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Adopting electronic medical records in primary care: Lessons learned from health information systems implementation experience in seven countries

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ABSTRACT

The adoption of health information systems is seen world wide as one method to mitigate the widening health care demand and supply gap. The purpose of this review was to identify the current state of knowledge about health information systems adoption in primary care. The goal was to understand factors and influencers affecting implementation outcomes from previous health information systems implementations experiences. A comprehensive systematic literature review of peer reviewed and grey literature was undertaken to identify the current state of knowledge regarding the implementation of health information systems. A total of 6 databases, 27 journal websites, 20 websites from grey sources, 9 websites from medical colleges and professional associations as well as 22 government/commission websites were searched. The searches returned almost 3700 article titles. Eighty-six articles met our inclusion and exclusion criteria.

Articles show that systems' graphical user interface design quality, feature functionality, project management, procurement and users' previous experience affect implementation outcomes. Implementers had concerns about factors such as privacy, patient safety, provider/patient relations, staff anxiety, time factors, quality of care, finances, efficiency, and liability. The review showed that implementers can insulate the project from such concerns by establishing strong leadership, using project management techniques, establishing standards and training their staff to ensure such risks do not compromise implementation success. The review revealed the concept of socio-technical factors, or "fit" factors, that complicate health information systems deployment. The socio-technical perspective considers how the technical features of a health information system interact with the social features of a health care work environment.

The review showed that quality of care, patient safety and provider/patient relations were not, positively or negatively, affected by systems implementation. The fact that no articles were found reviewing the benefits or drawbacks of health information systems accruing to patients should be concern to adopters, payers and jurisdictions. No studies were found that compared how provider–patient interactions in interviews are effected when providers used electronic health information systems as opposed to the paper equivalent. Very little information was available about privacy and liability.

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1. Introduction

1.1. Background

In many countries, the health care sector is entering into a time of unprecedented change [1]. Never before have there been such strong demographic trends between health care demand and supply. Canada is no exception. By 2041, 22% of the Canadian population is expected to be aged 65 or over, up from 13% in 2001 [2]. The number of aged is growing and their care needs will progressively become more intense. But soaring health care demand is not just driven by age. Many drivers exist, including obesity which is on the rise in both children and adults [3]. Obesity brings its own health complications which are managed in primary care. These examples stem from chronic disease management in primary care, but are only indicators of similar trends in demand found in other forms of disease management.

Just as there are a large number of patients in the baby-boom generation, there are also a proportionately large number of physicians. These physicians are also increasingly heading towards retirement. In 2004, 30% of physicians working in Canada were 55 years of age or older, and 61% were 45 years of age or older [4]. Declines in the physician work force were evident early in the millennium when provinces saw an average 3.1% drop in physician resources [5]. Canada's health workforce is retiring earlier and the average age of the remaining working population is increasing (from 39.1 years in 1994 to 40.8 in 2000) [6].

The gap between health human resource supply and demand for care will not be temporary. Not only is the baby-boom generation of primary care physicians retiring alongside their patients, but a shortfall in replacements is expected in the next decades. A shortfall in medical school enrolments is expected because of increased training requirements, higher average tuition fees [7], and increasing certification requirements due to more health professions being regulated (now over 30 professions) [6]. Of those entering into medical schools, fewer are choosing primary care as their area of speciality. Even though there are many sub-specialties within family practice, family practice students have only occupied half of the available spaces, whereas in other areas of medicine, the number of students wanting to enrol is double the available space [6]. Primary care physicians are remunerated less [8] and are faced with developing and sustaining a business to make a living, which they are not trained to do. Comparatively, specialists are paid a salary by the jurisdiction or health region to show up for work in a ready-made job context [9]. Geriatric primary care physicians are expected to be even fewer because of the extraordinary professional challenge that caring for the elderly, often with complex needs, represents. Finally, there is also a shift in the demographics of care providers. More women than men have been choosing health care as their profession. In 1999, 76% of health care students in Canada were female, and these graduates have now become today's providers. Female carers are more likely to take time off for family and are less likely to work overtime; many work part-time [6].

The adoption of health information systems is seen world wide as one method to mitigate the widening health care demand and supply gap [10,11]. The adoption rates of electronic medical records are on the rise [12]. Even though popular opinion holds that the application of health informatics improves patient safety [11,13], improves physician office efficiency [11,13], and mitigates shortages in health human resources [13], such systems can compromise short-term physician office performance [14–16], intimidate physicians and their office staff [9] and have been shown, on occasion, to increase medical errors [17,18]. Previous analyses [19] have shown that the implementation process is as important as the system itself. With particular shortages of clinicians expected in primary care in the future, it becomes imperative to understand the barriers to implementation success, so that adopters can be more successful.

1.2. Objectives

The objective of this research was to undertake a systematic review of the literature from several countries to identify the current state of knowledge about health information systems adoption. The goal was to understand factors and influencers from previous experiences of health information systems implementations and to respond to the question: "What lessons can adopters of Electronic Medical Records in general practice learn from previous implementation experiences?" A structured literature review of peer reviewed and grey literature published during the period 2000 to the end of 2007 from Canada, the United States, Denmark, Sweden, Australia, New Zealand and the United Kingdom was conducted from November 2007 to January 2008 to identify the current state of knowledge regarding implementations of health information systems. These countries were selected based on their reputations as leaders in health care reform and adoption of health information systems.

The term "general practice" was considered to refer to the same care setting as the term "primary care". Primary care is defined as the first point of contact a person has with the health system and usually refers to family practice. This is the point where people receive care for most of their everyday health needs [20]. While our objective was to extract lessons learned for adopters in primary care, we examined implementation experience from other care domains to see if experienced would vary by care domain. We defined ambulatory care as any form of care delivered on an outpatient basis, including care delivered from physician offices, emergency departments and urgent care centres. We considered acute care as care delivered for severe illness, often, but not exclusively, from hospital settings. We considered community care to be primary care provided in non-hospital settings. Secondary care, tertiary care and specialty care were considered to be similar concepts where care was provided to patients who were referred from primary care.

An *Electronic Medical Record* (EMR) is a computerized health information system where providers record detailed encounter information such as patient demographics, encounter summaries, medical history, allergies, intolerances, and lab test histories. Some may support order entry, results management and decision support [21]. Some may

also contain features or be integrated with software that can schedule appointments, perform billing tasks, and generate reports [22]. Providers use this system to record encounter, medical or physician-specific information [23]. Such systems are configured to reflect the needs of individual physicians or groups of physicians who are directly caring for a patient in their practice. An EMR is a provider oriented health information system. Such systems are sometimes referred to as *physician office systems* or *practice management systems* [21,24].

It is appropriate to clarify the difference between EMRs and *Electronic Health Records* (EHRs), at least for the purposes of this review. While in some jurisdictions, the concept of an EHR refers to those described above for EMRs [13,25], for purposes of this review, an EHR is a patient-oriented, aggregated, longitudinal [26] system of systems which assembles health information about a patient over a wide area network from, potentially, many geographically dispersed data sources. An EHR provides each individual with a aggregate, secure and private lifetime record of their key health history and care within the health system and shares encounter information available electronically with authorized health care providers and the individual anywhere, anytime in support of high quality care [27]. It may draw on health information from sources such as EMRs, drug repositories, centralized lab data sources and other point-of-service applications over many encounters to assemble a complete health record about the patient [27,28]. It is a patient centric document that may contain information from a broad range of providers other than family physicians, such as specialists, social workers, pharmacists, radiologists, dietitians, physiotherapists, and nurses.

2. Methodology

Peer reviewed articles were searched using search strings on CINAHL, MEDLINE, PUBMED, EMBASE, The Cochrane Library, and IEEE Xplore. The search was conducted in both MEDLINE and PUBMED because PUBMED contains citations before they are indexed with MeSH and added to MEDLINE [29]. Health informatics and general practice journals were searched for articles not yet indexed in the databases. Databases were subsequently searched by author to find any other articles that were not found through the database searches but which were still appropriate for the review. Then, using an ancestry approach, the references of articles were scanned to mine for further relevant articles. Many conference, news, government, government commission, health professional and special interest group websites provided relevant, non-peer reviewed information from practical experience. The last step was a general Internet search using the Google engine.

3. Results

A total of 6 databases, 27 journal websites, 20 websites from grey sources, 9 websites from medical colleges and professional associations as well as 22 government/commissions websites were searched. The searches returned almost 3700 article titles. Applying inclusion and exclusion criteria systematically produced 466 articles whose abstracts were to be reviewed. Screening the articles by abstract reduced the data store to 242 articles to be read. After reading the articles, 86 unique articles met our inclusion and exclusion criteria. In addition to the databases listed above, Table 1 shows the journals, government, commission, college/association and grey sources that were searched.

When critically appraising the articles, they were categorized from several perspectives to gain insight into the review. Of the 86 articles reviewed, 20 pertained to computerized physician order entry (CPOE) systems, 21 pertained to electronic medical records, 12 pertained to electronic health records and another 27 pertained to clinical decision support systems, picture archiving and communication systems, nursing information systems and personal health records. Five articles did not pertain to any specific system.

Articles were also categorized by the type of care setting for their implementation. Articles generally referred to implementations in hospital settings [35], general practice/primary care [34] or no specific or documented setting [17]. Although articles were found to come from a wide range of care settings, such as primary care, ambulatory care, long-term care, acute care, emergency care and community care, we did not find articles which identified unique implementation experience attributable to any one area of care. Many of the same lessons were extracted from widely differing care settings. Articles were reviewed for the major factors and issues they advocated as supporting or confounding their health information systems implementation. The majority of articles [31] pertained to various socio-technical factors which complicated the implementations. Fifteen articles related to project management and financial factors and the remaining articles related to patient safety, data privacy, quality of care, liability, efficiency, training, standardization of clinical terms and other topics.

4. Discussion

This literature review was a comprehensive systematic search of several sources to understand factors which affect implementations of health information systems in general practice. Fig. 1 illustrates several factors which affect the goal of implementation success. Fig. 1 shows the "fit factor" or "socio-technical factor" directly adjacent to the project goal as the review found it can directly influence implementation success. Implementers also had concerns over privacy, patient safety, provider/patient relations, staff anxiety, time needed to implement, quality of care, financial, efficiency, and liability. Articles reported that these risks can be managed through sound project management, strong leadership, implementation of standardized terminologies and staff training. Fig. 1 illustrates this by showing these four insulating factors inserted between risk factors and the project goal.

The socio-technical perspective considers how the technical features of a health information system interact with the social features of a health care work environment [30,31]. These concepts contend that there is a relationship [30,32,33] between the tools that facilitate the health care processes and the interpersonal interactions needed to carry out the day-to-day clinical tasks of a care facility [31]. New implementations

Table 1 – Sources

Journal websites	Government/commissions websites	Grey sources	Colleges and Professional Associations
Family Practice Management	Certification Commission for Healthcare Information Technology	Edmonton Journal	American Academy of family Practitioners
American Family Physician	Physician Office System Program Alberta	Calgary Herald	Centre for Health Information Technology
Archives of Family Medicine	British Columbia e-MS	Government Health IT	College of Family Physicians of Canada
Annals of Family Medicine	Physician Information Technology Office, British Columbia	Healthcare Informatics	McMaster University COMPETE Program
Family Medicine	General Practice Computing Group, Australia	Canadian Healthcare Technology	Canadian College of Health Service Executives
Journal of the American Medical Association	Health Canada	Healthcare IT News	Royal Australian College of General Practitioners
Journal of the American Medical Informatics Association	Denmark, Medcom	Canadian EMR	Danish College of General Practitioners
Health Informatics Journal	ONCHIT, US Department of Health and Human Services	The New Generalist	Royal New Zealand College of General Practitioners
Computers in Nursing	National Institutes of Health	Health Informatics New Zealand	Royal College of General Practitioners
Medical Informatics and the Internet in Medicine	Canada Health Infoway	Health Care and Informatics Review Online	Health Research Council of New Zealand
International Journal of Medical Informatics	British Columbia Medical Journal	Health Informatics Society of Australia	
The Internet Journal of Medical Informatics	Medical Journal of Australia (MJA)	Healthelink, Australia	
Health Affairs	Canadian Medical Association Journal (CMAJ)	Swedish Federation of Medical Informatics	
Hospital Topics	EMR Toolkit	British Computer Society's Primary Health Care Specialist Group	
Archives of Internal Medicine	The Swedish Council on Technology Assessment in Health Care	Health Informatics Europe	
Critical Care Medicine	New Zealand Health Information Service	Virtual Centre for Health Informatics, Denmark	
Critical Care Nursing Quarterly	The National Board of Health and Welfare	OpenClinical	
BMC Medical Informatics and Decision Making	UK Health Informatics Society	ePractice.eu	
American Journal of Medicine	NSW Dept of Health	Good-eHealth	
Archives of Ophthalmology	Australia Department of Health	eHealth Impact	
American College of Physicians Pediatrics			
Wisconsin Medical Journal			
Australian Family Physician			
New Zealand Family Physician			
British Journal of General Practice			
Informatics in Primary Care			
Electronic Healthcare			

challenge organizations to build a collective understanding of their processes so that they understand how a new system will fit in [14,34–36]. Such efforts often uncover process inefficiencies [32,33,37–40]. Health information system implementations become an opportunity to overhaul such processes. Some authors have proposed using socio-technical requirements gathering techniques over traditional methods because traditional methods only define technological needs [31,41]. Socio-technical requirements gathering considers how the technical requirements of the system need to fit into the operational, organizational and cultural processes used to provide care.

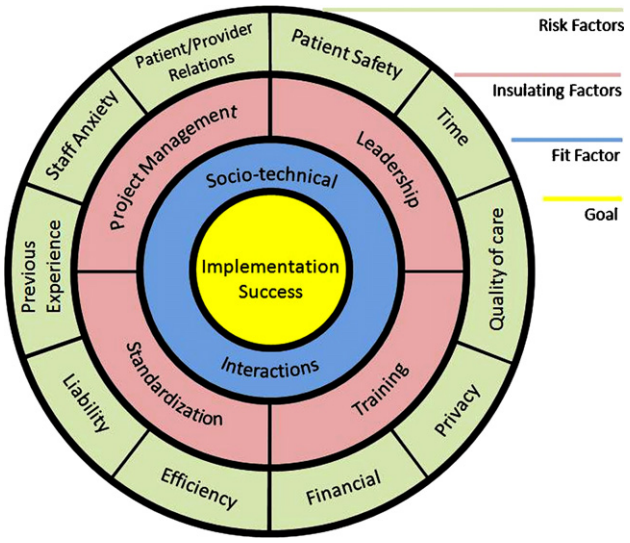

Fig. 1 – Insulating and risk factors.

Successful implementations are supported by executives [16,40–51]. Studies found that assigning a physician to champion a project also led to success [39,40,45,49,52–56]. While the studies advocated physician leadership, a team approach is critical during design, development and implementation phases [11,16,39,40,50,54–61]. Most often the staff, not the physician, has the best knowledge of existing and optimized processes. Different members of the workforce bring different perspectives and skills to the implementation [39,62]. Adopting an interdisciplinary approach can bring the richness of all those varying perspectives to bear on the project.

Despite strong leadership, some narrative reviews reported that new implementations sometimes became a source of anxiety and aggravation to staff. Staff anxiety was stimulated by changes to long established processes, increased dependence on computer systems [63,64], eroded capacity for decision making [32], perceived increases in levels of accountability to clinicians doing order entry [65] and concerns that new health information systems would affect the provider–patient relationship [37,66,67]. Articles reported resistance to change by staff, especially when change was thrust upon them. Various predictable and unpredictable positive and negative behaviours were reported as a result [30,66]. Articles recommended proactively addressing staff concerns and including staff in projects as a means to manage resistance [39,48,49,54,55,58,60,61,68].

The literature reports that implementation failure can be minimized by using project management processes [35,38,39,43,49,68–71] because they control the procurement, schedule, tasks, resources, and quality of the project. Articles documented two general ways to deploy health information systems—"the big bang" approach or an incremental approach [69]. A "big bang" approach installs the system quickly and requires users to use the system immediately. In an incremental approach, features are made available to users according to a plan. Users are exposed to the system progressively often making data entries in a previous system and the new system during a transition period. An incremental project approach was recommended for large organizations with complex processes, with complex organizational cultures or powerful political structures [53,69,72] because it permits time to adapt to the change. When discussing system procurement, most articles focused on procurement strategies for large organizations. Many articles advised physician champions to ask vendors for product customizations to maximize system fit with organization processes [38,73]. Small physician offices would not possess the buying power to command such attention from vendors.

Users' previous experiences with health information technology affected their experience with a new system, both positively and negatively [74]. Previous experience seemed to define what was considered to be intuitive system features. The more intuitive the system or the more familiar it seemed to the user, the more likely it was to be used [42,59]. Since each system is unique, training is usually required [11]. The intensity of training, the timing of the training and the availability of training and support post-implementation all affected user experience [46,59,62,68,75,76]. Access to experts on call (or "at the elbow" [40]) and post-implementation training were found to improve clinicians' experiences with the system in the first period after implementation [16].

Studies reported that health information technology could affect the provider–patient dynamic. When designing the layout of an exam room, the computer monitor placement was shown to affect the interaction between provider and patient [77]. Analysis showed that during an interview, when providers turned away from patients to enter clinical data into the system, a natural conversation breakpoint occurred. Interestingly, the study suggested that this breakpoint allowed the patient time to think about the interview and add detail to it enhancing the transfer of information between patient and provider [37,77]. The study observed physicians showing patients their patient record to reinforce physician comments [77]. Physicians who stopped talking when entering data used more gestures to communicate with patients, than those physicians who continued to talk while entering data [77]. Patients did not show any signs of boredom or frustration while physicians attended to the EMR [77]. One study acknowledged that systems occupy space within the exam room and advised implementers to provide appropriate physical space for systems [67]. No studies were found that compared how provider–patient interactions in interviews were effected when providers used electronic health information systems as opposed to the paper equivalent.

Several articles reported that quality of care was not adversely nor positively affected with a health information system implementation [78–82]. However, one author argued that health information systems, like other interventions, should be regulated and certified [83]. Like other forms of medical interventions (as an example, drugs), health information systems should be certified so erroneous system design or implementation do not lead to adverse medical events. He also advocated that health information system users should be certified to mitigate chances for adverse events due to incorrect usage.

Some articles studied various dimensions of time as it pertains to implementations. Studies advocated that it takes time

to implement a system and it takes time to learn how to use it [11,14–16]. Consequently, studies observed a decline in patient throughput immediately after implementation [14,15,54,59]. Although initially, clinicians believed it would take them more time to complete clinical activities after implementation, time and motion analyses found that there was a slight decrease [84–86] in the time taken for common clinical documentation activities once the team was proficient with the system. Aggregately, health information systems did not offer time savings, nor required more time for documentation. In one case where a time saving was encountered, that saving was put back into the encounter time for more patient care tasks [86]. The literature search did not find articles focusing on how long it takes to stabilize workflow processes after an implementation.

Expectedly, another common theme found in the search was that pertaining to financial concerns. Costs cited as deterrents to health information systems adoption were system costs, training, and lost opportunity cost due to ramp up or system down time [87,88]. Narrative reviews commented that, left to their own resources, physicians would often not adopt health information systems [87,89,90] simply because they do not see the return on investment value in them [91]. One study did show a positive return on investment for a family practice that was organizationally connected to a hospital [92]. Physician advocates seemed to be aggravated by benefits of systems adoption accruing largely to payers as opposed to physicians. Since payers received the benefits, physician advocates suggested that some of the costs should be supported by payers [88,93]. Articles concluded that funding is required to drive adoption [53,87,88,90–92]. Proposals from narrative review papers suggest cost sharing or financial sponsorship from government entities is required to support the high cost of adoption [90,93,94]. Our review showed that adoption is influenced by financial factors to varying degrees in different jurisdictions. A more detailed investigation of financial reimbursement models for adoption and their implications to physician remuneration models is required and is the subject of our next research.

Proponents of health information systems suggest that adoption leads unconditionally to a reduction in adverse medical events. One study [17], which has also been critically reviewed [95], showed adverse medical events were increased after health systems implementation. Koppel et al. [18] reported 22 potential causes for medical errors. Despite these, most studies relating to safety found that health information systems themselves were not the source of adverse medical events, but rather the processes around the systems facilitated the errors. Analysis showed that error sources resolved down to training issues, implementation issues, and the time needed to become accustomed to the system [26,41,73,96,97]. Studies did provide advice on how to mitigate errors; solid training, bar-coding systems, pilots and strong IT management were tools purported to minimize errors [98]. Authors advocated that quality of care and implementation success could be improved and errors minimized by establishing standardized terminology and lab test results ranges [11,50,75,99].

Two popular areas of discussion proved not to be significant themes in the review. A small number of articles expressed concern over privacy implications of electronic health records systems, however, no study assessed and compared experiences of privacy breach when using computer systems versus paper systems. Articles quoting this concern did not offer tangible action to address them [100,101]. A few narrative reviews were concerned with the topic of liability [11,82,101] although given the litigious nature of the US, it was surprising that more reviews did not discuss liability. These reviews simply asserted that liability could be mitigated with the adoption of health information systems, but did not support their assertion with a study [11,82].

The model shown in Fig. 1 summarizes the factors outlined above. In any implementation, physician leaders strive for implementation success. Socio-technical interactions directly influence success. Implementers need to be aware of system fit to achieve success. However, implementers perceive privacy, patient safety, provider/patient relations, staff anxiety, time needed to implement, quality of care, financial, efficiency, and liability as risks that can pressure and derail a project. Implementers can insulate the project from such risks by establishing strong leadership, using project management techniques, establishing standards and training their staff to ensure such risks do not compromise implementation success.

Despite many topics being discussed, there are gaps in the articles. No articles were found reviewing the benefits or drawbacks of health information systems, specifically PHRs and EMRs, which accrue to patients. No articles were found which reviewed patient readiness to use such tools or their readiness in taking an active role in their care that using such tools would imply. One article advocated patient-centred models of care delivery [50] but we were left wondering what informatics lessons could be provided from that perspective. Even though there was equal focus placed on implementations from several care settings, few studies examined individual or small (less than 3 physicians) practitioner experiences. No studies were found which attempted to understand how health information systems mitigate gaps in health human resource supply and demand or their effectiveness in combined strategies with demand management, supply side management, or team-based approaches to health care reform. The search did not produce articles that reviewed health information system features; therefore none recommended preferential or minimum features that should be considered when purchasing a system. The literature review search did not provide information which documented the jurisdictions' practical experiences of setting up a conformance and certification program. And finally, no studies examined how health information systems could facilitate quality assurance processes using peer-reviewed second opinion as telepathology technology is often used in pathology.

5. Strengths & weaknesses

This literature review has examined the last 8 years of health information systems implementation literature in seven countries. While the study has yielded a number of key factors that are relevant to adopters, governments, pay-

ers and vendors, the study may have missed relevant articles published prior to 2000 or after 2007.

This literature search was carried out by one reviewer (one of the authors), and this may have introduced bias into the search process because only that person's background and experience was applied to the search. No opportunity for discussion, critique or critical assessment of the process or its results amongst a number of reviewers was possible, reducing the methodological quality of the review.

The review was limited to articles written in the English language because this is the native tongue of the authors. Relevant information from articles and websites written in other languages would provide valuable information.

The review made significant use of six databases which are owned and operated from the US. As a result, there are only a small number of publications from other countries known to be leaders in the adoption of health information systems such as New Zealand, Sweden and Denmark. It is possible that influential information unique to these jurisdictions was missed. To address this bias, websites from these jurisdictions were searched. However, the searches were hampered by the simplicity of site search utilities and language. The reviewer often resorted to manual searches to complete the review. The review was limited to countries based on their perceived leadership in adoption. We were left wondering whether lessons learned in more primitive settings could also be applicable. Some fundamental lessons in adoption may have been overlooked.

Analyzing articles based on the care setting narrowed the articles to implementations in either hospitals or general practice. Although the analysis made these assessments rigorously, it is possible that such a narrow result set based on care setting indicates a weakness in the search process or a weakness in the analysis. Given our focus was to find lessons learned to provide to general practitioners regarding their EMR implementations, we are not surprised that we did not find articles which document the benefits of HIT to patients. However, the benefits and implications of HIT to patients is considered an interest of ours and will be the focus of future research.

6. Conclusions

Health system stakeholders cannot expect our health care system's performance to meet the increasing demand placed on it, unless interventions are taken. Populations are aging which increases the intensity and diversity of care demand. But soaring health care demand is not just driven by age. More people are obese than before [3]. Obesity brings many complicating health risks [102] such as cardiovascular diseases, diabetes, arthritis, sleep and breathing disorders, depression, and cancer all of which are first detected in primary care. Moreover, it is not just middle aged adults who are obese, but children too [103], meaning that increased primary health care demand is more permanent than originally thought due to the complicating factors relating to a so-called "epidemic of obesity" [3].

Health information systems are seen to be one solution to the pending problem. Such solutions can assist physicians in tracking patient medical history, interventions, encounters, lab test results as well as managing allergies and drug contraindications. But as shown above, such implementations are not simple technical projects. They come with risks, the apprehension over which can paralyze a health information systems project in its tracks—or even prevent it from starting altogether.

The countries studied are choosing to use health information systems as one of many strategies to alleviate the concern of the above scenario. They will establish policies to drive the adoption of health information systems, or even mandate them, thereby placing physician offices in a position where they are implementing systems even if they are not ready for such change. Health information systems implementations are not as simple as purchasing and installing software. As discussed above, significant cultural and organizational upheaval may result from these projects which could compromise the project. Physicians and their staff may have concerns over efficiency, financial, quality, liability, safety and other factors which must be addressed before they consider investing significant resources in the project. They may be more likely to consider adoption, and their implementations may prove to be more successful, if they know that leadership, project management, training, and standardization of terminology could help improve their chances of success. To quote Protti [50], "the hard stuff is the soft stuff!"

If jurisdictions or payers choose to advocate electronic medical records, they will need to provide support services to physician offices. Physicians will have reservations around the efficiency, financial, quality, liability, and safety implications of EMRs. Governments may need to coach physicians through implementations providing leadership training, project management, and product training services. They may also find that physicians may require financial support to interest them in adoption. Physicians are not likely to be distracted from their patients in a fee for service payment model toward a project that is expected to reduce their throughput, taking away valuable revenue opportunity. As for-profit enterprises, EMR vendors interested in developing a competitive edge for their businesses might do well to ensure their project management, change management and after-sales support services consider these findings. This literature review harvests experiences from previous health information system implementations in a wide array of care settings in seven countries. Physicians, payers, governments, and vendors should take note of the lessons learned from these experiences. Doing so may save time and money and may, in the long run, lead to better implementation outcomes.

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Summary points

What was already known

- Health information systems can mitigate gaps in health care demand and supply.
- Health care demand is expected to climb due to an aging population and growing "epidemic of obesity".
- Adoption of health information systems in primary care is hampered by clinicians concerns that privacy, patient safety, quality of care, and efficiency will decline after implementations.
- Left to their own decisions, physicians do not adopt electronic health information systems due to high costs, risks of liability and data security.

What this study added

- Health information systems do not improve or erode efficiency, quality of care, or patient safety. Health information systems themselves were not the source of adverse events, but rather the processes around the systems facilitated the errors.
- The quality of the implementation process is as important as the quality of the system being implemented.
- Physician leaders can mitigate the above risks with training, bar-coding systems, pilots, standardization of medical terminology and strong IT management.
- Health system usability, computer skills and the system's fit within the organizational culture and processes are significant factors in implementation success.

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