates of EHR use in Canada in primary care are comparably low: in 2004, only 16% of primary care and family physicians reported using electronic patient records, and 20% reported having electronic laboratory results [15]. The recent Commonwealth Fund study suggests that in 2006, 23% of Canadian physicians were using an EHR and 11% were prescribing medications electronically. The use of EHRs was higher in those Canadian provinces where governments provided financial incentives for EHR adoption.

In contrast, computerization of general practice in the United Kingdom is substantially higher than in the U.S. or Canada, with one study reporting that 97% of the 8810 practices in England use a system that includes clinical documentation by physicians [16]. A different survey across all of the United Kingdom found EHR use rates to be 89% among general practitioners (GPs) [10]. Nearly all GPs use these systems for managing laboratory results and recording clinical notes. Although nearly all prescriptions and laboratory tests are written electronically, transmission to the lab and pharmacy is far from universal. The computerization of the GP practice in the UK is due to a complex set of factors, including promotions of free computers, availability of inexpensive software and direct government funding of capital and recurrent costs of EHRs. Two GP suppliers (VAMP and AAH Meditel) introduced free computer schemes which eventually covered a large portion of all practices in England by the year 2000 [17]. The more recent NHS contract with GPs created a set of quality measurement and improvement requirements that further encouraged computerization of medical records [17]. Our experts suggested that the long list of quality measures involved has been central to ensuring that features such as decision support are widely used.

Germany and the Netherlands also had high rates of EHR use among ambulatory care providers. The data from the CMWF study suggests that approximately half of the GPs in Germany have an EHR, which was spurred on when computerized billing programs were upgraded with clinical documentation and results-viewing software. Surprisingly, although EHR adoption rates in Germany are modest, nearly 3 out of 5 German GPs have the ability to order prescriptions electronically [10]. Electronic transmission to the pharmacy is still uncommon.

The use of EHRs among GPs in the Netherlands was among the highest of the nations we examined: nearly all GPs in the Netherlands document clinical encounters electronically and have electronic results viewing. These results are borne out by the CMWF survey, which found that 98% of Dutch GPs reported having an EHR and 78% reported the ability to access clinical results electronically [10]. One important discrepancy between our interviews with Dutch experts and the CMWF survey was that our experts believed that GPs write most of their prescriptions by hand but the CMWF survey reported that 85% of physicians write prescriptions electronically [10]. The use of IT systems among specialists is very low but not quantified in any survey data.

Finally, EHR use among GPs in Australia and New Zealand is very high. McInnes and colleagues found that 98% of GPs in Australia prescribe electronically (typically printing out the prescription and handing it to the patient), and that nearly 90% of these systems have some level of decision support [18]. Sixty-four percent of GPs exclusively wrote clinical progress notes electronically, while another 14% did so at least part of the time. The CMWF survey found that 79% of Australian GPs reported using EHRs and 81% reported electronic prescribing [10].

In New Zealand, nearly all GPs (99%) are using a Practice Management System (PMS) for administrative functions, which has many features to support clinical activities [19]. Because of this widely installed PMS, 90% of the GPs write prescriptions electronically, 81% obtain electronic laboratory results, and 72% store full electronic clinical notes. The CMWF survey corroborates these figures, finding that 92% of primary care providers use an EHR and 78% write prescriptions electronically.

3.2. *EHRs in hospitals*

We found almost no high-quality, reliable data on EHR use in acute care settings from any of the seven nations. Our experts confirmed the lack of systematic information about EHR use in this critical sector of the healthcare. To the extent that there were data, EHR adoption rates in the inpatient setting were surprisingly low in all the nations examined.

The recent review found that rates of EHR use in U.S. hospitals were low [9]. Two surveys examining the use of CPOE within hospitals found that, through 2003, the rates of use were likely around 5–15% [20,21]. Beyond CPOE, EHR use in U.S. hospitals is likely to be approximately 10% given several small studies that have found rates in that range, although precise estimates are not available [9]. One notable success story of acute care EHR adoption in the U.S. is the Veterans Health Administration, which has over 160 hospitals and has achieved universal use of EHRs with CPOE and other advanced IT tools (such as bar-coded medication administration).

In the UK, the use of computers in hospitals is uncommon although there are no good data on this topic. Given nearly universal use among GPs, NHS has begun to prioritize hospital IT systems for future efforts. A survey conducted in 2004 estimated 7.7% of hospitals in the UK to have fully electronic clinical results and only 2.6% of hospitals to have electronic prescribing [22]. In contrast to the ambulatory setting, hospital leaders have often viewed HIT as an added cost with little benefit [17], limiting its appeal.

Rates are similarly low elsewhere in Europe. In Germany, our experts suggested that less than 1% of hospitals have electronic clinical notes and less than 0.5% of hospitals use electronic prescribing. While most German lab systems support electronic lab results viewing, paper and fax are the preferred means of communicating results within the hospital. Although there are no reliable estimates, Dutch experts suggested that EHRs and electronic prescribing are rare in their hospitals.

Adoption of electronic health records in Canadian hospitals is also in its infancy. Very few Canadian hospitals use electronic prescribing, in part because they rely on local operating or capital budgets rather than on national funding to support these programs. Similarly, Australia and New Zealand have computerized patient administration systems and many use laboratory results reporting. However, computerized documentation is limited to electronic discharge summaries which are sent directly from hospitals to general practitioners and there is little to no electronic prescribing in the hospital setting.

3.3. *Health information exchange*

Despite widespread interest, clinical data exchanged across providers remains low in each country. In some countries, HIE has begun in earnest with substantial resources dedicated to further expansion, though other nations are still in the planning stages.

In the U.S., much of the focus on sharing of data between providers has been organized around Regional Health Information Organizations (RHIOs). These entities have already been started in many regions [23]. RHIOs are generally nonprofit regional organizations whose primary aims are to convene provider organizations with the hope of initiating health data exchange. Preliminary reports suggest that only a small number (fewer than a dozen) have begun to exchange clinical data [24]. Furthermore, the financial sustainability of RHIOs, a critical factor in their long-term success, remains unknown.

The Canadian approach has focused on Infoway, a national effort to provide vision and strategy to increase the national adoption of EHRs. On the HIE front, Infoway promotes the interchange of a wide array of clinical data, including laboratory, pharmacy, and hospital information. One of Infoway's primary goals is to implement an interoperable EHR for 50% of Canadians by 2010. Because Infoway envisages an eventual pan-Canadian interoperable EHR, it is currently developing privacy and security standards [24]. Provinces such as Alberta and Newfoundland are in the process of implementing province-wide programs to allow data sharing across hospitals, clinical laboratories, and physicians' offices [25]. However, poor underlying levels of EHR use in the primary care and hospital settings have hindered widespread HIE.

HIE has received substantial attention from national policy makers in Europe. The National Programme for IT (NPfIT) in the UK has prioritized sharing of clinical data across providers and the automatic transmission of electronic prescriptions to pharmacies. To this end, the National Health Service has allocated £12.4 billion to NPfIT to build an integrated national EHR system, which will also be used by pharmacies and laboratories. Approximately 5% of prescriptions are being transmitted electronically to pharmacies. A current pilot project is the Primary Care Summary Record program, which pulls key pieces of data from the EHR and transmits a summary to the National Spine for authorized professionals to access. As of fall 2007, approximately 14% of primary care practices were able to create and transmit this summary record. Furthermore, the GP2GP program, whose goal is to ensure the transmission of the full EHR between GPs, is in early stages of testing.

While there is currently no provider-to-provider exchange of clinical information in the Netherlands, it is a central goal of the Dutch government to obtain such interoperability. The primary focus is the SwitchPoint, a program intended to help providers communicate medication lists and clinical summaries to other providers. The SwitchPoint project is still in a nascent stage, with final tests having recently been completed. The pilot phase, which began in late fall 2006, will be rolled out to regions that cover 1–2 million patients.

We found no single approach to HIE in Germany. While major healthcare software companies have attempted to create an infrastructure for physicians to exchange clinical data, these efforts have had minimal success. Due to security concerns, many physicians prefer to store patient records on computers that are not connected to the Internet. Despite this obstacle to HIE adoption, there are currently two pilot projects focused on providing health information exchange capabilities for providers. The first, called "D2D" (www.d2d.de) is a secure communication standard to exchange billing information and patient data. About 2300 (less than 2%) of German physicians in private practice are participating in the D2D pilot program, which conducts approximately 70,000 data transactions per month. The second program, "Vita X," offers EHRs and supports provider-to-provider exchange. While Vita X is also in its infancy, its use is expected to become more widespread, as it is provided by the same vendor that supplies EHR systems to 50% of the German private practices.

The most promising approach to HIE in Germany is the electronic health insurance card. Although the card currently holds administrative data only, the next generation of technology will allow access to electronically stored patient medical information. It will initially include only emergency data set and medication history but all key elements of a patient's EHR should be available. The voluntary program will also support electronic transmission of prescriptions to a pharmacy.

There has been some implementation of HIE in both Australia and New Zealand with more likely to come. In Australia, the National E-Health Transition Authority (www.nehta.gov.au) has undertaken substantial planning for HIE implementation. In addition, a New South Wales pilot project is encouraging hospitals and community providers to exchange clinical data for some 50,000 patients. Current HIE in both Australia and New Zealand allows GPs with EHRs to automatically download pathology reports and imaging reports from a variety of public and private diagnostic sectors. In addition, both countries also have national immunization registries (and Australia has a cervical smear registry, as well), which can be fed and accessed electronically. Finally, in both nations, hospitals are increasingly sending discharge summaries electronically to GPs, who in turn are sending referrals and other communications to hospitals and specialists electronically. Some experts suggest that the lack of a single national identifier code has hindered HIE in Australia to a substantial degree. New Zealand, by contrast, which does have a single consumer health identifier, may have an easier time creating a national HIE program.

4. Discussion

We examined the state of electronic health record adoption and health information exchange in seven industrialized nations and found both similarities and striking differences among them. While the adoption and use of EHR systems in the hospital setting was in its early stages in every nation, most nations were far ahead of the United States in adoption of EHR in the ambulatory care setting. While fewer than 1 in 4 ambulatory care physicians in the U.S. use an EHR and fewer than 1 in 10 such physicians prescribe electronically, nearly all general practitioners in the UK, Netherlands, Australia and New Zealand do both. Germany lags behind these four nations, though it is ahead of the U.S., while Canada's ambulatory EHR adoption is comparable to that of the U.S. Finally, while active health information exchange is in its early stages across all nations, several European countries have already made great strides in setting up the infrastructure necessary to effectively share clinical data, and Australia has also conducted substantial planning.

There are several reasons for the variation in EHR use among ambulatory care physicians. For instance, high rates of adoption among UK physicians comes from a complex set of factors including a long history of computerization, driven partly by free or inexpensive hardware and software. The NHS 2003 contract with GPs, which put in place large financial incentives for meeting quality standards, has spurred the use of more sophisticated EHR systems with decision support. The Netherlands and Germany have not employed this level of direct governmental financial investment, but they both benefit from the existence of relatively few vendors (for example, there are 8 in the Netherlands), national requirements for electronic billing, high availability of computer systems and software, and therefore high levels of EHR use among ambulatory physicians. Adoption in New Zealand was driven by a combination of factors in which the government played an important but indirect role: requirement of GPs to submit claims and capture other data electronically [26]. By contrast, Canadian and American physicians, who receive no large-scale external funding, and reap few incentives for quality improvement or other requirements necessitating the use of computers in clinical practice, have thus lagged behind substantially. In a few U.S. markets, pay-for-performance is becoming increasingly important, but these are the exception and the level of reimbursement is modest [27].

It may be surprising that hospitals across the seven nations have been slow to adopt EHRs. Hospitals generally have greater resources than individual practitioners and much of the data about clinical benefits of EHRs have been demonstrated in the hospital setting. There are two related explanations for the slow EHR adoption in hospitals. First, in the nations we evaluated, policy makers have paid little attention to hospital EHR adoption. The U.S. is the farthest along in measuring hospital quality [28] but even in the U.S., there are no clear financial incentives for hospitals to significantly improve the care they provide. Second, hospital EHR systems are expensive, often disruptive, and require integration with legacy systems. Therefore, without clear incentives, most hospitals have seen little reason to adopt EHRs. Hospitals could potentially serve as major drivers for EHR adoption and HIE in communities; thus, the lack of progress of inpatient EHR adoption represents a potential target for policymakers.

There are important lessons on HIE worth noting. The UK has had to make sizeable financial investments—most of which have come from the national government. There are substantial challenges to allowing physicians who use different EHR systems to connect to a common platform and communicate with each other. When this has happened successfully, it has been with a restricted number of vendors, as in the Netherlands and UK. Large-scale HIE programs such as the UK's raise substantial privacy concerns and have generated a great deal of resistance despite the potential benefits.

Employing a different approach, Canada's Infoway project is more limited both in scope and in investment; it focuses on several narrowly defined goals [29], such as electronic exchange of prescriptions, which might represent a successful model, though the benefits would obviously be more limited. Finally, the U.S. approach, which the federal government has encouraged rather than led, has been to let regional organizations experiment with local initiatives. Whether this will lead to successful models of HIE that will spread nationally is largely unknown, but there are major concerns about whether these entities can develop sustainable business models [24]. It may be that these exchanges are a public good and, therefore, require ongoing government support.

Our study has several important limitations. While we tried to rely on high-quality survey data whenever possible, we were limited in our estimates of EHR adoption by the lack of data in several of the nations examined. To compensate, we vetted all estimates with a series of experts in each nation. Our comparisons of HIE were also limited by the absence of data in most of

Table 1 – Comparison of rates of electronic medical record use

	Australia	Canada	Germany	Netherlands	New Zealand	United Kingdom	United States
Primary care							
HER (%)	79–90	20–23	42–90	95–98	92–98	89–99	24–28
CPOE (%)	75–81	5–11	59	85[a]	90	>90	9
Hospital care							
HER (%)	<10	<10	<5	<5	<10	8	N/A
CPOE (%)	<1	<1	<5	<5	<1	3	5–10

[a] Rate taken from the Commonwealth Fund report (REF). Experts suggest that this rate is substantially lower though no other data exist.

Table 2 – Major efforts in health information exchange

	Australia	Canada	Germany	Netherlands	New Zealand	United Kingdom	United States
Major policy	National E-Health Transition Authority (NEHTA)	Health Infoway	D2D, Smart Cards	National SwitchPoint	Health Information Strategy	National Programme for IT	RHIOs
State of health information exchange	Early pilot projects but small investment has lead to little actual HIE. Greater focus on Telemedicine. Planning for next steps in HIE underway	Province-wide effort in Alberta. National program developing but <5% of prescription, labs currently exchangeable through Infoway	<2% of physicians engaged in D2D. Most Germans have Smart Cards which currently have only administrative data but next generation will allow access to clinical data stored on a server	Pilot phase involving nearly 20% of population in effect. Full implementation of HIE by end of 2008	Planning stages. HIE mostly focused on exchange of discharge summaries, lab and pathology reports with GPs	Several programs under way. Small fraction of GPs able to create summary records for transmittal. Full record exchange still in infancy	Less than 12 organizations exchanging any data. Total patient population involved ≪1% of U.S.

Summary points

Already known on the topic

- Health information technology (HIT) can improve quality and reduce cost.
- Cross-national health information comparisons are not currently available.

Insights gained

- Most countries are in the beginning stages of implementing HIT.
- Examining different countries' HIT approaches can provide valuable insight.
- Some countries are achieving success with HIT in the ambulatory sector, but have yet to perform favorably in the hospital sector.
- Health information exchange between countries will prove very useful to continued progress for all countries.

the nations examined. While projected dates for completion of certain HIE milestones were based on expert opinion, they will change over time. An additional limitation is that we examined only a select sample of countries. Other nations such as Denmark [30] and Japan [31] have also made great strides in EHR adoption and use. Our choice of nations was not meant to suggest that these are the countries that are furthest along but ones that serve as important models for comparison. There are other important technologies that will likely have comparable benefits, like personal health records [32], which we were not able to examine. Finally, EHR use and HIE are rapidly changing and therefore, although our estimates are current, they are likely to change quickly.

We examined the use of EHRs in the ambulatory and hospital settings, as well as health information exchange, in seven high-income industrialized nations. We found near-universal use of EHRs among practitioners in the ambulatory setting in 4 nations with the U.S. and Canada notably lagging behind. We found little data on the hospital sector but the best evidence suggests that there is little inpatient EHR use in any of these countries. While there is tremendous interest in HIE in each nation, the level of investment, planning and effort devoted to HIE is variable. The major lesson for each nation, but particularly for the U.S., is that there are several key levers that have been especially successful at increasing EHR adoption: direct financial support (either through loans or grants), quality-of-care incentives, and requiring that computers be used for key administrative tasks. Another important lesson is that without a considerable, concerted effort, which will likely include re-aligning financial incentives, EHR adoption in hospitals will lag behind. Finally, it is likely that only nations willing to invest significant financial resources and undertake the difficult work of creating standards and interchanges will reap the benefits of HIE for their citizens in the near future (Tables 1 and 2).

Acknowledgement

The project was funded by the Commonwealth Fund, New York, NY

REFERENCES

[1] J.M. Corrigan, M.S. Donaldson, L.T. Kohn (Eds.), Crossing the Quality Chasm: A New Health System for the 21st Century, National Academy Press, Washington, DC, 2001.
[2] E.A. McGlynn, S.M. Asch, J. Adams, et al., The quality of health care delivered to adults in the United States, N. Engl. J. Med. 348 (26) (2003) 2635–2645.
[3] C. Schoen, R. Osborn, P.T. Huynh, et al., Primary care and Health Aff. (Millwood) Suppl Web Exclusives (July-Dec 2004) w4-487-503.
[4] B. Chaudhry, J. Wang, S. Wu, et al., Systematic review: impact of health information technology on quality, efficiency, and costs of medical care, Ann. Intern. Med. 144 (10) (2006) 742–752.
[5] S.J. Wang, B. Middleton, L.A. Prosser, et al., A cost-benefit analysis of electronic medical records in primary care, Am. J. Med. 114 (5) (2003) 397–403.
[6] J. Walker, E. Pan, D. Johnston, J. Adler-Milstein, D.W. Bates, B. Middleton, The value of health care information exchange and interoperability, Health Aff. (Millwood) (2005), Suppl Web Exclusives: W5-10-W5-8.
[7] R. Hillestad, J. Bigelow, A. Bower, et al., Can electronic medical record systems transform health care? Potential health benefits, savings, and costs, Health Aff. (Millwood) 24 (5) (2005) 1103–1117.
[8] J.G. Anderson, Social, ethical and legal barriers to e-health, Int. J. Med. Inform. 76 (5–6) (2007) 480–483.
[9] A.K. Jha, T.G. Ferris, K. Donelan, et al., How common are electronic health records in the United States? A summary of the evidence, Health Aff. (Millwood) 25 (6) (2006) w496–w507.
[10] C. Schoen, R. Osborn, P.T. Huynh, M. Doty, J. Peugh, K. Zapert, On the front lines of care: primary care doctors' office systems, experiences, and views in seven countries, Health Aff. (Millwood) 25 (6) (2006) w555–w571.
[11] D. Blumenthal, C. DesRoches, K. Donelan, Health information technology in the United States: the information base for progress, Robert Wood Johnson Foundation, 2006 (May 24, 2007).
[12] A.M. Audet, M.M. Doty, J. Peugh, J. Shamasdin, K. Zapert, S. Schoenbaum, Information technologies: when will they make it into physicians' black bags? MedGenMed 6 (4) (2004) 2.
[13] D. Gans, J. Kralewski, T. Hammons, B. Dowd, Medical groups' adoption of electronic health records and information systems, Health Aff. (Millwood) 24 (5) (2005) 1323–1333.
[14] C.W. Burt, E. Hing, D.A. Woodwell, Electronic Medical Record Use by Office-based Physicians: United States 2005, National Center for Health Statistics, Hyattsville, MD, 2006.
[15] Reported IT use in the National Physician Survey, 2005 (accessed at http://www.cma.ca/Multimedia/CMA/Content_Images/Inside_cma/WhatWePublish/LeadershipSeries/English/howdoing.pdf).
[16] Information management and technology in general practice, 2005 (accessed May 20, 2007, at http://www.rcgp.org.uk/information/publications/information/PDFInfo/07_Feb05.pdf).
[17] T. Benson, Why general practitioners use computers and hospital doctors do not. Part 2. Scalability. BMJ 325 (7372) (2002) 1090–1093 (Clinical research ed).
[18] D.K. McInnes, D.C. Saltman, M.R. Kidd, General practitioners' use of computers for prescribing and electronic health records: results from a national survey, Med. J. Aust. 185 (2) (2006) 88–91.
[19] R. Didham, I. Martin, R. Wood, K. Harrison, Information technology systems in general practice medicine in New Zealand, N. Z. Med. J. 117 (1198) (2004) U977.
[20] J.S. Ash, P.N. Gorman, V. Seshadri, W.R. Hersh, Computerized physician order entry in U.S. hospitals: results of a 2002 survey, J. Am. Med. Inform. Assoc. 11 (2) (2004) 95–99.
[21] D.M. Cutler, N.E. Feldman, J.R. Horwitz, U.S. adoption of computerized physician order entry systems, Health Aff. (Millwood) 24 (6) (2005) 1654–1663.
[22] M. Bywater, UK Findings from HINE European Hospital Survey, Harrogate, England, 2005.
[23] J.M. Overhage, L. Evans, J. Marchibroda, Communities' readiness for health information exchange: the National Landscape in 2004, J. Am. Med. Inform. Assoc. 12 (2) (2005) 107–112.
[24] J. Adler-Milstein, A. McAfee, D.W. Bates, A.K. Jha, The State of Regional Health Information Organizations: current activities and sources of funding, Health Aff. (Millwood) 27 (1) (2007) w60–w69.
[25] A. Ausford, N. Campbell, D. Gaudette, J. MacGregor, Implementing an EHR: is it possible to sustain the momentum? in: E Health 2005 Conference, Toronto, Canada, 2005.
[26] R. Didham, I. Martin, R. Wood, K. Harrison, Information technology systems in general practice medicine in New Zealand N. Z. Med. J. 117 (1198) (2004).
[27] M.B. Rosenthal, R.G. Frank, Z. Li, A.M. Epstein, Early experience with pay-for-performance: from concept to practice, JAMA 294 (14) (2005) 1788–1793.
[28] A.K. Jha, Z. Li, E.J. Orav, A.M. Epstein, Care in U.S. hospitals—the Hospital Quality Alliance program, N. Engl. J. Med. 353 (3) (2005) 265–274.
[29] R.E. Scott, P. Jennett, M. Yeo, Access and authorisation in a Glocal e-Health Policy context, Int. J. Med. Inform. 73 (3) (2004) 259–266.
[30] C. Nohr, S.K. Andersen, S. Vingtoft, K. Bernstein, M. Bruun-Rasmussen, Development, implementation and diffusion of EHR systems in Denmark, Int. J. Med. Inform. 74 (2–4) (2005) 229–234.
[31] H. Yoshihara, Development of the electronic health record in Japan, Int. J. Med. Inform. 49 (1) (1998) 53–58.
[32] I. Iakovidis, Towards personal health record: current situation, obstacles and trends in implementation of electronic healthcare record in Europe, Int. J. Med. Inform. 52 (1–3) (1998) 105–115.